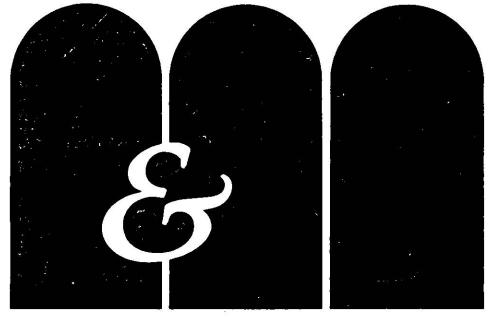

TEXAS A&M UNIVERSITY

1978 - 1979
GRADUATE
CATALOG

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TEXAS A&M UNIVERSITY

GRADUATE CATALOG

RECORD OF 1977-1978 SESSION

ANNOUNCEMENTS FOR 1978-1979 SESSION

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* * *

Robert D. Cherry . . . . . Secretary to the Board of Regents

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THE TEXAS A&M UNIVERSITY SYSTEM

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THE ACADEMIC CALENDAR FOR 1978-79

Summer Session 1978

June 5	Monday. Orientation for new students.
June 6	Tuesday. Registration for the first term.
June 7	Wednesday. Beginning of classes.
June 9	Friday. Last day for enrolling in the University for the first term and for adding new courses.
June 12	Monday. Last day for dropping courses with no record.
June 23	Friday. Last day for dropping courses with no penalty.
July 4	Tuesday. Independence Day Holiday.
July 11	Tuesday. Last day for first term classes. Beginning of final examinations, 7 p.m.
July 12	Wednesday. Last day for the first term final examinations.
July 13	Thursday. Registration for the second term.
July 14	Friday. Beginning of classes. All final grades due, 10 a.m.
July 18	Tuesday. Last day for enrolling in the University for the second term and for adding new courses.
July 19	Wednesday. Last day for dropping courses with no record.
August 4	Friday. Last day for dropping courses with no penalty.
August 15	Tuesday. Grades for graduating students due, 10 a.m.
August 17	Thursday. Last day of second term classes. Beginning of final examinations, 7 p.m.
August 18	Friday. Last day of second term final examinations.
August 19	Saturday. Commencement for First and Second Term graduating students.
August 21	Monday. All final grades due, 10 a.m.

REGULAR SESSION

Fall Semester 1978

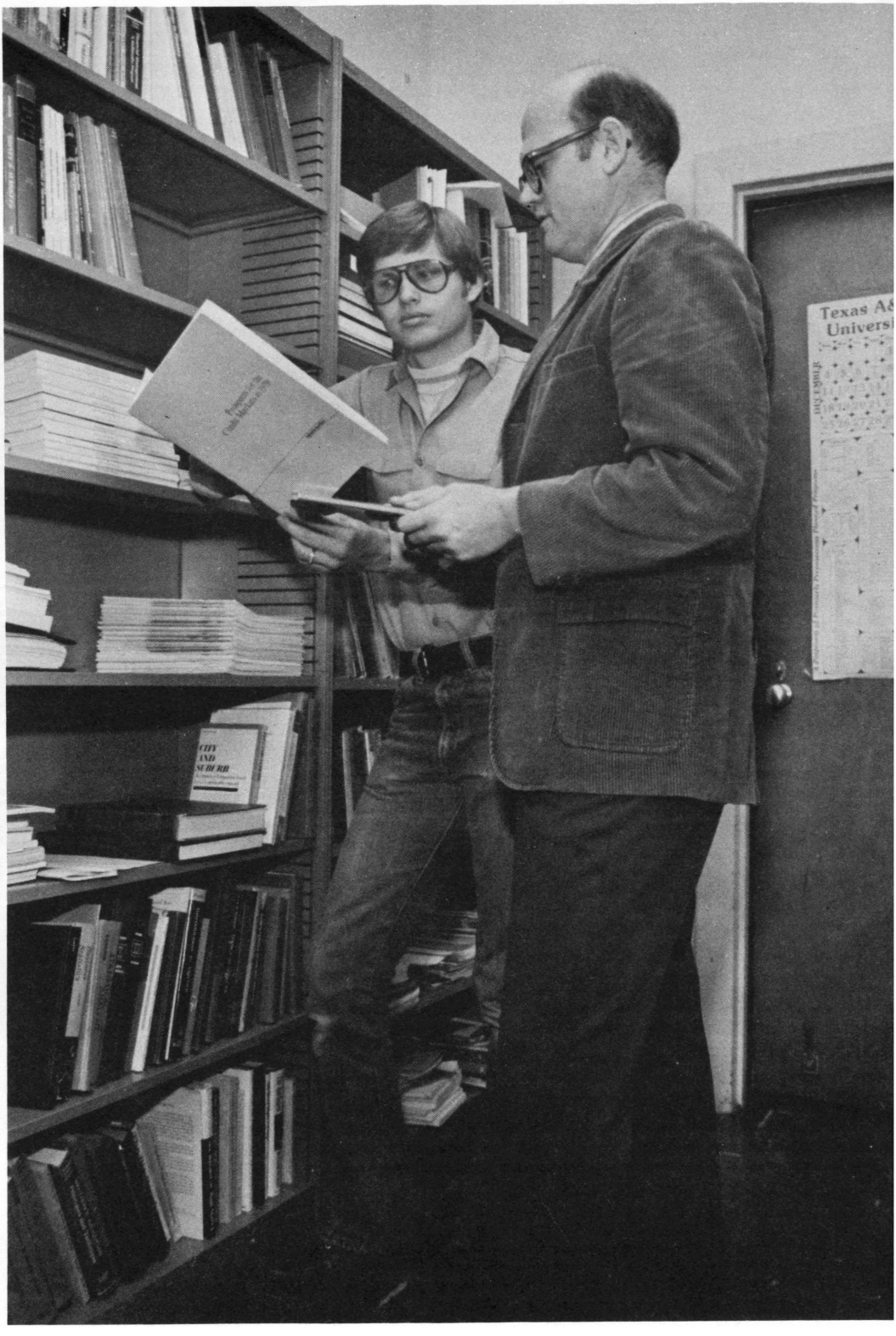
August 21-25	Monday through Friday. Delayed registration, adds and drops.
August 28	Monday. Beginning of Fall Semester classes.
September 1	Friday. Last day for enrolling in the University for the Fall Semester or for adding new courses.
September 8	Friday. Deadline for applying for graduate and undergraduate degrees to be awarded in December.
September 12	Tuesday. Last day for dropping courses with no record.
October 16	Monday. Mid-semester grade reports.
October 23	Monday. Last day for dropping courses without penalty.
November 23-26	Thursday-Sunday inclusive. Thanksgiving Holidays.
December 8	Friday. Last day of Fall Semester classes. Commencement.
December 9	Saturday. Commencement.
December 11	Monday. First day of Fall Semester examinations.
December 15	Friday. Last day of Fall Semester examinations.

Spring Semester 1979

January 10-12	Wednesday through Friday. Delayed registration, adds and drops.
January 15	Monday. Beginning of Spring Semester classes.
January 19	Friday. Last day for enrolling in the University for the Spring Semester or for adding new courses.
January 30	Tuesday. Last day for dropping courses with no record.
February 9	Friday. Deadline for applying for graduate and undergraduate degrees to be awarded in May.
March 5	Monday. Mid-semester grade reports.
March 12-18	Week of Spring recess.
March 19	Monday. Last day for dropping courses without penalty.
May 4	Friday. Last day of Spring Semester Classes. Commencement.
May 5	Saturday. Commencement and Final Review.
May 7	Monday. First day of Spring Semester examinations.
May 11	Friday. Last day of Spring Semester examinations.

Summer Session 1979

June 4	Monday. Registration for the first term.
June 5	Tuesday. Beginning of classes.
June 7	Thursday. Last day for enrolling in the University for the first term and for adding new courses.
June 8	Friday. Last day for dropping courses with no record.
June 21	Thursday. Last day for dropping courses with no penalty.
July 4	Wednesday. Independence Day Holiday.
July 10	Tuesday. Last day for first term classes. Beginning of final examinations, 7 p.m.
July 11	Wednesday. Last day for the first term final examinations.
July 12	Thursday. Registration for the second term.
July 13	Friday. Beginning of classes.
July 17	Tuesday. Last day for enrolling in the University for the second term and for adding new courses.
July 18	Wednesday. Last day for dropping courses with no record.
August 3	Friday. Last day for dropping courses with no penalty.
August 16	Thursday. Last day of second term classes. Beginning of final examinations, 7 p.m.
August 17	Friday. Last day of second term final examinations.
August 18	Saturday. Commencement for First and Second Term graduating students.


Texas A&
Universi

GRADUATE FACULTY

(Listings of degrees and rank correct as of September 1, 1977. Listings of Graduate Faculty membership correct as of February 28, 1978. Figures in parentheses indicate date of first appointment on the University Staff and date of appointment to present position, respectively.)

Abel, Robert B., *Assistant Vice President for Marine Programs and Professor of Management.* (1977) B.S., Brown University, 1947; M.E.A., George Washington University, 1961; Ph.D., American University, 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, *Secretary, Academic Council; Associate Professor of Physics and Acting Head of Department.* (1966, 1972) B.S., Texas A&M University, 1957; M.A., Rice University, 1960; Ph.D., Texas A&M University, 1965.

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, John E., *Research Soil Scientist, Blackland Research Center (Temple).* (1969) B.S., University of Nebraska, 1942; M.S., 1949; Ph.D., Iowa State University, 1956.

Adams, Leslie Garry, *Associate Professor of Veterinary Pathology.* (1969, 1972) B.S., Texas A&M University, 1963; D.V.M., 1964; Ph.D., 1968.

Adams, Ralph James Q., *Assistant Professor of History.* (1974) B.S., Indiana University, 1965; M.A., Valparaiso University, 1962; Ph.D., University of California at Santa Barbara, 1972.

Adkins, William G., *Professor of Economics and Research Economist, Texas Transportation Institute.* (1956, 1964) B.S., Texas A&M University, 1951; M.S., 1953; Ph.D., 1963.

Adkisson, Perry Lee, *Vice President for Agriculture and Renewable Resources and Professor of Entomology.* (1958, 1978) B.S., University of Arkansas, 1950; M.S., 1954; Ph.D., Kansas State University, 1956.

Agarwal, Raghumal Bankeiai, P.E., *Assistant Professor of Mechanical Engineering.* (1970) B.Sc., University of Bombay (India), 1962; B.S., Michigan Technological University, 1965; M.Eng., Texas A&M University, 1968; Ph.D., 1971.

Ahr, Wayne Merrill, *Associate Professor of Geology.* (1970, 1976) B.S., University of Texas at El Paso, 1960; M.S., Texas A&M University, 1965; Ph.D., Rice University, 1967.

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

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, *Associate Professor of Marine Sciences and of Wildlife and Fisheries Sciences and Head of Department of Marine Biology. (Galveston).* (1966, 1978) A.B., Kenyon College, 1950; M.A., Rice University, 1952; Ph.D., 1954.

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

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

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

Allen, Roland E., *Associate Professor of Physics.* (1970, 1976) B.A., Rice University, 1963; B.A., University of Houston, 1965; Ph.D., University of Texas at Austin, 1969.

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

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

Anderson, Carol Riggs, *Associate Professor of Educational Psychology.* (1969, 1972) B.S., Texas Woman's University, 1958; M.A., 1962; Ed.D., Columbia University, 1966.

Anderson, Frank G., Jr., *Visiting Member, Department of Biology.* (1978) B.S., Texas A&M University, 1950; M.D., University of Texas Medical Branch at Galveston, 1954.

Anderson, James Gilbert, *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, *Assistant Professor of Economics.* (1975) B.A., Rockford College, 1967; M.A.T., 1971; M.S., Purdue University, 1972; Ph.D., 1975.

Anderson, Robert John, *Associate Professor of Business Analysis and Research.* (1967, 1977) B.A., Cornell College, 1955; M.S., University of Wisconsin, 1957; Ph.D., Texas A&M University, 1970.

Anderson, Swiki Arlis, P.E., *Associate Professor of Mechanical Engineering.* (1967, 1977) B.S., Lamar University, 1963; M.E.S., 1966, Ph.D., Texas A&M University, 1971.

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

Angelovic, Joseph W., *Visiting Member, Department of Wildlife and Fisheries Sciences.* (1975) B.S., Utah State University, 1957; M.S., 1960; Ph.D., 1965.

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, 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.

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.

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

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

Arnold, Connie R., *Visiting Member, Department of Wildlife and Fisheries Sciences.* (1975) B.S., Southwest Texas State University, 1958; M.A., 1962; Ph.D., Texas A&M University, 1968.

Arnold, Keith Alan, *Associate Professor of Wildlife and Fisheries Sciences.* (1966, 1972) A.B., Kalamazoo College, 1959; M.S., University of Michigan, 1961; Ph.D., Louisiana State University, 1966.

Arnott, Howard J., *Visiting Member, Department of Biology.* (1971) B.A., University of Southern California, 1952; M.S., 1953; Ph.D., University of California at Berkeley, 1958.

Ash, Michael James, *Associate Professor of Educational Psychology.* (1973, 1976) 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.

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

Austin, Donald B., *Professor of Landscape Architecture and Head of Department.* (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.

Avery, Thomas Eugene, *Professor of Forest Science.* (1974) B.S.F., University of Georgia, 1949; M.F., Duke University, 1950; Ph.D., University of Minnesota, 1958.

Ayoub, Abdel-Kader, P.E., *Associate Professor of Electrical Engineering.* (1968, 1971) B.S., University of Alexandria (United Arab Republic), 1948; M.S., University of Texas, 1952; Ph.D., 1955.

Bailey, Everett Murl, *Associate Professor of Veterinary Physiology and Pharmacology.* (1970, 1974) D.V.M. Texas A&M University, 1964; M.S., Iowa State University, 1966; Ph.D., 1968; Diplomate, American Board of Veterinary Toxicology, 1972.

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

Baker, Robert Donald, *Professor of Forest Science.* (1970, 1975) B.S.F., University of California, 1951; M.F., 1952; Ph.D., State University of New York College of Forestry at Syracuse, 1955.

Ballinger, Richard Henry, *Professor of English.* (1954, 1957) B.A., University of Texas, 1936; M.A., 1936; Ph.D., Harvard University, 1953.

Barham, Warren S., *Professor of Horticultural Sciences and Head of Department.* (1976) B.S., University of Arkansas, 1941; Ph.D., Cornell University, 1950.

Barker, Donald Gene, *Professor of Educational Psychology.* (1959, 1967) B.A., Baylor University, 1952; M.A., 1954; Ph.D., University of Texas, 1961.

Barnes, Jack Allen, *Assistant Professor of Computing Science.* (1973) B.A., McMurry College, 1960; M.S., Texas A&M University, 1963; Ph.D., 1966.

Barr, Ronald E., *Assistant Professor of Engineering Design Graphics.* (1975) B.S., Marquette University, 1969; M.S., 1975; Ph.D., 1975.

Barrow, David Lee, *Assistant Professor of Mathematics.* (1973) B.S., Oklahoma State University, 1965; Ph.D., University of Michigan, 1973.

Barry, Peter James, *Associate Professor of Agricultural Economics.* (1971, 1973) B.S., University of Illinois, 1963; M.S., 1964; Ph.D., 1969.

Barzak, Robert William, *Associate Professor of English.* (1955, 1962) B.A., Texas A&M University, 1949; M.A., University of Illinois, 1951; Ph.D., 1959.

Basco, David R., *Associate Professor of Civil Engineering and of Ocean Engineering.* (1969, 1974) B.S., University of Wisconsin, 1960; M.S., 1962; Ph.D., Lehigh University, 1970; Dipl. H.E., (Delft), 1976.

Bashaw, Elexis Cook, *Research Geneticist, ARS, USDA, and Lecturer in Soil and Crop Sciences.* (1951, 1967) B.S., Purdue University, 1947; M.S., 1948; Ph.D., Texas A&M University, 1954.

Basmann, Robert L., *Professor of Economics.* (1969) B.S., Iowa State University, 1950; M.S., 1953; Ph.D., 1955.

Bass, George F., *Professor of Anthropology.* (1976) B.A., Johns Hopkins University, 1954; M.A., 1955; Ph.D., University of Pennsylvania, 1964.

Bassett, James Wilbur, *Professor of Animal Science.* (1963, 1972) B.S., Texas A&M University, 1948; M.S., Montana State University, 1957; Ph.D., Texas A&M University, 1965.

Bassichis, William H., *Associate Professor of Physics,* (1970) B.S., Massachusetts Institute of Technology, 1959; M.S., Case Institute of Technology, 1961; Ph.D., 1963.

Bates, George Winston, *Associate Professor of Biochemistry and Biophysics.* (1969, 1974) B.S., California State College at Los Angeles, 1963; Ph.D., University of Southern California. 1967.

Battalio, Raymond C., *Associate Professor of Economics.* (1969, 1975) B.S., University of California, 1966; M.S., Purdue University, 1968; Ph.D., 1969.

Baur, Joseph Ralph, *Plant Physiologist, ARS, USDA, Department of Range Science.* (1967) B.S., Purdue University, 1960; M.S., 1963; Ph.D., Texas A&M University, 1967.

Bay, Darrell Edward, *Assistant Professor of Entomology.* (1974) B.S., Kansas State University, 1964; M.S., 1967; Ph.D., 1974.

Bay, William Wallace, *Associate Dean for Academic Affairs, College of Veterinary Medicine and Professor of Veterinary Pathology.* (1966, 1974) B.S., Texas A&M University, 1948; D.V.M., 1948; M.S., Purdue University, 1950; Ph.D., 1952.

Bayliss, Garland Erastus, *Associate Professor of History.* (1956, 1973) B.S., University of Arkansas, 1951; M.A., University of Texas at Austin, 1953; Ph.D., 1972.

Beals, Robert P., P.E., *Associate Professor of Industrial Engineering.* (1966, 1971) B.S., Wayne State University, 1953; M.S., 1956; Ph.D., Texas A&M University, 1970.

Beard, James Bashore, *Professor of Agronomy.* (1975) B.S., Ohio State University, 1957; M.S., Purdue University, 1959; Ph.D., 1961.

Beasom, Samuel La Monte, *Associate Professor of Wildlife and Fisheries Sciences.* (1973, 1977) B.S., Texas A&M University, 1967; M.S., University of Wisconsin, 1969; Ph.D., Texas A&M University, 1973.

Beattie, Bruce, *Associate Professor of Agricultural Economics.* (1974) B.S., Montana State College, 1963; M.S., 1964; Ph.D., Oregon State University, 1970.

Beaumont, Roger A., *Associate Professor of History.* (1974) B.S., University of Wisconsin, 1957; M.S., 1960; Ph.D., Kansas State University, 1963.

Beaver, Bonnie V., *Associate Professor of Veterinary Anatomy.* (1969, 1976) B.S., University of Minnesota, 1966; D.V.M., 1968; M.S., Texas A&M University, 1972.

Becka, Richard, *Associate Professor of Philosophy.* (1968) B.S., John Carroll University, 1950; M.A., St. Louis University, 1952; Ph.D., University of Ottawa (Canada), 1963.

Bell, Alois A., *USDA Scientist, Department of Plant Sciences.* (1970) M.Sc., University of Nebraska, 1958; Ph.D., 1961.

Bell, Rurel Roger, *Professor of Veterinary Microbiology and Parasitology.* (1952, 1968) D.V.M., University of Georgia, 1952; M.S., Texas A&M University, 1955; Ph.D., University of Minnesota, 1968.

Benedict, Chauncey Roy, *Professor of Plant Physiology.* (1966, 1969) B.S., Cornell University, 1954; M.S., 1956; Ph.D., Purdue University, 1960.

Bennett, Earl Dean, *Professor of Accounting.* (1968, 1969) B.S., John Brown University, 1945; M.B.A., Harvard University, 1947; C.P.A., Louisiana, 1948; Ph.D., University of Michigan, 1959.

Bennett, Roy Marshall, *Assistant Professor of Educational Curriculum and Instruction.* (1972) B.S., Abilene Christian College, 1949; M.Ed., 1966; Ph.D., Iowa State University, 1970.

Benson, Fred Jacob, P.E., *Vice President for Engineering and Nonrenewable Resources; Director, Texas Engineering Experiment Station; and Professor of Civil Engineering.* (1937, 1978) B.S., Kansas State University, 1935; M.S., Texas A&M University, 1936.

Benton, Wilbourn Eugene, *Professor of Political Science.* (1957, 1962) B.A., Texas Tech University, 1939; M.A., 1941; Ph.D., University of Texas, 1948.

Berg, Robert R., *Director of University Research and Professor of Geology.* (1967, 1972) B.A., University of Minnesota, 1948; Ph.D., 1951.

Bergbreiter, David E., *Assistant Professor of Chemistry.* (1974) B.S., Massachusetts Institute of Technology, 1970; Ph.D., 1974.

Bergum, Bruce O., *Professor of Psychology.* (1969, 1975) B.S., Northwestern University, 1952; M.S., 1953; Ph.D., 1958.

Berner, Leo, Jr., *Associate Dean of the Graduate College and Professor of Oceanography.* (1966, 1972) B.A., Pomona College, 1943; M.S., University of California at Los Angeles, 1952; Ph.D., 1957.

Bernstein, Robert A., *Associate Professor of Political Science.* (1969, 1975) B.S., Cornell University, 1965; M.S., 1966; Ph.D., 1970.

Berridge, Robert I., *Professor of Educational Administration.* (1971, 1976) B.S., Seton Hall College, 1951; M.S., Texas A&I University, 1958; Ed.D., Michigan State University, 1969.

Berry, Ivan L., *Agricultural Engineering, USDA, Department of Agricultural Engineering.* (1969) B.S., University of Missouri, 1960; M.S., 1961; Ph.D., Texas A&M University, 1969.

Berthold, Dennis A., *Associate Professor of English.* (1972, 1975) B.A., University of California at Riverside, 1964; M.A., 1966; Ph.D., University of Wisconsin at Madison, 1972.

Bertrand, Clint Albert, *Professor of Engineering Technology.* (1953, 1975) B.S., Texas A&M University, 1953; M.S., 1959; D.Ed., 1964.

Bhaskaran, Govindan, *Associate Professor of Biology.* (1975) B.S., University of Kerala, (India), 1955; M.S., 1957; Ph.D., University of Bombay, (India), 1961.

Bickham, John W., *Assistant Professor of Wildlife and Fisheries Sciences.* (1976) B.S., University of Dayton, 1971; M.S., 1973; Ph.D., Texas Tech University, 1976.

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Sweet, Merrill Henry, *Associate Professor of Biology.* (1963, 1966) B.A., University of Connecticut, 1958; Ph.D., 1963.

Sweeten, John M., *Extension Agricultural Engineer and Lecturer in Agricultural Engineering.* (1975) B.S., Texas Tech University, 1965; M.S., Oklahoma State University, 1967; Ph.D., 1969.

Swinney, Richard J., *Assistant Professor of Interdisciplinary Education.* (1976) B.S., Southern Oregon College, 1961; M.Ed., University of Oregon, 1964; Ed.D., Oregon State University, 1975.

Swoboda, Allen Ray, *Associate Professor of Soil Science.* (1967, 1971) B.S., Texas A&M University, 1961; M.S., Virginia Polytechnic Institute, 1963; Ph.D., Texas A&M University, 1967.

Taber, Willard Allen, *Professor of Biology.* (1963, 1968) B.A., Iowa State University, 1949; M.S., 1951; Ph.D., Rutgers University, 1954.

Talpaz, Hovav, *Associate Professor of Agricultural Economics.* (1974, 1977) B.A., High University of Agriculture and Economics, Israel, 1963; Ph.D., Michigan State University, 1973.

Tang, Yi-Noo, *Professor of Chemistry.* (1967, 1977) B.S., Chung Chi College (Hong Kong), 1959; Ph.D., University of Kansas, 1964.

Tanksley, Thomas Dewitt, Jr., *Professor of Animal Science.* (1965, 1973) B.S., Texas A&M University, 1947; M.Ed., 1953; Ph.D., 1968.

Taylor, Charles R., *Assistant Professor of Agricultural Economics.* (1976) B.S., Oklahoma State University, 1968; M.S., Kansas State University, 1970; Ph.D., University of Missouri, 1972.

Teer, James Garth, *Professor of Wildlife and Fisheries Sciences and Head of Department.* (1962, 1970) B.S., Texas A&M University, 1950; M.S., Iowa State University, 1951; Ph.D., University of Wisconsin, 1964.

Teetes, George L., *Associate Professor of Entomology, TAES (Lubbock).* (1970, 1974) B.S., Texas A&M University, 1964; M.S., 1965; Ph.D., 1971.

Terrell, Robert, N., *Associate Professor of Animal Science.* (1976, 1977) B.S., Oklahoma State University, 1958; M.S., University of Tennessee, 1961; Ph.D., University of Wisconsin, 1966.

Thames, Walter Hendrix, Jr., *Professor of Plant Pathology.* (1959, 1968) B.S.A., University of Florida, 1947; M.S., 1948; Ph.D., 1959.

Thomas, John G., *Extension Entomologist, Department of Entomology.* (1976) B.S., Texas A&M University, 1955; B.S., 1959; M.S., 1961; Ph.D., Kansas State University, 1962.

Thomas, Norman D., *Associate Professor of Anthropology.* (1973, 1975) B.A., University of New Mexico, 1951; M.A., 1956; Ph.D., University of California at Berkeley, 1967.

Thomas, Richard Eugene, *Acting Dean, College of Engineering and Professor of Aerospace Engineering.* (1964, 1972) B.Aero.E., Ohio State University, 1951; B.A., 1953; M.S., 1956; Ph.D., 1964.

Thomas, William B., *Assistant Professor of Animal Science and Extension Animal Husbandman.* (1963, 1970) B.S., Texas A&M University, 1953; M.S., 1957; Ph.D., 1968.

Thompson, Aylmer Henry, *Professor of Meteorology.* (1960, 1966) A.B., University of California at Los Angeles, 1947; M.A., 1948; Ph.D., 1960.

Thompson, Herbert Gordon, Jr., *Associate Professor of Marketing.* (1951, 1954) B.S., Miami University, 1947; M.B.A., 1949.

Thompson, Louis Jean, P.E., *Associate Professor of Civil Engineering.* (1966) B.S., Texas A&M University, 1949; M.S., 1951; D.Sc., University of Virginia, 1966.

Thornton, Hubert Richard, P.E., *Associate Professor of Mechanical Engineering.* (1967) B.S., Alfred University, 1954; M.S., 1957; Ph.D., University of Illinois, 1963.

Thurston, E. Laurence, *Associate Professor of Biology.* (1970, 1975) B.S., State University of New York at Genesco, 1964; M.S., Iowa State University, 1967; Ph.D., 1969.

Tieh, Thomas T., *Associate Professor of Geology.* (1966, 1971) B.S., University of Illinois, 1958; M.S., Stanford University, 1962; Ph.D., 1965.

Toler, Robert William, *Professor of Plant Pathology.* (1966, 1974) B.S., University of Arkansas, 1950; M.S., 1958; Ph.D., North Carolina State University, 1961.

Tolle, Glen C., P.E., *Associate Professor of Mechanical Engineering.* (1972, 1977) B.S., University of Texas at Austin, 1962; M.S., Texas Tech University, 1963; Ph.D., University of Houston, 1970.

Tollefson, Arthur L., *Associate Professor of Educational Psychology.* (1976) B.A., Concordia University, 1948; M.A., University of Minnesota, 1953; Ph.D., 1956.

Tolmsoff, Walter J., *Lecturer in Biochemistry and Biophysics.* (1976) B.S., Oregon State University, 1956; M.S., 1958; Ph.D., University of California, 1963.

Tolson, Homer, *Associate Professor of Health and Physical Education.* (1968, 1973) B.P.E., Purdue University, 1963; M.S., 1964; Ph.D., 1968.

Tomaszewski, Michael A., *Dairy Specialist and Lecturer in Animal Science.* (1976) Assoc., Stockbridge School of Agriculture, 1963; B.S., Colorado State University, 1966; M.S., University of Massachusetts, 1968; Ph.D., North Carolina State University, 1972.

Tormollan, Francis Charles, P.E., *Associate Professor of Marine Engineering (Galveston).* (1964) B.S., University of Texas, 1955; M.S., 1957.

Treadwell, T. K., Jr., *Associate Professor of Oceanography.* (1971, 1974) B.S., University of Oklahoma, 1940; M.S., University of California, 1949.

Treybig, Leon Bruce, *Professor of Mathematics.* (1968, 1970) B.A., University of Texas, 1953; Ph.D., 1958.

Tribble, Robert E., *Assistant Professor of Physics.* (1975) B.S., University of Missouri, 1969; Ph.D., Princeton University, 1973.

Trost, Frederick Jerome, *Professor of Architecture and of Building Construction.* (1967, 1977) B.Arch., Columbia University, 1961; Registered Architect.

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

Tsutsui, Minoru, *Professor of Chemistry.* (1968) B.A., Gifu University (Japan), 1938; M.S., University of Tokyo (Japan), 1941; Ph.D., Yale, 1954; D.Sc., Nagoya University (Japan), 1960.

Tuleen, Neal A., *Associate Professor of Agronomy.* (1967, 1975) B.S., Purdue University, 1954; Ph.D., University of Minnesota, 1966.

Tummins, Marvin, *Professor of Accounting.* (1976) B.S., Western Kentucky University, 1947; M.B.A., University of Denver, 1948; Ph.D., Louisiana State University, 1953.

Turpin, Robert Davis, P.E., *Professor of Civil Engineering.* (1966) B.S., University of Texas, 1948; M.S., 1949; Ph.D., Ohio State University, 1957.

Ueckert, Darrell N., *Associate Professor of Range Science.* (1977) B.S., Texas Tech University, 1966; M.S., Colorado State University, 1968; Ph.D., 1970.

Unterberger, Betty M., *Professor of History.* (1968) B.A., Syracuse University, 1943; M.A., Radcliffe College, 1946; Ph.D., Duke University, 1950.

Unterberger, Robert R., *Professor of Geophysics.* (1968) B.S., Syracuse University, 1943; Ph.D., Duke University, 1950.

Urban, Thomas, *Associate Professor of Management. (1976) B.S., University of Detroit, 1961; M.B.A., Indiana University, 1967; D.B.A., 1971.*

Uvacek, Edward, Jr., *Associate Professor of Agricultural Economics.* (1963, 1968) B.S., Rutgers University, 1952; M.S., 1956; Ph.D., Texas A&M University, 1967.

Valencich, Trina, J., *Assistant Professor of Chemistry.* (1976) B.S., University of California at Irvine, 1968; Ph.D., 1974.

Van Arsdel, Eugene Parr, *Associate Professor of Forest Science and of Plant Pathology.* (1968) B.S.F., Purdue University, 1947; M.S., University of Wisconsin, 1952; Ph.D., 1954.

van Bavel, Cornelius H. M., *Professor of Soil and Crop Sciences.* (1967) B.S., State Agricultural University (Netherlands), 1945; M.S., Iowa State University, 1946; Ph.D., 1949.

van Buijtenen, Johannes Petrus, *Professor of Forest Science and of Genetics.* (1960, 1971) B.S., State Agricultural University (Netherlands), 1952; M.S., University of California, 1954; Ph.D., Texas A&M University, 1955.

Van Cleave, Horace William, *Professor of Entomology.* (1964, 1975) B.S., Texas A&M University, 1952; M.S., 1958; Ph.D., Oklahoma State University, 1969.

Vanderzant, Carl, *Professor of Animal Science and of Food Science and Technology.* (1953, 1962) B.S., State Agricultural University (Netherlands), 1947; M.S., 1949; Iowa State University, 1950; Ph.D., 1953.

Vanderzant, Erma Schumaker, *Biochemist of the Cotton Insects Branch, Entomology Research Division, USDA; Associated with the Department of Biochemistry and Biophysics.* (1954) B.S., Iowa State University, 1943; Ph.D., 1953.

Van Domelen, John E., *Professor of English.* (1970, 1974) B.A., Calvin College, 1957; M.A., University of Michigan, 1960; Ph.D., Michigan State University, 1964.

Van Doorninck, Frederick H., Jr., *Associate Professor of Anthropology and of Geography.* (1977) B.A., Princeton University, 1956; Ph.D., University of Pennsylvania, 1967.

Van Doren, Carlton Stevens, *Professor of Recreation and Parks.* (1968, 1974) A.B., University of Illinois, 1955; A.M., 1957; Ph.D., Michigan State University, 1967.

VanFleet, David D., *Associate Professor of Management.* (1973, 1975) B.S., University of Tennessee, 1963; Ph.D., 1969.

Van Riper, Paul Pritchard, *Professor of Political Science.* (1970) A.B., DePauw University, 1938; Ph.D., University of Chicago, 1947.

Varner, Larry W., *Associate Professor of Range Science and of Wildlife and Fisheries Sciences.* (1975, 1977) B.S., Abilene Christian College, 1966; M.S., University of Nebraska, 1968; Ph.D., 1970.

Vastano, Andrew C., *Associate Professor of Oceanography.* (1962, 1969) B.S., North Carolina State University, 1956; M.S., University of North Carolina, 1960; Ph.D., Texas A&M University, 1967.

Vastine, William J., *Economist (TAES).* (1972) B.S., Ohio State University, 1960; M.S., 1963; Ph.D., 1966.

Veblen, Eric P., *Assistant Professor of Political Science.* (1976) B.A., Dartmouth College, 1964; M.A., Yale University, 1966; Ph.D., 1969.

Vedlitz, Arnold, *Assistant Professor of Political Science.* (1973, 1975) B.A., Louisiana State University, 1968; M.A., 1970; Ph.D., University of Houston, 1975.

Vernon, Ralph Jackson, *Professor of Industrial Engineering.* (1951, 1971) B.S., Clemson University, 1950; M.Ed., Texas A&M University, 1951; Ph.D., University of Iowa, 1968.

VerWest, Bruce J., *Assistant Professor of Physics.* (1976) B.S., Michigan State University, 1971; M.A., State University of New York, 1973; Ph.D., 1974.

Vickrey, Thomas M., *Assistant Professor of Chemistry.* (1976) B.A., Hope College, 1971; Ph.D., Texas Tech University, 1974.

Villalon, Benigno, *Assistant Professor, TAES (Weslaco).* (1976) B.A., Texas A&M University, 1964; M.S., 1965; Ph.D., 1969.

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.

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

Wagner, Jackson Wayne, *Associate Professor of Human Anatomy.* (1974, 1975) A.B., Fresno State College, 1957; Ph.D., University of California at San Francisco, 1960.

Walker, James Knox, Jr., *Associate Professor of Entomology.* (1968, 1971) B.S., Texas A&M University, 1951; M.S., 1956.

Walker, Laurence C., *Visiting Member, Department of Forest Science.* (1970) B.S., Pennsylvania State University, 1948; M.F., Yale University, 1949; Ph.D., State University of New York College of Forestry at Syracuse, 1953.

Walther, Fritz, *Professor of Wildlife and Fisheries Sciences.* (1971, 1974) Physikum, Johann Wolfgang Goethe University of Frankfurt (Germany), 1944; Diplom, 1956; Dr. Phil., 1963.

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

Walton, Ned E., *Assistant Dean, College of Engineering and Associate Professor of Civil Engineering.* (1971, 1977) B.S., Texas A&M University, 1964; M.S., 1966; Ph.D., Texas A&M University, 1972.

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

Watson, Rand Lewis, *Professor of Chemistry.* (1967, 1977) B.S., Colorado School of Mines, 1962; Ph.D., University of California at Berkeley, 1966.

Watterston, Kenneth G., *Visiting Member, Department of Forest Science.* (1970) B.S., State University of New York College of Forestry at Syracuse, 1959; M.S., 1962; Ph.D., University of Wisconsin, 1966.

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

Weaver, Richard W., *Associate Professor of Soil Science.* (1970, 1976) B.S., Utah State University, 1966; Ph.D., Iowa State University, 1970.

Webb, Bill Dean, *Research Chemist, Agricultural Research Service, USDA, Texas Agricultural Experiment Station (Beaumont).* (1963) B.S., Texas A&M University, 1956; M.S., 1959; Ph.D., 1961.

Webb, Earl Sherman, *Professor of Agricultural Education.* (1961, 1967) B.S., University of Missouri, 1949; M.Ed., 1955; Ed.D., 1959.

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

Weir, Glendon H., *Assistant Professor of Anthropology.* (1976) A.A., Eastern Arizona University, 1973; B.A., Texas A&M University, 1974; Ph.D., 1976.

Welch, Charles D., *Associate Professor of Soil Science and Extension Soil Chemist.* (1963, 1970) B.S., University of West Virginia, 1942; M.S., North Carolina State University, 1948; Ph.D., 1960.

Welker, Robert B., *Assistant Professor of Accounting.* (1975) B.S., Florida State University, 1971; M.A., 1972; D.B.A., Arizona State University, 1977.

Wendt, Charles W., *Associate Professor of Soil Science, TAES (Lubbock).* (1967, 1974) B.S., Texas A&M University, 1951; M.S., 1957; Ph.D., 1966.

Weseli, Donald F., *Associate Professor of Animal Science.* (1964) B.S., Ohio State University, 1953; M.S., 1954; Ph.D., 1958.

West, Philip T., *Associate Professor of Educational Administration.* (1974, 1977) B.S., Boston University, 1962; M.S., Hofstra University, 1967; Ph.D., University of Iowa, 1971.

Whitburn, Merrill D., *Associate Professor of English.* (1973, 1977) A.B., University of Michigan, 1960; A.M., 1960; Ph.D., University of Iowa, 1973.

Whitehouse, Ulysses Grant, *Associate Professor of Biology.* (1953, 1968) B.S., University of Kentucky, 1940; M.S., 1941; M.S., University of Iowa, 1942; Ph.D., Texas A&M University, 1955.

Whiteley, Eli Lamar, *Associate Professor of Agronomy.* (1946, 1959) B.S., Texas A&M University, 1941; M.S., North Carolina State University, 1949; Ph.D., Texas A&M University, 1959.

Whiting, Robert Louis, P.E., *Director, Texas Petroleum Research Committee and Professor of Petroleum Engineering.* (1946, 1976) B.S., University of Texas, 1939; M.S., 1943.

Whitney, N. G., *Assistant Professor of Plant Sciences.* (1976) B.S., University of Houston, 1964; M.A., Sam Houston State University, 1967; Ph.D., Texas A&M University, 1972.

Whitson, Robert, *Assistant Professor of Agricultural Economics and Range Science.* (1974) B.S., Texas Tech University, 1965; M.S., 1967; Ph.D., Texas A&M University, 1974.

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

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

Wiese, Allen Franklin, *Professor of Agronomy, TAES (Bushland).* (1966, 1967) B.S., University of Minnesota, 1949; M.S., 1951; Ph.D., 1953.

Wild, James Robert, *Assistant Professor of Plant Sciences.* (1975) 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.

Wilke, Otto C., *Associate Professor of Agricultural Engineering, TAMU Agricultural Research and Extension Center (Lubbock).* (1968) B.S., Texas A&M University, 1964; M.S., 1965; Ph.D., 1968.

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

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

Williams, Jack Kenny, *Chancellor, Texas A&M University System and Professor of History.* (1970, 1977) B.A., Emory and Henry College, 1940; M.A., Emory University, 1947; Ph.D., 1953.

Williams, John Donald, *Associate Professor of Veterinary Public Health and of Food Science and Technology.* (1974) B.S., Texas A&M University, 1955; M.S., 1957; Ph.D., 1961.

Wilson, William B., *Associate Professor of Marine Sciences and of Wildlife and Fisheries Sciences (Galveston).* (1967, 1970) B.S., Texas A&M University, 1948; M.S., 1950; Ph.D., 1966.

Wiltbank, James W., *Professor of Animal Science.* (1975) B.S., Brigham Young University, 1951; M.S., University of Wisconsin, 1952; Ph.D., 1955.

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

Wolf, Harold William, *Professor of Civil Engineering.* (1970) B.S., State University of Iowa, 1949; M.S., 1964; Ph.D., University of California at Los Angeles, 1965.

Wolfe, Arthur Vernon, *Associate Professor of Management.* (1969) B.A., Columbia University, 1946; M.A., University of Wisconsin, 1947; Ph.D., University of Chicago, 1966.

Wood, Randall D., *Professor of Biochemistry and Biophysics.* (1976) B.S., University of Kentucky, 1959; M.S., 1961; Ph.D., Texas A&M University, 1965.

Woodcock, David Geoffrey, *Professor of Architecture and Head of Department.* (1962, 1973) B.Arch., University of Manchester (England), 1960; Dip.T.P., 1966; Chartered Architect (United Kingdom).

Woods, Calvin E., *Professor of Civil Engineering.* (1972) B.S., University of Houston, 1955; M.S., University of Colorado, 1959; Ph.D., University of Texas, 1964.

Woods, Donald J., *Assistant Professor of Psychology.* (1975) B.S., Fordham College, 1968; M.S., Northwestern University, 1970; Ph.D., 1971.

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, H. Jack, *Assistant Professor of Political Science.* (1967, 1974) B.A., Baylor University, 1949; M.A., 1957; LL.B., 1964.

Wootan, Charley V., *Director, Texas Transportation Institute and Head, Transportation Economics Division.* (1966, 1976) B.S., Texas A&M University, 1950; M.S., 1951; Ph.D., 1965.

Wooten, Alvin Boyd, *Professor of Agricultural Economics and Director, Texas Real Estate Research Center.* (1954, 1965) B.A., Texas A&M University, 1948; M.S., 1950; Ph.D., 1955.

Wormuth, John Hazen, *Associate Professor of Oceanography.* (1972, 1977) Ph.D., Scripps Institute of Oceanography, 1971.

Wright, Arthur L., *Associate Research Economist, Texas Real Estate Research Center, and Associate Professor of Agricutural Economics.* (1972) B.S., Southern Illinois University, 1960; M.S., 1961; Ph.D., University of Missouri, 1970.

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.

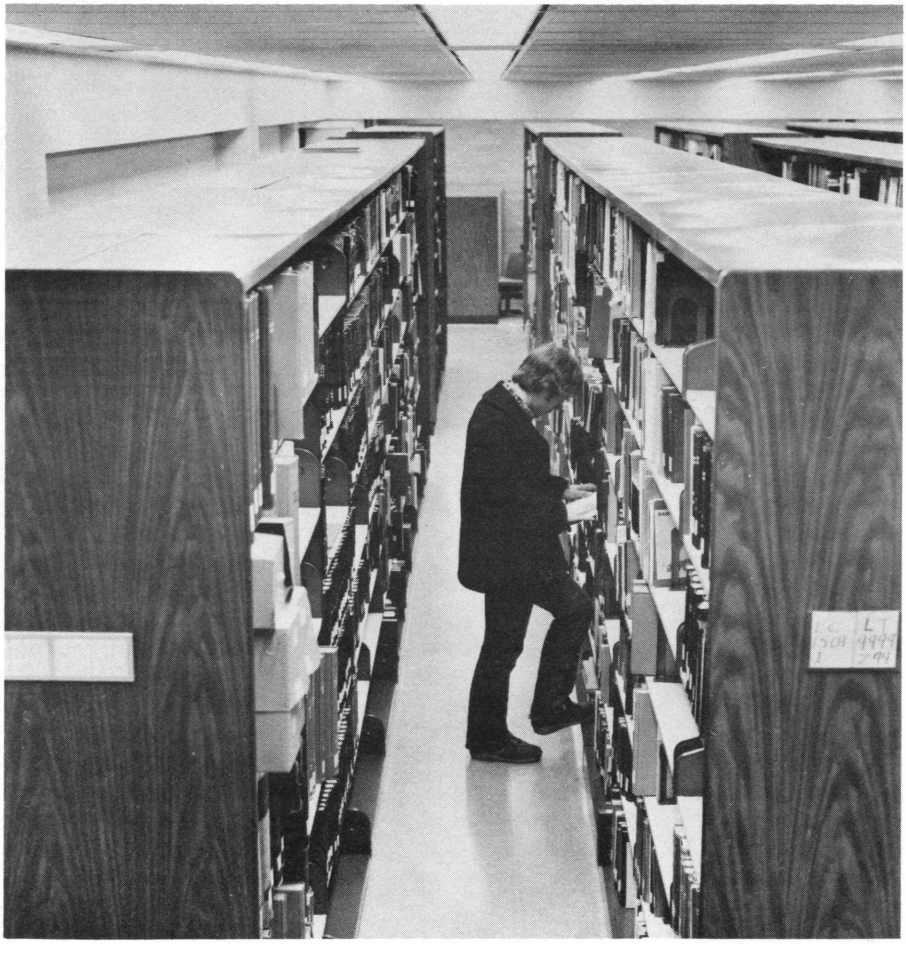
Youngblood, Dave Harper, *Professor of Physics.* (1967, 1976) B.S., Baylor University, 1961; M.A., Rice University, 1963; Ph.D., 1965.

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

Zweig, Peter Jay, *Assistant Professor of Architecture.* (1974) B.A., Syracuse University, 1971; B.Arch., 1971; M.Arch., 1972; Registered Architect.

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.



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 Graduate Faculty. The faculty of the Graduate College consists of the President, the Deans, and selected members of the staff who are actively engaged in recognized scholarly activities, fundamental research, or professional activity.

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 Academic Council. 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 Computing Science (M.C.S.)
Master of Education (M.Ed.)
Master of Engineering (M.Eng.)
Master of Landscape Architecture (M.L.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.	
Agricultural Engineering	M.Eng.	M.S.	Ph.D.
Agronomy		M.S.	Ph.D.
Animal Breeding		M.S.	Ph.D.
Animal Nutrition		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.
Mechanized Agriculture	M.Agr.		
Natural Resources Development	M.Agr.		
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.	
Building Construction	M.S.			
Landscape Architecture	M.L.A.		D.E.D.	
Urban and Regional Planning	M.U.P.		D.E.D.	

College of Business Administration

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

College of Education

Adult and Extension Education	M.Ed.	M.S.	Ed.D.	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.
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.	
Computing Science	M.C.S.	M.S.	Ph.D.	
Electrical Engineering	M.Eng.	M.S.	Ph.D.	
Engineering			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.
Meterology	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.
Modern Languages	M.A.	
Political Science	M.A.	
Psychology	M.S.	
Sociology	M.S.	Ph.D.

College of Science

Biology	M.S.	Ph.D.
Botany	M.S.	Ph.D.
Chemistry	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.	
Laboratory Animal Medicine	M.S.	
Veterinary Anatomy	M.S.	Ph.D.
Veterinary Medicial Sciences		Ph.D.
Veterinary Medical Sciences (Radiology and Nuclear Medicine)	M.S.	
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		Ph.D.
Veterinary Toxicology	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 researches. 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.

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, Sam Houston State University, Stephen F. Austin State University, Southwest Texas State University and Tarleton State University. Details concerning these cooperative graduate programs are available from the Graduate Deans of the institutions involved.

ADMISSION

Admission to Texas A&M University and any of its sponsored programs is open to qualified individuals regardless of race, color, religion, sex, 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 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 for the Aptitude Test of the Graduate Record Examination (GRE). The Graduate Management Admission Test (GMAT) may be substituted in the College of Business Administration only. These tests should be taken within five (5) years of the date of application for admission to the Graduate College. Applicants in the Department of Biology are also required to submit scores on the appropriate GRE Advanced Test. 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 (5) calendar years prior to application for admission to the Graduate College may not normally be used to satisfy admission requirements.

During 1978-79 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 Testing Service, Box 955, Princeton, N.J. 08540; or The Academic Counseling and Testing Center, Texas A&M University, College Station, Texas 77843.

Inquiries regarding admission to the Graduate College should be addressed to: The Dean 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.

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 the Dean of Admissions and Records, should be filed at least four 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:

June 15 for the Fall Semester
November 1 for the Spring Semester
March 15 for the Summer Session

In addition to the records sent to the office of the Dean 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 remains valid for two (2) calendar years only, unless the student during this period engages in active graduate work.

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. Beginning with the Fall semester, 1977, 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 will 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.

Continued registration as a post-baccalaurete, non-degree graduate student is contingent each semester upon satisfactory academic performance and the recommendation of the department with which the student is affiliated.

Graduate students in a non-degree status who failed initially to qualify for admission to advanced degree programs but who aspire to work for advanced degrees may be given the opportunity to demonstrate the ability to do graduate work, if the departments so recommend.

International Students. A student from another country who seeks admission to the Graduate College must meet the same requirements for admission and candidacy as students from the United States, including the submission of scores on the Graduate Record Examination, or in the College of Business, the Graduate Management Admission Test. In addition, prospective students from other countries must demonstrate the ability to speak, write, and understand the English language. Prospective students whose native language is not English must take the **Test of English as a Foreign Language** (TOEFL), which is administered by the Educational Testing Service, Princeton, New Jersey, in over 200 centers around the world. A registration form and a "Bulletin of Information for Candidates" may be obtained by

writing to TOEFL, Educational Testing Service, Princeton, New Jersey 08540, U.S.A.

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

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

More detailed information about Texas A&M University and particularly about enrollment procedures is incorporated in a pamphlet "Information for Prospective International Students," a copy of which may be obtained by writing to: Dean of Admissions and Records, Texas A&M University, College Station, Texas 77843, U.S.A.

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

REGISTRATION

Before the first registration the student should consult the graduate advisor representing the field of his or her major interest. This advisor will assist in planning the student's first registration.

The load for a full-time graduate student is twelve (12) to sixteen (16) hours per semester or six (6) hours per six-week summer term. The load for Graduate Assistants on one-half time employment is nine (9) to twelve (12) hours per semester or four (4) hours per six-week summer term. Recipients of fellowships and assistantships are normally required to register for the course loads specified above.

Graduate students who have completed all course work on their degree programs, but who are still engaged in research for their theses or dissertations, must register for a minimum of four (4) hours of 691 (Research) credit each semester or 12-week summer session until all requirements for the degree have been completed. Students who are completing thesis or dissertation research *in absentia* must register for no more and no less than four (4) hours of 691 (Research) credit each semester or 12-week summer session until all requirements for the degree have been completed, unless an approved petition for exception is on file in the Graduate College prior to registration.

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.

Double Registration. Undergraduates at Texas A&M University who at the beginning of a given semester are within twelve (12) hours of graduation or at the beginning of a summer term are within six (6) hours of graduation may apply for admission to the Graduate College provided they meet the Graduate Record Examination 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 sixteen (16) hours in the regular semester or six (6) hours in a six-week summer term.

A superior undergraduate student is otherwise eligible to enroll in a graduate course for graduate credit only if he 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 and is not including it for credit on his undergraduate degree program. Such petitions must be approved by the Head of the student's major (undergraduate) department **and** the student's academic dean.

VA Benefits. Veteran students should note that in order to receive full VA benefits they must be registered for not less than twelve (12) credit hours of course work each full semester or four (4) credit hours per six-week summer term.

Graduate Credit. Graduate credit will not be allowed normally 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 (8) hours taken prior to admission to the Graduate College may be utilized in the degree program.

Graduate Advisors. A graduate student entering the University for the first time is required to consult with the advisor in his or her particular field of interest regarding courses and various programs of study. Departmental graduate advisors will be available for consultation several days prior to registration. Early in the first semester an advisor will assist each new graduate student in choosing an Advisory Committee and working out a degree program for consideration by the student's full Advisory Committee.

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, national origin or unrelated physical or mental handicaps.

FEES

The fees set out herein for graduate students for the session of 1978-79 are strictly approximations and are subject to change because of economic conditions and/or legislative requirements. The tuition and required fees listed below are based on registration for fifteen (15) semester credit hours during the Fall and Spring Semesters and six (6) semester credit hours during the First and Second term of the Summer Session.

	First Semester	Second Semester	Summer Session First Term	Summer Session Second Term
Tuition Fee (See Explanation of Fees) for Texas residents	$ 60.00	$60.00	$ 25.00	$ 25.00
Tuition Fee (See Explanation of Fees) for nonresidents	$600.00	$600.00	$240.00	$240.00
Student Services Fee	$ 19.00	$ 19.00	$ 9.50	$ 9.50
Building Use Fee	$ 90.00	$ 90.00	$ 36.00	$ 36.00
Student Center Complex	$ 10.00	$ 10.00	$ 5.00	$ 5.00
Health Center Fee	$ 15.00	$ 15.00	$ 7.50	$ 7.50

In addition to expenses as outlined above, state law requires the payment of laboratory fees which shall reflect the cost of materials and supplies used and which shall be not less than $2 nor more than $8 per laboratory course.

Each applicant for an advanced degree is required to pay a diploma fee of $8. A fee of $15 is required to cover the cost of binding three copies of the thesis or dissertation. A Collating and Editing Fee of $10 is required of all students whose degree requirements include a thesis, dissertation, or record of study. Each candidate for the doctorate is required to pay a dissertation (or record of study) microfilming fee of $27.50. A copy of the Fiscal Department receipt for payment of these fees must be presented to the office of the Dean of the Graduate College and recorded on the student's records.

Any student registering for "Degree Only" will be required to pay a service fee of $15.

EXPLANATION OF FEES

Tuition

Resident students (Texas residents) pay four dollars ($4) per semester credit hour, but the total of such charges shall be not less than fifty dollars ($50) per semester or trimester, and not less than twenty-five dollars ($25) per six-week summer term.

Nonresident students pay forty dollars ($40) per semester credit hour.

Alien students who attended the University at any time prior to June 19, 1975, pay fourteen dollars ($14) per semester credit hour, but the total of such charge shall be not less than two hundred dollars ($200) per semester or trimester and not less than one hundred dollars ($100) per summer term. Alien students registering for the first time after June 19, 1975, shall pay forty dollars ($40) per semester credit hour unless the student is a citizen of a country that charges citizens of the United States tuition at publicly funded colleges and universities an amount which is equal to or less than two hundred ($200) per semester or trimester or one hundred dollars ($100) per summer term, in which case the alien student pays fourteen dollars ($14) per semester credit hour, but not less than two hundred dollars ($200) per semester or trimester and not less than one hundred dollars ($100) per summer term. Information on countries whose citizens are eligible for the reduced tuition rates may be obtained from the Office of Admissions and Records.

Students who in either semester register (including payment of fees) after the beginning of classes pay an additional fee of $4.

Student Services Fee

The student services fee is required of all students and covers the services at the University Center and the Intramural Program. It entitles the student to receive the Battalion newspaper, and covers admission to all athletic events played at the University (with the exception of football games) under the auspices of the Athletic Department, to Town Hall Programs, and to the Great Issues and Recital Series.

Building Use Fee

The building use fee is required of all students and is to cover bonded indebtedness incurred for the expansion, air conditioning, and/or rehabilitation of University Center, G. Rollie White Coliseum, various University auditoriums, the University Library, Kyle Field Stadium, Student Health Center and other campus facilities.

Student Center Complex Fee

This fee is required of all students for operating, maintaining, improving and equipping the Student Center Complex.

Health Center Fee

This fee is required of all students for operating, maintaining and equipping the University Health Center.

Exemptions

Certain students in the following classifications are exempt from paying tuition and some of the required fees by action of the State of Texas and the Texas A&M University Board of Regents. Specific eligibility requirements under these provisions can be obtained from the Office of the Registrar.

Children of Prisoners of War or Persons Missing in Action are exempt from paying Tuition, Laboratory Fees, Student Services Fee, Building Use Fee, Student Center Complex Fee, and the Health Center Fee.

Dependent children of disabled or killed-on-duty firemen and peace officers and firemen who are enrolled in Fire Science courses are exempt from paying the above fees.

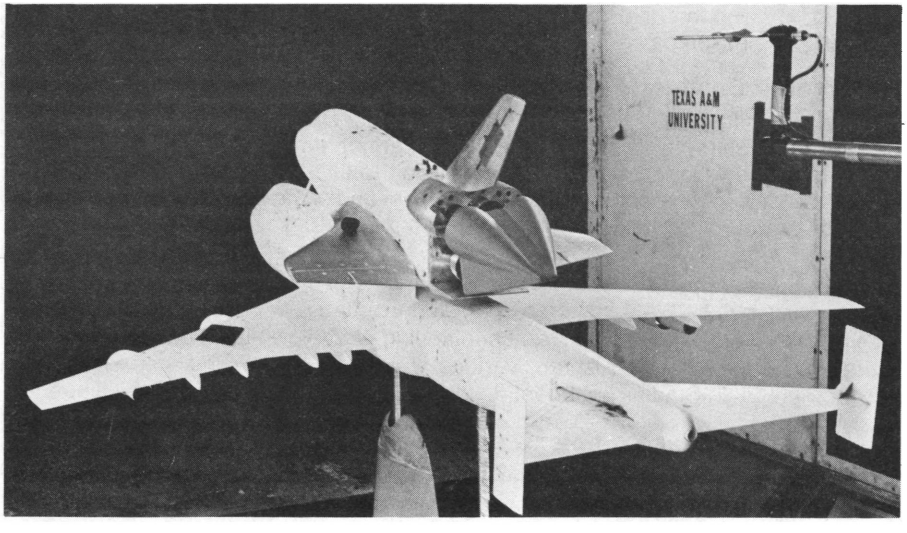
Blind and Deaf students who are eligible for the rehabilitation services of the State Commission for the Blind and/or Division of Vocational Rehabilitation of the Texas Education Agency are exempt from the above fees and also the General Property Deposit.

Certain veterans (and dependents of veterans who died in active service) who are Texas citizens and who were honorably discharged from World War I, World War II, Korean War or the "Cold War" which began on termination of the Korean War are exempt from paying tuition, laboratory fees, Building Use Fee and the Student Center Complex Fee. Orphans of members of the Texas National Guard and the Texas Air National Guard killed since January 1, 1946, while on active duty either in the service of their state or the United States may also be eligible under this provision.

The State Board of Education will certify 235 students from other nations in the American Hemisphere to be exempt from paying tuition at institutions of higher learning in the State of Texas.

Full time Texas A&M University System employees and students registered *in absentia* will only be required to pay tuition and laboratory fees.

Students taking less than six semester hours during long terms and less than three semester hours during summer terms are exempt from the Health Center Fee.



Refunds

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

Tuition, Student Services Fee, Building Use Fee, Student Center Complex Fee, Health Center Fee, and Laboratory Fee

Fall or Spring Semester or Trimester

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

Six-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

MARRIED STUDENT APARTMENTS

University-owned apartments, both furnished and unfurnished (in limited numbers), are available to married students. Rentals range from approximately $70 to $190 per month, including normal utilities, depending upon the type of apartment assigned. Application for a married student apartment should be made directly to the Student Apartments Office, Box 117, Faculty Mail Service, College Station, Texas 77843.

DEGREE PROGRAM

A graduate student's Degree Program includes all courses which are listed on the official form (except prerequisites or "other courses"). All courses on the approved Degree Program must be completed with a satisfactory grade to meet the 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.

SCHOLARSHIP

A minimum grade point ratio (G.P.R.) of 3.00 (B average based on a 4.00 maximum) in all course work other than in those courses in which grades of Satisfactory (S) or Unsatisfactory (U) are given 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 utilized in computing the grade point ratio.

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 utilized 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 Degree Program from another institution shall be utilized in computing the student's final over-all grade point ratio.

Courses listed for graduate credit on the official 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 grade point ratio falls below the minimum of 3.00, the student will be considered to be on scholastic probation. If the minimum grade point ratio is not attained in a reasonable time, the student will be required to withdraw from the Graduate College. A grade of C is the lowest grade for which graduate credit will be given. In courses receiving grades of Satisfactory (S) or Unsatisfactory (U), only the S grade is acceptable toward the completion of a Degree Program. Courses taken on a "Pass-Fail" basis may not be utilized for graduate credit.

Every non-degree graduate student must attain a 3.00 GPR on the initial twelve (12) credit hours of course work for which the student enrolls and must maintain a 3.00 GPR thereafter in order to remain eligible to register.

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, program of study, etc., must be proposed to the Dean of the Graduate College by petition, with endorsements by all 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 Main Campus at College Station, nine (9) credit hours during one semester or during two consecutive six-week summer terms. The term "Main Campus" refers to the campus of Texas A&M University located at College Station, Texas. 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 (9) credit hours to be taken during one semester or during two consecutive six-week summer terms. However, such a petition must be approved prior to the student's registration for the final nine (9) credit hours of required course work. Special provisions are made for the fulfilling of residence requirements in certain specified master's degree programs carried on at Moody College at Galveston, Texas.

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 (9) credit hours per semester, or nine (9) credit hours per 12-week summer session. Specific authorization for such programs must be granted in advance by the employing agency.

Student's Advisory Committee

A student should consult with the departmental graduate advisor or department chairman in the field of his or her major interest for the selection of a graduate Advisory Committee. An Advisory Committee for the Master's degree will be composed of not fewer than three members of the Graduate Faculty, one of whom must be from outside the major field. The chairman of the committee will direct the student's total graduate program.

Degree Program

The student's Advisory Committee, in consultation with the student, will develop the 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 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. Any prerequisite courses recommended should also be listed on the form.

Students submitting degree programs for Master of Science 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").

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 fourteen (14) weeks prior to the close of the semester or summer session in which the student expects to receive the degree.

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 (6) 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 twelve (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. **(Note also c, below).**
   c. Not more than a total of twelve (12) credit hours of 689 (Special Topics).
   d. Not more than a total of twelve (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 (8) hours each of 691 (Research), or 685 (Problems), nor more than three (3) hours of 690 (Theory of Research) — nor more than twelve (12) hours of any combination of these.
3. Not more than two (2) hours of seminar.
4. Not more than eight (8) 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 utilized for the degree of Master of Science.

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.

Time Limit

No student will be granted a Master's degree from Texas A&M University unless all requirements accepted for fulfillment of the degree are completed within a period of seven (7) consecutive calendar years. If within this time period a student does not complete all requirements for the degree sought, he cannot receive graduate credit for any course work which is more than seven (7) calendar years old at the time of the final examination.

Transfer of Credit

A student who has earned twelve (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 (6) 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 nor 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.).**

Foreign Languages

There is no specific language requirement for the Master of Science degree. For other Master's degrees, departments may, at their discretion, require a reading knowledge of one or more foreign languages.

Limitations for Staff Members

The following limitations have been 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 resident staff of the Texas A&M University System above the rank of Assistant Professor, or its equivalent, will not be granted a Master's degree at this institution. They may, however, enroll for graduate work.
2. Members of the faculty and staff of Texas A&M University will not be granted a graduate degree by Texas A&M University after receiving tenure at this institution.
3. Item 2, above, does not apply to those members of the faculty and staff who gained admission to the Graduate College of Texas A&M University and enrolled in course work leading to a graduate degree prior to January 1, 1972.

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 should embody original work on the part of the candidate. It must be grammatically correct, reflecting the ability of the candidate to express himself clearly. In general, the format should be consistent with that used in scholarly journals in the candidate's field. An abstract not exceeding 600 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 (3) copies of the thesis in its final form must be filed with the Thesis/Dissertation Clerk of the Graduate College (Room 248, Sterling C. Evans Library), after approval by the student's Advisory Committee and the Head of the student's major department, by dates announced each semester.

A thesis binding fee and a collating and editing fee must be paid to the Fiscal Department and the receipts shown to the secretary of the Dean of the Graduate College before the degree can be conferred.

Application for Degree

Formal application for the degree must be filed in the office of the Dean of the Graduate College not later than ninety (90) days prior to the end of the semester, or thirty (30) days prior to the end of the summer term in which the student expects to complete his requirements for graduation. A student must be formally registered in Texas A&M University for the semester in which the degree is to be conferred, or for either six-week term of the summer session at the end of which the degree is to be conferred.

Final Examination

The candidate must pass a final examination not less than two (2) weeks before the date on which the degree is to be conferred. Three (3) copies of the thesis in final form signed by the student's Advisory Committee and the Head of the student's major department must be submitted to the Thesis/Dissertation clerk of the Graduate College, together with the announcement for the final examination, at least two (2) weeks in advance of the scheduled date for the 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 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 his 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.

Candidates may exempt the final examination provided their grade point ratio 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.

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 24 semester hours must be in the major department, and a minimum of 6 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 Science degree.

Students who elect to pursue non-thesis option Master of Science degrees are not eligible to include 691 (Research) courses on their degree programs. 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 and 4) Plant Protection.

To satisfy the residence requirement the student must complete twelve (12) credit hours on the Main Campus at College Station.

Approximately twelve (12) of the minimum of thirty-six (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 (8) credit hours of 684 (Professional Internship), eight (8) credit hours of 685 (Problems), nor more than three (3) credit hours of 690 (Theory of Research) may be utilized toward the degree of Master of Agriculture — nor any combination of 684, 685, and 690 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.

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 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.

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 fifty-two (52) hours of course work and a satisfactory comprehensive final examination. For holders of five-year professional degrees in Architecture who also have significant professional experience, the minimum number of hours of required course work is thirty-six (36), none of which may consist of 684 (Professional Internship), with the approval of the Department faculty. 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 coursework in the Department of Environmental Design to attain B.E.D. equivalency.

To satisfy the residence requirement the student must complete twelve (12) credit hours on the Main Campus at College Station.

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 examination **is not to be administered until all other requirements for the degree, including any internship, have been substantially completed.** Depart-

mental requirements and regulations relating to degree plans, professional internships, etc., may be found in the departmental brochure.

No more than eight (8) credit hours of 684 (Professional Internship), eight (8) credit hours of 685 (Problems), nor more than three (3) credit hours of 690 (Theory of Research) may be utilized toward the degree of Master of Architecture — nor any combination of 684, 685, and 690 totaling in excess of 25 ¼ of the total credit hour requirement shown on the individual Degree Program.

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 English, History, Political Science, or Modern Language. The residence requirements for this degree are exactly the same as for the Master of Science degree, as is the requirement of a thesis. The thesis is expected to be a competently phrased narrative of the student's original research topic. Of the minimum of thirty (30) semester hours required for the Master of Arts degree, no more than six (6) credit hours for thesis research may be counted toward the degree. The 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 utilized for the degree of Master of Arts.

Foreign Languages: For the degree of Master of Arts a reading knowledge (usually represented by two (2) years of college study) of at least one foreign language is normally required.

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).

Students submitting 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 degree programs, the requirements for the degree may be satisfied by completing a minimum of 36 semester hours, of which 24 semester hours must be in the major department, and a minimum of 6 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.

Students who elect to pursue non-thesis option Master of Arts degrees are not eligible to include 691 (Research) courses on their degree programs. 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 graduate programs leading to the degree of Master of Business Administration. Students may concentrate in the professional fields of accounting, business administration (undifferentiated), business computing science, finance, management or marketing.

The holder of a bachelor's degree in Business Administration will normally be prepared to go directly into graduate courses leading to the M.B.A. degree, which requires a minimum of thirty-six (36) credit hours. The holder of a bachelor's degree not in Business Administration will be required to take preprofessional courses as explained in the section **Graduate Courses of Instruction by Departments.**

To satisfy the residence requirement the student must complete twelve (12) credit hours on the Main Campus at College Station.

No more than eight (8) credit hours of 684 (Professional Internship), eight (8) credit hours of 685 (Problems), nor more than three (3) credit hours of 690 (Theory of Research) may be utilized toward the degree of Master of Business Administration — nor any combination of 684, 685, and 690 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 oral 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 (2) weeks in advance of the scheduled date.

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 COMPUTING SCIENCE

The degree of Master of Computing Science is a non-thesis degree, designed to complement the Master of Science degree in Computing Science. The degree requires the completion of a minimum of thirty-six (36) hours of course work and a satisfactory comprehensive final examination.

To satisfy the residence requirement the student must complete twelve (12) credit hours on the Main Campus at College Station.

No more than eight (8) credit hours of 684 (Professional Internship), eight (8) credit hours of 685 (Problems), nor more than three (3) credit hours of 690 (Theory of Research) may be utilized toward the degree of Master of Computing Science — nor any combination of 684, 685, and 690 totaling in excess of 25% of the total credit hour requirement shown on the individual Degree Program.

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 (2) 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 oral examination.** The final oral 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 Education 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 and physical education, industrial 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 thirty-six (36) hours of course work and a satisfactory comprehensive final examination.

To satisfy the residence requirement the student must complete twelve (12) credit hours on the Main Campus at College Station.

No more than eight (8) credit hours of 684 (Professional Internship), eight (8) credit hours of 685 (Problems), nor more than three (3) credit hours of 690 (Theory of Research) may be utilized toward the degree of Master of Education — nor any combination of 684, 685, and 690 totaling in excess of 25% of the total credit hour requirement shown on the individual Degree Program.

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 (2) 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 oral 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 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 his last semester may apply for admission to the Graduate College to work toward the non-thesis degree of Master of Engineering, majoring in his particular field of engineering. Approximately one-third of the required minimum of thirty-six (36) credit hours of course work will be taken in fields outside of the major field.

The minimum residence requirement for the degree of Master of Engineering is one full semester of sixteen (16) credit hours, or the equivalent, on the Main 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 (8) credit hours of 684 (Professional Internship), eight (8) credit hours of 685 (Problems), nor more than three (3) credit hours of 690 (Theory of Research) may be utilized toward the degree of Master of Engineering — nor any combination of 684, 685, and 690 totaling in excess of 25% of the total credit hour requirement shown on the individual Degree Program.

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 (2) 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 oral 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 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 forty (40) hours of course work and a satisfactory comprehensive final examination.

To satisfy the residence requirement the student must complete twelve (12) credit hours on the Main Campus at College Station.

No more than eight (8) credit hours of 684 (Professional Internship), eight (8) credit hours of 685 (Problems), nor more than three (3) credit hours of 690 (Theory of Research) may be utilized toward the degree of Master of Landscape Architecture — nor any combination of 684, 685, and 690 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 oral 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.

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 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 forty-eight (48) hours of course work and a satisfactory oral examination.

To satisfy the residence requirement the student must complete twelve (12) credit hours on the Main Campus at College Station.

No more than eight (8) credit hours of 684 (Professional Internship), eight (8) credit hours of 685 (Problems), nor more than three (3) credit hours of 690 (Theory of Research) may be utilized toward the degree of Master of Urban Planning — nor any combination of 684, 685, and 690 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 (2) 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 oral 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 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 4 weeks prior to registration (3-4 months prior to registration for foreign students; use foreign 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 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 deadlines 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 3 approved copies of the thesis and announcement of the final examination	ADCom & DH / Dean	At least 2 weeks prior to final oral examination (see **Catalog** for specific details)
9. 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
10. Arrange for cap and gown		Texas A&M Bookstore in the University Center.

THE DEGREE OF DOCTOR OF PHILOSOPHY

Work leading to the Degree of Doctor of Philosophy is designed to give the candidate a thorough and comprehensive knowledge of his professional field and to train him 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 his demonstrated ability to do independent research. In addition, the candidate must have acquired the ability to express himself 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 Main Campus at College Station. Students who hold Master's degrees when they enter doctoral degree programs must spend one (1) academic year in resident study on the Main Campus. In either case, one (1) academic year beyond the first year of graduate study must be in continuous residence on the Main Campus of Texas A&M University at College Station. One academic year may include two (2) adjacent regular semesters or one (1) regular semester and one (1) adjacent 12-week summer session.

To satisfy the continuous residence requirement, the student must complete a minimum of nine (9) credit hours per semester or 12-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 (1) academic year (eighteen [18] credit hours) on the Main 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 [9] credit hours per semester) on a proportionate basis. Full-time staff members of the University or of closely affiliated organizations stationed at the Main Campus may fulfill total residence requirements by the completion of less-than-full course loads.

A minimum of ninety-six (96) credit hours beyond the baccalaureate degree or sixty-four (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 his Advisory Committee and approval of the Dean of the Graduate College, a student may be permitted to carry on work in connection with his dissertation *in absentia.*

Time Limit

Effective September 1, 1969, no student will be granted a doctoral degree (Ph.D., Ed.D. or equivalent degree) from Texas A&M University unless all requirements for that degree are completed within a period of ten (10) consecutive calendar years. If within this time period a student does not complete all requirements for the degree sought, he cannot receive graduate credit for any course work which is more than ten (10) calendar years old at the time of the final examination.

Students who enrolled in the Graduate College for doctoral degree work prior to September 1, 1969, must complete all requirements for the doctoral degree no later than August 31, 1979.

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 Chairman of the Advisory Committee. The student's Advisory Committee will consist of **not fewer than four (4) members of the Graduate Faculty** representative of the student's several fields of study and research; **one (1) of the members must be from a department other than the student's major department.**

The Chairman, in consultation with the student, will select the remainder of the Advisory Committee. The Chairman will then notify the tentative members of the Advisory Committee, giving the student's name and field of study and requesting 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.

The student's Advisory Committee has the responsibility for guiding and directing the entire academic program of the student and for initiating all academic actions concerning the student. The Chairman of the Advisory Committee, who usually has immediate supervision of the student's research and dissertation, has the responsibility for calling required meetings of the Advisory Committee, and for calling meetings at any other time considered desirable. The duties of the Advisory Committee include responsibility for the degree program, the research proposal, the preliminary examination (written and oral), the dissertation, 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 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 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 degree program must be submitted to the Graduate College prior to the third semester's registration.** The degree program will be submited on standard forms, with endorsements by the student's Advisory Committee and the Head of his major department, for the approval of the Dean of the Graduate College, who will, at the time of approval, appoint a representative of the Graduate Council to the student's Advisory Committee. A field of study may be chiefly in one department or may be in a combination of departments.

Transfer of Credit (See also page 79.)

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, nor 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.). 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. No credit may be obtained by correspondence study, or for any course of fewer than three weeks duration.

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. The chosen option or options of each department are indicated in this catalog at the beginning of the section listing the course offerings of the individual departments.

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. 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 six (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 and 691 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 his 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 (2) 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 Chairman 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 continuation of the oral portion of the Preliminary Examination, or (2) to 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.

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 (2) weeks. If a departmental examination is utilized 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 Advi-

sory 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 (G.C.R.) 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 his 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 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 (6) months. The departmental examination should be announced at least thirty (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 Chairman 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 Chairman 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 Chairman, must 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 (3) 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 (6) months has elapsed.

A student must be registered in any semester or summer session in which he or she asks to appear for either the Preliminary or the Final Examination.

Admission to Candidacy

To be admitted to candicacy 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 at least seven (7) months before the time when the degree is expected to be received, but usually not before the completion of two (2) full years of graduate work.

Limitations for Staff Members

The following limitations have been 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 resident staff of the Texas A&M University System above the rank of Assistant Professor, or its equivalent, will not be granted the doctoral degree at this institution. They may, however, enroll for graduate work.
2. Members of the faculty and staff of Texas A&M University will not be granted a graduate degree by Texas A&M University after receiving tenure at this institution.
3. Item 2, above, does not apply to those members of the faculty and staff who gained admission to the Graduate College of Texas A&M University and enrolled in course work leading to a graduate degree prior to January 1, 1972.

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 (GCR), 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 collection of data.

The ability to perform independent research must be demonstrated by the dissertation. 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 form should be obtained from the office of the Graduate College.**

By dates announced each semester the candidate must submit to the office of the Thesis/Dissertation Clerk of the Graduate College (Room 248, Sterling C. Evans Library) three (3) 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 600 words and a vita page are included in the dissertation. Two (2) 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 of $27.50. This fund is used to film doctoral dissertations in cooperation with University Microfilms.

Application for Degree

Formal application for the degree must be filed in the office of the Graduate College not later than ninety (90) days prior to the end of the semester, or thirty (30) days prior to the end of the summer term in which the student expects to complete requirements for graduation. A student must be formally registered in Texas A&M University for the semester in which the degree is to be conferred, or for either term of the summer session at the end of which the degree is to be conferred.

Final Examination

The candidate for the doctoral degree must pass a final examination not less than two (2) weeks before the date on which the degree is to be conferred. Three (3) copies of the dissertation in final form signed by the department head and members of the student's Advisory Committee, with the exception of the Graduate Council Representative, must be submitted to the Thesis/Dissertation clerk of the Graduate College, together with the announcement for the final examination, 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 candidate's completed dissertation will be available to this committee. 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 his 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.

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 prepares practitioners; graduates may be expected to fill instructional, supervisory, and administrative positions in the actual arenas in which educational services are to be rendered.

Although substantively different from the Ph.D. 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, their role-related studies, their internship experience, and their professional reports (see below) 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 and Physical Education, Industrial 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 Examination scores and an academic record acceptable to the department to which they apply. They must also complete a written entrance assessment instrument which tests their knowledge of the requirements and duties of the professional role to which they aspire and demonstrates their ability to write with clarity, organization, and correctness.

Program of Study

Each student's program of study 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 (6) one-hour proseminars stressing the foundation concepts with which every Doctor of Education 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 9 or more semester hours each;
6. a professional internship of at least 6 semester hours related to the professional role to which the student aspires;
7. a terminal project and professional report (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 main 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 5 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 6 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 5-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.

Terminal Project and Professional Report

The major requirement for the Ed.D. degree is the completion of a project of considerable magnitude which is directly related to the practical concerns and problems of the profession and which is either embodied in or summarized by a professional report. The project may involve (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 and formative and summative evaluation, or (3) action research on a curricular, instructional, supervisory, or administrative problem leading to revised operation based on empirical data. The project may grow out of the student's program of study, out of the internship, or out of original ideas for assessment, analysis, or problem solution. The results of the project may take the form of validated curriculum units or guides; tested instructional materials; a set of detailed designs or plans; a report to a superintendent, board of education, or other governing agency; an organized and analyzed set of data; or a variety of other forms. Its format and substance, however, should be appropriate to the audience for whom it is prepared.

Whatever the nature of the terminal project undertaken by the candidate, he or she will be required to prepare a Record of Study in the form of a written professional report which rationalizes, explains, and supports the activities undertaken in the project and supports its conclusions (or conclusions drawn from it) with adequate investigations, empirical data, and/or a comprehensive bibliography. All Records of Study (professional reports) must correspond to guidelines prepared by the College of Education and should be characterized by accuracy of observation and measurements, thoroughness of analysis and synthesis, and accuracy and completeness of presentation. The basic project may be incorporated in the professional report or be separate from it, depending on the nature of the project and the form of its embodiment.

Examinations

Each Ed.D. degree candidate will be required to take a departmentally-prepared written qualifying examination prior to the completion of 30 hours of doctoral work. The required six hours of proseminar must be completed before the qualifying examination is taken. Continuation in the program and/or any additional required study will be dependent on the results of this 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 utilization 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 composed of a 68-semester-credit-hour pre-professional program and a 168-semester-credit-hour professional program which includes an internship.

Following entry into the professional program, the student will complete a five academic year (152 semester-credit-hour minimum) course of study and a one academic year (16 credit hour) internship in which the student will extend his education in a practice-oriented environment such as an industrial organization. Students

entering with bachelor's or master's degrees in engineering or certain specialized non-engineering disciplines may take reduced programs as defined by the Doctor of Engineering Program Committee. 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 examination for the Doctor of Engineering degree is administered by an appropriate committee as specified 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

Students may enter the program after completing a 68 semester-credit-hour pre-professional program. Admission at this level requires a GPR of 2.50 overall or 2.75 in the last 45 semester credit hours. Applicants possessing baccalaureate or graduate degrees may seek advance level admission provided they meet or exceed the 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, complete and provide test scores on the Nelson-Denny Reading Test and on the Minnesota Engineering Analogies Test and be interviewed by the Admissions Sub-Committee 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 170 semester-credit-hour review described below.

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.

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 major or administrative department concerning appointment of the Chairman 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 major department.

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

The Chairman in consultation with the student will select the remainder of the Advisory Committee. The Chairman will then notify the tentative members of the Advisory Committee, giving the student's name and field of study and 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 Chairman 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 degree program, the internship, the 170-hour examinations (written and oral), 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 degree program which will constitute the basic academic requirements for the degree. The student's 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 major 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 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 16 semester credit hours.

The 80 semester credit hours of graduate course work shall include 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.

Scholarship

In order to remain in good standing, students admitted to the Doctor of Engineering Program must maintain a GPR of 3.0 during their undergraduate studies and 3.25 during their graduate studies.

Examinations

All students admitted to the Program are required to pass a written and oral examination administered after completing a total of 170 semester credit hours. This 170 hours includes the 68 semester-credit-hour pre-professional program and 102 credit hours of the professional program. A student who fails the 170 credit hour 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 six months, upon the recommendation of the Advisory Committee.

The candidate for the degree of Doctor of Engineering must pass a final 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

his 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 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 9 months, or equivalent, working under the supervision of a practicing engineer in industry, business or government. The objectives of the internship are two-fold: (A) 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 (B) 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. These may include, but are not limited to, problems of management, labor relations, public relations, environmental protection, and economics.

Internship agreements will be negotiated between appropriate industrial organizations and the College of Engineering. Specific arrangement for the internship will be made through the student's major department. The organization, internship supervisor, and the nature of the problem will be pre-determined by mutual consent of the student, the graduate advisor and 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.

Students who have had extensive engineering experience may substitute equivalent academic course credit for the internship on an individual basis, provided that they submit an acceptable Internship Report.

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 one copy 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 signatures of the Department Head and the student's Advisory Committee, with the exception of the representative of the Graduate Council.

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 program is intended to provide the candidate with academic and research competence of the highest order in the professions of architecture, landscape architecture, or urban and regional planning.

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 degree program. Courses will be selected from current, approved, interdisciplinary listings.

Admission

In addition to the normal admission requirements of the Graduate College, each applicant must submit the following to the College of Architecture and Environmental Design.

A. An illustrated brochure, or portfolio, which has been designed to exhibit the individual's professional experience and competence. Preferred format size is 8¼ " x 11 ".
B. A comprehensive paper describing in detail the individual's goals, objectives, and the proposed program of study.

Students entering the D.E.D. program must complete ninety-six (96) semester hours of approved graduate study beyond the baccalaureate degree. In addition, the candidate must complete one of the three following assignments to demonstrate professional competence:

A. A written dissertation on a subject approved by the candidate's Advisory Committee.
B. A comprehensive professional report resulting from research and a related period of professional internship approved by the candidate's Advisory Committee.
C. A major design and/or planning research project approved by the candidate's Advisory Committee.

Options B & C require the filing of a Record of Study before the final examination can be administered. The requirements and procedures for this Record of Study are similar to those for theses or dissertations.

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 4 weeks prior to registration (3-4 months prior to registration for foreign students; use foreign 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 Degree Program		Prior to Preliminary Examination (See **Catalog** for specific details)
6. Arrange Preliminary Examination	ADCom / Dean	At least 7 months prior to expected graduation date
7. Submit proposal for dissertation or record of study	ADCom, DH / GCR & Dean	At least 7 months prior to expected graduation date
8. Request ADCom to recommend admission to candidacy; completion of 5, 6, and 7 above required	ADCom / Dean	At least 7 months prior to expected graduation date
9. Prepare rough draft of dissertation	ADCom	
10. Apply for degree	Dean	During final semester; see Graduate College Calendar for deadlines
11. Submit 3 approved copies of dissertation or record of study and announcement for final examination	ADCom, DH & Dean	At least 2 weeks prior to final examination (see **Catalog** for specific details)
12. 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. During the semester or summer session in which the degree is conferred, a student must be officially registered in the University.

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 ninety (90) days prior to the end of the semester or thirty (30) days prior to the end of the summer term in which the student expects to have the degree conferred.

Each candidate for a degree must attend the commencement exercises in appropriate academic regalia unless a petition to be excused, signed by the Chairman of the student's Advisory Committee, is approved by the Dean of the Graduate College. The petition should be submitted at least thirty (30) days prior to commencement.

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

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 (9) months, whereas the appointment to a teaching assistantship may vary from nine (9) to twelve (12) months. Graduate Assistantships — Research are usually twelve (12) month appointments, although vacancies may be filled for shorter periods.

A course load of nine (9) to twelve (12) credit hours of academic work per semester and four (4) hours per summer term is normally required of graduate assistants.

The stipend for all assistantships is competitive with that paid by most other institutions. Stipends are paid in monthly installments.

A limited number of Graduate College 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 Graduate College Fellow may be required to spend up to one-fourth time on **relevant teaching activities** during one semester only (or during one 12-week summer session) during a 12-month period. Since Graduate College Fellowships normally permit full-time study and research, the holder of such a grant will be expected to register for twelve (12) to sixteen (16) credit hours per semester and six (6) hours per six-week summer term.

Additional fellowships sponsored by individuals, industrial corporations, and private foundations are available in certain departments.

Applications for all assistantships and fellowships, together with transcripts, letters of recommendation, and Graduate Record Examination scores, should be filed with the Dean of the Graduate College on or before March 1 preceding the academic year for which awards are to be made.

Forms for making application for assistantships and fellowships are available in the office of the Graduate College. Information regarding assistantships and fellowships may be obtained by writing directly to the head of the department concerned.

LIBRARY FACILITIES

Sterling C. Evans Library

The university's principal research collections, numbering over 1,120,494 physical volumes and the microtext equivalent of 246,446 volumes, are housed in a centrally located facility which provides seating for 1,800 readers. Three hundred and fifty lockers located on the third and fourth floors are available for assignment to graduate students. There are, in addition, 140 closed studies for use by faculty members and doctoral students engaged in research requiring extensive and constant use of library materials. Construction is underway for a $12 million library addition, scheduled for completion late in 1979.

The general collection is organized for use on a subject division plan, with three service desks available for reference assistance. Humanities/Social Sciences Reference is on the first floor, Documents Division is on the second floor, and Science and Technology Reference is on the fourth floor.

Approximately 15,000 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 210,000 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.

As a member of the Center for Research Libraries, the library can provide access to the Center's more than 3 million volumes of research materials. Information about the Center for Research Libraries is available from Interlibrary Services Division on the first floor of the Sterling C. Evans 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.

Special Collections

These collections, housed on the third floor, consist of 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, 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 branch is located in the Veterinary Administration Building, and has over 32,270 volumes. The library subscribes to approximately 690 American and foreign periodicals. It serves both the College of Medicine and the College of Veterinary Medicine. On-line access to MEDLINE is provided to faculty and students.

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:

Department of Security and Traffic, which coordinates and implements university functions relating to security and traffic — to include traffic control, vehicle registration, building and property security, and enforcement of all state and university laws and regulations (located at the corner of Jersey and Houston streets).

Memorial Student Center, which is both a facility and a program providing services, facilities, and programs for the social, cultural and recreational needs of the Texas A&M University community. Programs produced for the campus community are initiated, organized and presented by the MSC Council and Directorate.

Office of the Students' Legal Advisor, which offers legal advice and counseling to all students (located in Room 306, YMCA Building).

Office of the Commandant, which plans, coordinates and implements programs of the Corps of Cadets. Army, Navy/Marine and Air Force ROTC programs are offered (located in the Military Science Building).

Personal Counseling Service, which provides personal, social, emotional, marriage, human sexuality, career and group counseling; a career, educational and personal growth information library; test interpretation; and referral to other services (located in Room 017, YMCA Building).

Student Activities, which assists approximately 400 student organizations with organizational development, funding and activities. This office also publishes calendars, handbooks and other publications of an informational nature for the university community (located in Room 221, Memorial Student Center).

Student Affairs, which is responsible for student development, residence halls, discipline, off-campus roommate service, apartment listings, concessions permits, SOTA (Students Older Than Average), and Hassle-Free (an off-campus program) (located in Rooms 103 and 108, YMCA Building).

University Health Service, which provides a modern clinic for out-patient services and beds for 44 in-patients. The facilities of the clinic include a modern laboratory, and 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, gynecology and psychiatry.

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 5 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 accidents, ten days of treatment(s) per semester for cases requiring hospitalization at the University, medications according to pharmacy policy (medications unavailable at the hospital must be purchased by the student), and x-rays and laboratory tests as indicated.

The University Health Center does not perform or provide care for major surgery. In these cases, the student selects the hospital and surgeon and assumes financial responsibility for surgical or medical procedures.

Handicapped Students

Texas A&M University makes every effort to assure that no otherwise qualified handicapped person shall, on the basis of the handicap, be subjected to discrimination either as related to student involvement in, or to employment in, any of the University's programs or activities. Such students are invited to visit the Student Activities Office in Room 221 of the Memorial Student Center to discuss any problem or to obtain general assistance as special needs arise.

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 the offering of the course.

DEPARTMENT OF ACCOUNTING

E. D. Bennett, L. L. Bravenec, D. L. Crumbley, S. D. Grossman, J. R. Hasselback, S. H. Kratchman*, L. G. Pointer, G. Schugart (Acting Head), C. D. Stolle, R. H. Strawser, M. Tummins, R. B. Welker

The graduate courses in the Department of Accounting provide further study facilities for those preparing to work in public accounting and as accountants in government and business. They also include courses suitable for those preparing for teaching careers, particularly at college level. A graduate program consisting of coursework in accounting and including work in related fields such as computer science, finance, management, marketing and economics, leads to the M.B.A. degree with a major in accounting. Individual curricula lead to the degree of M.S. (Accounting) and the Ph.D. in Business Administration with a major field in accounting.

The bachelor's degree in Business Administration is the normal requirement for admission to graduate courses in accounting. The holder of a degree obtained in some other field can take preparatory courses at the graduate level that will allow the student to complete the requirements for a graduate degree in accounting.

(Acct.)

602. Business Combinations and Accounting Measurements. (3-0). Credit 3. Accounting treatments for business combinations are investigated together with the reporting practices followed by conglomerate companies. Students will examine Security and Exchange Commission decisions, corporation annual reports and stock exchange listing statements and develop case studies during the term. Prerequisite: Acct. 641 or equivalent.

607. Seminar in Auditing. (3-0). Credit 3. Current issues and research in auditing, attestation, and financial disclosures. Prerequisite: Acct. 407 or equivalent.

611. Management of Taxation. (3-0). Credit 3. Various income taxes on taxable entities. For business and other majors. Prerequisite: For non-accounting 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. Topic for course to be selected; may include oil, gas and mineral taxation, compensation techniques, consolidated returns, and foreign taxation. Prerequisite: Acct. 405 or 611.

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

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. Intensive examination of financial accounting. Emphasis upon conceptual aspects obtained through the problem approach. Prerequisites: Graduate classification and Acct. 640 or equivalent.

649. Managerial Accounting. (3-0). Credit 3. Cost accounting concepts and utilization of accounting data in planning and control of operations. Prerequisites: Acct. 640 or equivalent.

651. Development of Accounting Thought. (3-0). Credit 3. Inquiry into criteria for choices among income-determination and asset-valuation rules in context of public reporting. Prerequisite: Acct. 641 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. In depth investigation of some primary aspects of managerial accounting needs including 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, including tax analysis research, policy implications, behavioral aspects, and use of quantitative analysis. Prerequisite: Acct. 405 or 611.

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

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. Study of 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 standing in Accounting.

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

DEPARTMENT OF AEROSPACE ENGINEERING

L. A. Carlson, H. L. Chevalier, W. E. Haisler, W. B. Ledbetter, S. H. Lowy, (Acting Head)*, D. J. Norton, J. L. Rand, C. A. Rodenberger, C. H. Samson, Jr., R. A. Schapery, R. E. Thomas, R. S. Wick

The Department of Aerospace Engineering offers graduate work to provide more complete training in preparation for the practice of aeronautical/aerospace engineering and careers in pertinent areas of research. Programs leading to the degree of M.Engr., M.S., Ph.D., and D.Eng. are offered. There are no foreign language requirements in any of these programs. Major areas of interest are aerodynamics, structural analysis, propulsion, and wind engineering.

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. Investigations of structural dynamics problems are undertaken in well instrumented laboratories. Finite element solutions, flexible membrane analyses and computational fluid mechanics are efficiently developed with the Amdahl 470V/6 digital computer and supporting equipment.

*Graduate Advisor

(Aero.)

601. Principles of Fluid Motion. (4-0). Credit 4. Equations of motion for compressible and incompressible flow. One dimensional flows with transport. Multi-dimensional flow of perfect fluids. Introduction boundary layer theory. Prerequisite: Approval of instructor.

606. Space Propulsion. (3-0). Credit 3. Analysis of propulsion systems. High temperature flow and electrical fields including equilibrium and non-equilibrium chemistry. Applications to current propulsion devices. Prerequisite: Approval of instructor.

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.

620. Unsteady Aerodynamics. (3-0). Credit 3. Introduction to unsteady airfoil theory and discussion of techniques used for determining airloads and airload distributions on oscillating lift surfaces, e.g. aircraft wings and tailplanes. Treatment of problems of unsteady incompressible, subsonic, transonic and supersonic flows in two and three dimensions. Exact solutions and various approximations for particular cases will be given. 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. Atmospheric Engineering. (2-3). Credit 3. Natural aerodynamics applied to practical problems. The 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. Emphasis will be on laboratory simulation methods. Prerequisites: Undergraduate fluid mechanics.

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

685. Problems. Credit 1 to 4 each semester. Investigation of 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. Study of 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 Aerospace Engineering courses in applied mechanics such as elasticity, plasticity, continuum mechanics, etc., are listed under the section entitled Mechanics and Materials under Interdisciplinary Engineering.)

DEPARTMENT OF AGRICULTURAL ECONOMICS

W. G. Adkins, P. J. Barry, B. R. Beattie, R. V. Billingsley, W. E. Black, R. E. Branson, R. A. Dietrich, D. E. Farris, S. W. Fuller, B. L. Gardner, W. L. Griffin, C. R. Harston*, J. A. Hopkin (Head), J. B. Hottel, L. L. Jones, R. D. Kay, R. D. Knutson, R. D. Lacewell, C. F. Lard, D. R. Levi, J. R. Martin, L. C. Morgan, J. P. Nichols, J. B. Penson, I. W. Schmedemann, V. E. Schneider, C. E. Shafer, C. R. Shumway, T. L. Sporleder, H. Talpaz, C. R. Taylor, E. Uvacek Jr., W. J. Vastine, R. E. Whitson, A. B. Wooten, A. L. Wright

The objective of the Department of Agricultural Economics program 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, irrespective of his 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 he is expected to acquire a knowledge of economic theory, and 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 agricultural policy. The present and expanding program of research in the department affords the student a wide choice and capable guidance in his thesis or dissertation research.

The M.S. degree may or may not require a thesis and is oriented to the basic professional requirements. The Master of Agriculture degree offers a selection from the following areas of specializations: (1) agribusiness management, (2) agribank-

ing, (3) commodity analysis, (4) real estate economics, (5) international agricultural development. These areas are oriented to the needs of students who will seek employment rather than continue for the Ph.D. A professional internship is required but no thesis. 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.

*Graduate Advisor

(Ag. Ec.)

602. Agricultural Market Organization and Structure. (3-0). Credit 3. Analysis of the 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: Ag.Ec. 314.

603. Land Economics. (3-0). Credit 3. Study of selected problems of allocation and utilization of natural resources with special reference to government organizations, quasi-government bodies, and other interest groups. Prerequisite: Ag.Ec. 422 or equivalent.

604. Economics of Natural Resources Development. (3-0). Credit 3. Critical evaluation of policies and procedures in natural resource development and use. Emphasis given to the 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.

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.

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

611. Production Economics. (3-0). Credit 3. Economic principles for analyzing agricultural production and resource use; problems are treated regarding the technical unit, the firm and society emphasizing conditions for efficiency. Prerequisite: 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.

617. Market Development Research Theory. (3-0). Credit 3. Analysis of the 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 are examined. Considerable emphasis on market development technical research methods and operations.

619. Agricultural Business Analysis. (3-0). Credit 3. Oriented to students enrolled in Master of Agriculture degree program. Emphasis on practical application of modern decision-making tools to agribusiness. Stresses 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 together with appropriate quantitative methods to financial management in agriculture and financial markets serving agriculture. Prerequisites: Ag. Econ. 630, 611, 641, Stat. 608 or equivalent.

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. Resource Allocation in Agriculture. (3-0). Credit 3. Production economics. Theory of the firm applied to problems of product supply, factor demand and resource allocation, major estimating methods analyzed. Prerequisites: Ag.Ec. 611, Ecmt. 663 or Stat. 608 and Ag.Ec. 641 (corequisite).

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 graduate students in the College of Agriculture other than in agricultural economics.

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. Emphasis on 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 computer language (Continuous System Modeling Program). Prerequisite: Ag. Eco. 641.

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

655. Agricultural Marketing Operations. (3-0). Credit 3. Commodity system: structure and performance; forces of change affecting responses of marketeers to change within. Primarily emphasizing practical management: analysis, planning, organization and control. Prerequisites: Ag.Ec. 314, Econ. 203, or equivalent.

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. Study of 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

H. D. Brown, J. E. Christiansen*, K. L. Denmark, J. P. Grimes, D. R. Herring, J. W. Holcomb*, E. H. Knebel (Head)*, E. S. Webb*

Advanced study in agricultural education provides an opportunity for teachers of vocational agriculture to improve their efficiency as master teachers. Agricultural extension personnel and other professional workers in colleges, business, industry, and developing countries may also improve themselves through selected courses designed to meet the needs of professional persons in building programs for implementing changes. 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 advanced degrees in agricultural education should have at least one year of successful professional experience. However, evidence of maturity, purposefulness and scholastic ability may be considered in lieu of experience upon the approval of the Agricultural Education faculty and the Head of the Department.

The staff of the Department of Agricultural Education maintains close and continuous contact with teachers and agricultural extension service workers in the field by visiting departments of vocational agriculture and county offices of agricultural extension agents, by attending professional meetings, by assisting with in-service training, and by conducting off-campus classes of instruction. This intimate and continuous contact enables the staff to conduct its graduate programs with understanding and appreciation of the relative importance of the many complex problems and difficulties that professional agricultural workers encounter in their work.

(Ag.Ed.)

601. Advanced Methods in Agricultural Education. (3-0). Credit 3. Learning theories; emphasis upon 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 will be identified, analyzed and resolved. Prerequisites: Graduate standing and employment as a teacher.

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: Professional experience or 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, emphasizing ideas of individuals that culminated in agricultural education institutions and organizations. Prerequisite: Approval of Department Head.

616. Program Building in Agricultural Education. (3-0). Credit 3. Organization of educational programs in agriculture on local, state, and national basis. Prerequisite: Professional experience or 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 utilized 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, including institutional models, assignment of priorities, institutional linkages, communications, special program design, program strategies and program evaluation. Prerequisite: Professional experience or approval of Department Head.

681. Seminar. (1-0). Credit 1 each semester. Group study and discussion of current developments in agricultural education. Special emphasis given to research and legislation as they affect programs in teacher education, vocational agriculture, and related areas of education. Prerequisite: Graduate classification.

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. Study of 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, I. L. Berry, B. J. Blanchard, C. G. Coble, E. A. Hiler* (Head), J. P. Hollingsworth, T. A. Howell, E. B. Hudspeth, O. R. Kunze*, W. A. LePori*, W. M. Lyle, W. E. McCune, C. B. Parnell, D. L. Reddell, J. H. Ruff, B. R. Stewart, R. E. Stewart, D. A. Suter, V. E. Sweat, J. M. Sweeten, L. H. Wilkes, W. L. Zingery

The Department of Agricultural Engineering offers graduate studies leading to the degrees of Master of Science, Master of Engineering, Doctor of Engineering, and Doctor of Philosophy. In addition, the department offers the Master of Agriculture degree in Mechanized Agriculture. The department has no Ph.D. foreign language requirement. Depth of study and specialization may be selected from certain special fields such as machinery, product processing, structures, soil and water,

*Graduate Advisor

food engineering, animal environment, agricultural waste management and pollution abatement, and forest engineering (in cooperation with the Departments of Forest Science and Civil Engineering). 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 physical science or engineering.

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. Encompasses analysis of problem need, functional requirements, common materials used, design, testing, and production of efficient operational units. Prerequisite: Approval of Department Head.

605. Agricultural Structures. (3-0). Credit 3. Structural, environmental, and economic problems encountered in agricultural buildings. Special emphasis on design considerations for structural materials. Research methods and procedures as applied to agricultural structures. 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. Includes application of refrigeration, electric energy, and physical properties of agricultural products. Prerequisite: Approval of Department Head.

609. Farm Power. (3-0). Credit 3. Theory and principles of operation as applied to internal combustion engines used for agriculture. Emphasis given to application and functional design requirements and testing procedures. Prerequisite: Approval of Department Head.

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 including surface, sprinkler, trickle, and subsurface irrigation systems. Emphasis on the total system, including 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, with emphasis on 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, including soil, water and humidity devices and instruments for quality evaluation and control of agricultural products, including 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.

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, 6 hours of theory and 6 hours of practice per week are required. Prerequisite: Professional experience or approval of Department Head.

651. Biochemical Engineering. (3-0). Credit 3. Integration of principles of engineering, biochemistry and microbiology, including 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. (This course is offered jointly by Ag.En., B.E. and Ch.E. and is triple-listed.)

652. Enzyme Engineering. (3-0). Credit 3. Application of basic principles of life science and engineering technology, including large scale unit operations involved in production, isolation, immobilization, economical utilization of enzymes as well as optimization of enzyme reactor systems. Emphasis on application of enzymes in pharmaceutical, food and fine chemicals industries as well as medical and clinical application. Prerequisite: Approval of instructors. (This course is offered jointly by Ag.En., B.E. and Ch.E. and is triple-listed.)

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. Study of 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.

DEPARTMENT OF ANIMAL SCIENCE

J. W. Bassett, G. A. Broderick, O. D. Butler, Jr., J. Caldwell, M. C. Calhoun, Z. L. Carpenter (Acting Head)*, T. C. Cartwright, B. M. Colvin, B. E. Conrad, C. W. Dill, T. R. Dutson, W. C. Ellis, J. L. Fleeger, S. H. Fowler, T. R. Greathouse, P. G. Harms, J. H. Hesby, N. M. Kieffer, G. T. King*, D. C. Kraemer, H. O. Kunkel, W. A. Landmann, R. E. Lichtenwalner, H. Lippke, C. R. Long, C. S. Menzies, R. Nickelson, F. A. Orts, G. D. Potter, R. D. Randel, K. S. Rhee, J. K. Riggs, L. M. Schake, J. M. Shelton, G. C. Smith, A. M. Sorensen, Jr., T. D. Tanksley, Jr., R. N. Terrell, W. B. Thomas, M. Tomasewski, C. Vanderzant, D. F. Weseli, J. W. Wiltbank

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

Animal Breeding	(M.S. and Ph.D.)
Animal Nutrition	(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.)
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, immunogenetics, meats, meat chemistry, nutrition and reproductive physiology. The new Robert Justus Kleberg, Jr. Animal Science Center provides 39 laboratories for research and graduate training. Special equipment available in these laboratories or in readily available facilities, such as at the large Data Processing Center, offer 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 artificial insemination, 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.

Minors or joint majors in such areas 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.

ANIMAL SCIENCE

(An. Sc.)

601. General Animal Nutrition. (3-0). Credit 3. Biochemical and physiological bases for mammalian nutritional requirements. Historical and experimental approach to animal nutrition. Prerequisites: An.Sc. 303 and 309 (or equivalent) or approval of Department Head.

602. Protein and Energy Nutrition. (3-0). Credit 3. II Transformation of dietary protein and energy by homeotherms to provide for organisms nutritive requirements for protein and energy in health and production. Physical, physiological, and biochemical aspects and their application in practice emphasized. Prerequisites: An.Sc. 444; Bich. 410.

603. Experimental Nutrition. (1-6). Credit 3. II A review and application of procedures utilized in nutrition research. Principles and techniques of sample collection and analyses; their basis, application and limitation. Prerequisites: An.Sc. 444; 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, S 1979 Current knowledge and concepts in beef production; review of research relating to cow-calf production including breeding, management, nutrition, reproduction, and economic considerations. Prerequisites: An.Sc. 305, 306, 309 and 406 or approval of Department Head.

606. Advancements in Beef Cattle Production. (3-0). Credit 3. II, S 1979 Continuation of An.Sc. 605 except emphasis is placed on growing, and finishing cattle for slaughter. 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 Emphasizes 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. Feedlot Management. (3-0). Credit 3. II Current knowledge of commercial feedlot management. Disciplines of nutrition, management, breeding, meats, herd health, pollution control, and sanitation will be discussed. Prerequisite: An.Sc. 406.

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 are discussed. 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.

616. Quantitative Genetics II. (3-0). Credit 3. II Theories and methods useful in quantitative genetics research, including 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. Cross-listed with F.S.T. 617.

619. Advancements in Sheep and Angora Goat Production. (3-0). Credit 3. I; S 1979 Review of research relating to various phases of sheep and Angora goat enterprises. Evaluation of research; fitting sheep and Angora goats to whole farm and ranch system. Special attention to over-all economic operation. 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.

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. Special attention to 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 including 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 Study of basic biochemical, physiological and endocrine mechanisms involved in reproductive function. Current research principles and techniques useful in studying physiology of reproduction will be emphasized. Prerequisites: An.Sc. 433, Bich. 410, VPP 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. Topics to be studied include ovulation control, embryo transfer, multiple births, and control of parturition. Prerequisites: 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 will be emphasized. Cross-listed with F.S.T. 647.

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; major 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 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. Registration by 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 each semester. I Advanced study of dairy production problems with special emphasis on the research literature. Several principles are studied in search of a bio-economic model to improve production efficiency. Prerequisites: D.S. 418 or equivalent, and Stat. 651 recommended.

602. Dairy Production. (2-6). Credit 4 each semester. II Continuation of D.S. 601 with emphasis on research techniques and methodologies, data procurement and analysis, and reporting of results. Prerequisites: D.S. 601, Stat. 651, and Stat. 652 recommended.

605. Chemistry of Foods. (2-3). Credit 3. I Advanced study of chemistry of dairy foods and meats relating to their composition and characteristic properties important to their subsequent manufacture into food products. Prerequisite: Bi.Ch. 410 or 603. Cross-listed with F.S.T. 605.

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. Prerequisite: D.S. 326 or approval of Department Head. Cross-listed with F.S.T. 606.

608. Seafood Preservation and Processing. (3-2). Credit 4. I 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. Cross-listed with F.S.T. 608.

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 Study of 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 manufactures.

DEPARTMENT OF ARCHITECTURE

L. O. Degelman, D. C. Ekroth, J. S. Garner, H. L. Garnham, W. W. Harper*, C. M. Hix, G. J. Mann, R. T. Meeker*, D. Poniz, R. D. Reed, E. J. Romieniec, F. J. Trost, D. G. Woodcock, (Head)*, P. J. Zweig

The Department of Architecture offers programs of advanced study as preparation for professional careers in architecture, the construction industry, and related environmental design fields. Candidates for the non-thesis degree of Master of Architecture select an area of emphasis approved by the department. Current areas include Building Design, Construction Management, Interior Space Design, Systems Development, and Urban Design. The Department also provides coursework and advisory support for those students seeking the degree of Doctor of Environmental Design whose descriptive emphasis is in Architecture.

*Graduate Advisor

(Arch.)

601. Environmental Design I. (2-12). Credit 6. Basic aesthetic design theory; programming and analysis theories; visual communications techniques related to architecture. Design experiences related to the human environment. Intended for students entering the professional degree program with a nondesign background.

602. Environmental Design II. (2-12). Credit 6. Design of architectural space through case studies; emphasis on aesthetic, special and general environmental consequences of physical design; communications in two and three dimensions. Prerequisite: Arch. 601 or approval of Department Head.

605. Building 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. Prerequisite: Graduate classification in Architecture.

606. Building Design II. (2-12). Credit 6. Continuation of Arch. 605. Design experience including 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. Building Design III. (2-12). Credit 6. Individually directed design studios, including elected and assigned projects. Advanced analysis, synthesis and appraisal techniques responding to contemporary architectural issues. Prerequisite: Arch. 606 or equivalent.

608. Building 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.

614. Urban Design II. (2-4). Credit 3. Theories and processes which define urban growth and form. Interdisciplinary studies and analysis techniques necessary for designing in modern urban environments. Prerequisite: Arch. 613 or approval of instructor. Cross-listed with Land. 614.

615. Urban Design III. (2-12). Credit 6. Development of comprehensive professional solutions to physical urban problems based on analysis at community scale. Team structure problems will provide opportunity for individual emphasis. Prerequisite: Arch. 613 or equivalent. Cross-listed with Land. 615.

616. Urban Design IV. (2-12). Credit 6. Major study at urban design scale involving complex physical design. Professional documentation required. Prerequisite: Arch. 615 or equivalent. Cross listed with Land. 616.

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

624. Design Methods II. (3-0). Credit 3. Design as innovative problem solving. Focus on rational approaches to problem solving in architecture and related fields.

628. Contemporary and Creative Structures. (2-2). Credit 3. Contemporary and creative structures as related to architectural design. Form finding processes. Synthesis of form, structural behavior and use of material. Model techniques of close packing and polihedral structures, space frames, goedesics and domes, tensegrities and lightweight structures. Prerequisite: Graduate classification.

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: 9 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; emphasis on 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; special emphasis on the American city. Prerequisite: Graduate classification.

642. Data Processing in Environmental Design. (2-3). Credit 3. The application of the computer to architectural problems. Emphasis on 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.

643. History of Systems Development. (3-0). Credit 3. Historical development of various environmental building systems emphasizing methodology of their development and implementation. Prerequisite: Graduate classification.

644. Theory of Building Systems Development. (3-0). Credit 3. General factors in decision making process utilized in research and development of building systems. Classification and interrelationship of utilitarian function, structural function and environmental control requirements. System approach to architecture patterned by production-consumption cycle. Prerequisite: Approval of Department Head.

645. Alternative Futures and Architecture. (3-0). Credit 3. Theory and form-giving in architecture as affected by alternative futures, changing technology and environmental issues. Prerequisite: Approval of instructor.

650. Industrialized Building Systems. (3-0). Credit 3. Social, economic and technological forces determining building systems in both industrially developed and industrially underdeveloped countries. Detailed examination of selected examples.

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, polices 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 including standard conditions of construction contracts; selection of contracts; project procedures and administration; professional liability. Prerequisite: Mgmt. 312, graduate classification.

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

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

666. Interior Space Design 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. (3-4). Credit 5. Selected residential and nonresidential development projects of varying size analyzed by student teams with respect to the following: (a) economic feasibility and cash flow; (b) site analysis; and (c) design concept. Interdisciplinary faculty team. Prerequisite: Approval of Department Head. 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. Study of 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 coursework 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. Study of 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 thesis.

692. Professional Study. Credit 1 or more each semester. Conduct of approved professional study or project undertaken as the terminal requirement for the Doctor of Environmental Design degree. Preparation of a Record of Study summarizing the rationale, procedure, and results of the completed project. Prerequisite: Approval of committee chairman.

DEPARTMENT OF BIOCHEMISTRY AND BIOPHYSICS

G. W. Bates, N. R. Bottino, C. R. Creger, J. W. Dieckert, G. A. Donovan, A. S. Garay, R. D. Grigsby, J. M. Gunn, A. R. Hanks, E. D. Harris, G. M. Ihler, H. O. Kunkel, W. A. Landmann (Head), R. W. Lewis, J. M. Magill, E. F. Meyer, J. B. Moore, J. Nagyvary, R. D. Neff, C. N. Pace*, J. M. Prescott, H. A. Roller, W. J. Tolmsoff, E. A. Tsutsui, R. D. Wood

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 some experience in teaching, inasmuch as each is expected to serve as a teaching assistant at some time during his graduate work.

A non-thesis option for the M.S. degree is available to students not intending to enter a research career, or in special instances when recommended by the student's faculty advisory committee and approved by the Head of the Department.

The department encourages interdisciplinary research projects with other departments within the College of Agriculture, as well as with such other departments as chemistry, physics, biology, and oceanography.

Facilities are available for advanced instruction and student research in various phases of biochemistry and biophysics. Among the specialized items of equipment available are a Hitachi HU 11A high-resolution electron microscope, a high-resolution mass spectrometer, a Datex-Syntex four-circle X-ray diffractometer, a Vector General three dimensional interactive computer graphics display, a Carey Model 60 spectropolarimeter, preparative and analytical ultra centrifuges, a variety of electrophoretic instruments, several amino acid analyzers, a peptide sequencing unit, and automated gamma-ray spectrometers, as well as the usual array of spectrophotometers, fraction collectors, and gas chromatographs.

Research fields include protein chemistry, lipid chemistry and metabolism, enzymology, intermediary metabolism and human nutrition, nucleic acid chemistry and design of cancer drugs, structure studies by X-ray crystallography and computer graphics, mass spectrometry, biochemistry and physiology of pesticides, insect hormones and pheromones, plant biochemistry, and biochemical genetics.

The department has a foreign language or humanities requirement for the Ph.D. degree, as well as an English requirement for all students, including those seeking the M.S. degree, who are found to be deficient in writing skills. Detailed information may be obtained from the department office.

Students entering graduate work in biochemistry or biophysics are required to have adequate preparation in chemistry, mathematics, physics, and modern biology.

An interdisciplinary area of specialization is available in health physics, encompassing physics, biology, chemistry, and engineering from the standpoints of radiation effects and radiation safety. Typically, this consists of basic courses in radiation physics, radiation biology, and radiation chemistry with provisions for training and research in the student's specialized area of interest. To qualify, students should have an undergraduate degree in science or engineering, including mathematics through differential equations, physics through atomic or modern physics, a full year of chemistry, and a full year of biology or be prepared to make up deficiencies.

Graduate studies in health physics may also be undertaken in the Department of Nuclear Engineering.

*Graduate Advisor

BIOCHEMISTRY
(Bich.)

603. General Biochemistry I. (3-0). Credit 3. Constituents of living matter, their structure, chemical properties and their metabolism in the cell. Role of enzymes and their mode of action as catalysts for biological reactions stressed. Prerequisites: Chem. 228, 316.

604. General Biochemistry II. (3-0). Credit 3. A continuation of Bich. 603. Integration of chemistry and function of pathways, overall regulation, and work processes in living organisms. Prerequisite: Bich. 603.

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

618. Chemistry and Metabolism of Lipids. (3-0). Credit 3. Advanced course in lipid chemistry and metabolism. Prerequisite: Bich. 604.

624. Proteins and Enzymes (3-0). Credit 3. Chemical and physical properties of proteins and enzymes. Thermodynamics, kinetics, and mechanisms of enzyme catalyzed reactions. Prerequisites: Bich. 603; Chem. 324.

630. Current Topics in Metabolism I. (2-0). Credit 2. Selected topics in metabolism and biochemical pathways. May be repeated once for credit. Prerequisites: Bich. 604 and classification of 8.

636. Metals in Biological Systems. (3-0). Credit 3. Analysis of roles of metals in life processes. Exact molecular structure and function, including metals as integral part of many biomolecules and subcellular organelles and the metabolic processes mediated. Medical aspects included. 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. Emphasis on the mechanisms in normal and the diseased state of the human. Prerequisites: Bich. 411 or 604.

642. The Biochemistry of Metabolic Disorders. (2-3). Credit 3. Advanced level metabolism course emphasizing the perturbation of normal regulatory processes in disease states, including hormone action, second messengers, carbohydrate metabolism, protein turnover, interrelationship of fat, protein and carbohydrate metabolism, cancer, atherosclerosis, diabetes, cirrhosis. 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 including 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. Study of selected topics in an identified area of Biochemistry. May be repeated for credit. Prerequisites: Bich. 604.

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.

See Genetics 631 for full description of related course.

BIOPHYSICS
(Biph.)

621. Interpretation of Organic Mass Spectra. (3-0). Credit 3. Mass spectra of organic compounds including biologically related structures. Basic instrumentation for low- and high-resolution mass spectrometers presented. Fragmentation mechanisms are described for common classes of compounds. Prerequisite: Chem. 228.

622. Thermodynamics of Biochemical Equilibria. (3-0). Credit 3. Calculation of equilibrium constants for biochemical reactions. Includes methods of evaluating standard free energy changes for chemical reactions, standard free energies of formation of compounds, and activities of substances in solution. Prerequisite: Chem. 323.

625. Structural Biochemistry. (3-0). Credit 3. A body of information on the structure of biological molecules at or near atomic resolution is brought to bear on question of biological specificity. Computer aided molecular modeling techniques are employed and information retrieval techniques are developed in order to scan the vast amount of information available in the scientific literature. Prerequisite: Chem. 324.

626. Radioisotopes Techniques. (2-3). Credit 3. General course on the nature and utilization of isotopes in chemical and biophysical studies. History, general properties of nuclei, nuclear reactions, radiation, health physics and instrumentation. Prerequisites: Math. 122; Phys. 201 and 202.

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

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

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

DEPARTMENT OF BIOLOGY

G. Bhaskaran, V. M. Bryant, E. R. Cox, K. Dahm, N. O. Dronen, R. S. Egan, W. P. Fife, B. G. Foster, H. W. Harry, W. M. Kemp, W. R. Klemm, G. M. Krise*, D. M. Mueller, J. M. Neff, D. J. Opheim, E. T. Park, L. E. Ray, S. M. Ray, P. J. Rizzo, H. A. Roller, M. D. Schedlbauer, G. L. Schroeter, J. R. Seed (Head), C. J. Sherry, H. G. Shertzer, M. H. Sweet, W. A. Taber, E. L. Thurston, C. Vanderzant, U. G. Whitehouse, W. B. Wilson

The Department of Biology offers graduate studies leading to the M.S. and Ph.D. degrees in biology, botany, microbiology and zoology.

Other areas of study are aquatic and marine biology; biology of algae; various phases of ecology; plant, invertebrate and mammalian physiology; cell and molecular regulatory biology; electron microscopy; vertebrate and invertebrate endocrinology. The objective of the graduate training is to produce leaders in biological teaching and research. Biology has major applications in education, medicine, veterinary medicine, agriculture, fisheries, environmental and wildlife management. The Department recognizes that students are individuals, and strives to develop their talents through individual programs.

The Biology Department also offers cooperative research programs with other departments on campus. Graduate students in biology may do cooperative research in the areas of animal parasitology and physiology, agricultural plant sciences, wildlife management, fisheries biology, entomology, environmental engineering, oceanography, genetics, education and philosophy.

Information concerning the Ph.D. foreign language requirement may be obtained from the departmental office.

*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 will be studied in the field. Prerequisite: Biol. 357 or equivalent.

607. Ethnobotany. (3-3). Credit 4. Interrelationship between plants and man from prehistoric times to present, emphasizing 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. Course taught by lecture and 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. Study of immunological reactions as related to the diagnosis of human disease. Both basic immune phenomena and practical laboratory experience will be stressed. Prerequisite: Biol. 351 or equivalent.

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 with emphasis on orientation mechanisms in marine and freshwater fish and other aquatic organisms. Prerequisites: Major in Biology, Wildlife and Fisheries Sciences, Psychology or permission of instructor.

614. Palynology. (3-3). Credit 4. Principles and techniques used in palynology including pollen morphology, ontogeny, biochemistry, dispersion and preservation. Emphasis on 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; the relationship between structure and function at cellular and sub-cellular levels; the structural and ultrastructural aspects of cell division. Prerequisite: Graduate classification in biology or related science.

617. Ultrastructure of Microorganisms. (3-0). Credit 3. Structure and function in prokaryotic and eukaryotic microorganisms discussed on a comparative basis to seek out origins and possible evolutionary histories of complex cells and their parts. Prerequisite: Graduate classification in a biological or related science.

619. Systematic Botany. (2-6). Credit 4. Plant variation and evolution. Breeding systems, cytogenetics, hybridization, and phylogeny. Prerequisites: Biol. 201 or equivalent or approval of instructor.

620. Field Systematic Botany. (1-8). Credit 4. Descriptive approach to identification and classification of plants. Use of floras, manuals, and monographs, herbarium techniques, and classical analysis of plant communities. Prerequisites: 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, including field studies of mosses, liverworts and hornworts. Offered in alternate years. Prerequisite: Approval of instructor.

626. Lichenology. (3-3). Credit 4. Taxonomy, morphology, and ecology of lichenized fungi with laboratory emphasis on identification of the local species. Other topics to be discussed will include symbiosis, air pollution and lichens, chemosystematics, and modern herbarium techniques for lichens and other cryptogams. 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: 6 hours of biology or approval of instructor.

635. Physiology of Microorganisms. (3-0). Credit 3. Physiological activities of bacteria with special emphasis on 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. Particular attention to 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 permission of instructor.

647. Methods in Industrial Microbiology. (2-6). Credit 4. Bioassays of antibiotics, amino acids and vitamins, including 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 will be emphasized in lecture and lab. Isolation, purification, and assay of certain hormones and of enzymes involved in hormone metabolism. Prerequisite: Course in physiology, Bich. 410 or equivalent, and approval of instructor.

651. Mycology. (2-6). Credit 4. Fungi, with emphasis on 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. Covers in considerable detail systems of the body which are most affected by heavy exercise or man-made environment. Classroom demonstrations used. Prerequisite: Biol. 220 or 433 or 434 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.

654. Radiation Biology. (3-0). Credit 3. Effects of X-ray, gamma, alpha, beta, and neutron radiation on cells, tissues and organism with special emphasis on mammalian systems. Prerequisites: graduate classification in biological or related sciences and reasonable knowledge of the physical theory of the origin and interaction of various radiations.

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

660. Aquatic Ecology. (2-3). Credit 3. The nature, measurement and controlling factors of primary and secondary productivity in both standing and flowing freshwater systems. Emphasis in secondary productivity on invertebrates. Mathematical modeling of aquatic productivity. Emphasis on a quantitative approach but does not require calculus or previous modeling experience. Prerequisites: A previous course in ecology or limnology, Biol. 459 (Aquatic Biology) or equivalent, or permission of the instructor.

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 considered. Original literature emphasized. Prerequisites: Biol. 435 or equivalent; graduate classification or approval of instructor.

665. Biology of Invertebrates. (3-3). Credit 4. Topics in morphology, biology and phylogeny of invertebrates. Topics may be either detailed discussions of specific organisms or comparative information on a process. Prerequisite: Biology 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. Emphasis on 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 with emphasis on parasitism and mutualism. Prerequisite: Biol. 667 or approval of instructor.

669. Quantitative Electron Microscopy. (2-6). Credit 4. Interdisciplinary course in statistical and quantitative evalution of electron micrographs, diffractographs, electron energy, electron microprobe analysis, scanning electron micrographs, and related data. Theory and practice for all technical fields. Prerequisite: Biol. 430 or approval of instructor.

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. Selected Topics In ----. Credit 1 to 4. Study of 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.

DEPARTMENT OF BUILDING CONSTRUCTION

C. D. Claycamp*, L. O. Degelman, C. M. Hix*, J. H. Marsh* (Head), I. E. Montgomery, Jr., F. J. Trost*

The Department of Building Construction offers graduate studies leading to the Master of Science degree and provides support for students enrolled in any of the emphasis areas in the Master of Architecture program as well as elective support for students in many other advanced degree programs.

*Graduate Advisor

(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. 427 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 operations with special reference to business practices employed by construction firms.

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. Study of selected topics in an identified field of Building Construction. May be repeated for credit. Prerequisite: Approval of instructor.

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

DEPARTMENT OF BUSINESS ANALYSIS AND RESEARCH

R. J. Anderson, T. F. Anthony*, F. P. Buffa, N. H. Erb, J. I. Reynolds, G. L. Richardson, W. Rose (Head), W. T. Shearon*

The Department of Business Analysis & Research offers graduate studies leading to the Master of Science in Business Computing Science, the Master of Business Administration in Business Computing Science and the Doctor of Philosophy in Business Administration.

The M.S. in Business Computing Science is offered for students seeking to combine preprofessional business training only with a specially-designed program of technical study. The M.B.A. in Business Computing Science is an interdisciplinary program offered cooperatively with the Department of Industrial Engineering. The Ph.D. in Business Administration may include a minor or major field in Business Analysis & Research.

Graduate study in the Department is also offered to provide training in quantitative and business computing skills for other graduate programs. A new area of interest is that of physical distribution management, the management of movement, and related activities. Special coursework for developing capabilities for the design and methodology of business research programs is offered regularly.

*Graduate Advisor

(B.Ana.)

617. Automated Business Systems. (2-3). Credit 3. Business data processing emphasizing concepts of why and how the business community utilizes computing techniques. Selected business applications will be utilized.

620. Systems Analysis for Business Data Processing. (3-0). Credit 3. Concepts of planning, development, implementation, and operation required in major business data processing systems. Prerequisite: B.Ana. 617 or equivalent.

622. Corporate Information Planning. (3-0). Credit 3. Emphasis on cost/benefit analysis of business information systems and the relationship of this to organizational functions. Prerequisite: B.Ana. 617 or equivalent.

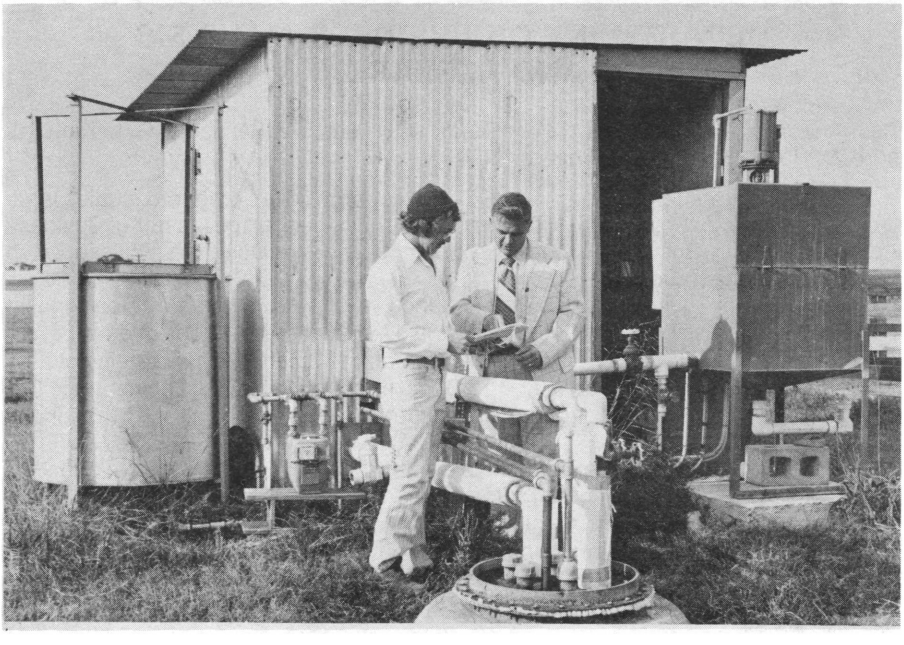
646. Business Trends, Fluctuation, and Measurements. (3-0). Credit 3. Business trends and economic fluctuations, theory, causes and control of cyclical behavior, analytical forecasting. Emphasis on basic business statistical techniques and applications. Prerequisite: Approval of instructor.

666. Quantitative Analysis for Business Decisions. (3-0). Credit 3. Formulation and structuring of business problems using selected quantitative techniques. Investigation of prior research and formulation of specific problems is emphasized. Prerequisites: BAna 646 or equivalent and graduate classification in Business Administration, or approval of instructor.

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. Focus is on 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. Emphasis on the development of analytical skills and the application of quantitative techniques for planning and controlling physical distribution operations. Prerequisite: B.Ana. 670 or 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. I, II, S 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 B.Ana. 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, including an evaluation of current research and controversial issues in quantitative methods, business data processing, and physical distribution management. For doctoral students only. Prerequisite: MBA degree or permission of Department Head.

689. Special Topics in ----. Credit 1 to 4. Study of 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

R. G. Anthony, J. A. Bullin, R. Darby, R. R. Davison, L. D. Durbin, P. T. Eubank, K. R. Hall*, D. T. Hanson, W. B. Harris, C. D. Holland (Head), J. C. Holste*

The Department of Chemical Engineering offers three graduate degrees: (1) Master of Science, (2) Master of Engineering (non-research) and (3) Doctor of Philosophy. Further, the Doctor of Engineering (non-research) degree granted by the College of Engineering may have chemical engineering as the field of specialization. A special program for B.S. degree holders in science seeking a masters 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. Core courses are Ch.E. 606, 608, 612, 623, 624, 629, 631 and 640. A minimum of four core courses form a partial requirement for the M.S. degree, five for the M.E. degree and all eight for the Ph.D. degree. A three hour course in technical writing is required for the Ph.D. degree as a language option.

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 equibria, extraction, process control, transport phenomena, economics, environmental research, activation analysis, lignite liquefaction and gasification, methanol fuel, and solar energy. Modern equipment is available in numerous laboratories designed for one of the above specialties. Digital and analog computers of medium size are also available within the department in addition to the major facilities of the Data Processing Center.

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.

*Graduate Advisor

(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 and process design calculations involving distillation of multicomponent and complex systems. Extractive and azeotropic distillation covered. Prerequisite: 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. 323, 324.

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 are considered. 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 will be emphasized. 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, the liquid state, theory of mixtures, the critical state, theory of conformal solutions, new theory of Flory for chain molecules, 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 with emphasis on vector and tensor equations of fluid mechanics. Behavior of Newtonian, non-Newtonian, and viscoelastic fluids stressed. Prerequisite: Math. 601. Cross-listed with M.M. 604.

641. Introduction to Bioengineering. (3-0). Credit 3. Application of principles of mass, energy and momentum transport to the characterization of biological systems. Ability to represent behavior of biological systems in terms of measurable properties of biomaterial and measurable environmental factors demonstrated. Prerequisites: Graduate classification; Ch.E. 424.

650. Electrochemical Processes. (3-0). Credit 3. Fundamentals of reversible and irreversible electrode processes with emphasis on energy conversion devices. The interaction between mass transport and kinetic mechanisms, industrial applications and corrosion considered. Prerequisites: Ch.E. 424 or approval of instructor.

651. Biochemical Engineering. (3-0). Credit 3. Integration of principles of engineering, biochemistry and microbiology, including 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, including large scale unit operations involved in production, isolation, immobilization, economical utilization of enzymes as well as optimization of enzyme reactor systems. Emphasis on 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. 651 and B.E. 651.

681. Seminar. (1-0). Credit 1. Graduate students will be required to attend one hour per week to discuss 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. Study of 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.

(The Chemical Engineering courses in mechanics and materials, such as continuum mechanics, mechanics and rheology of non-Newtonian and viscoelastic fluids, materials science, etc. are listed under Mechanics and Materials within the section entitled Interdisciplinary Engineering.)

DEPARTMENT OF CHEMISTRY

E. T. Adams, D. E. Bergbreiter, J. C. Carver, A. Clearfield, D. C. Conway, F. A. Cotton, K. H. Dahm, E. J. Fendler, J. H. Fendler, C. S. Giam, K. A. Gingerich, G. I. Glover, M. B. Hall, J. S. Ham, K. E. Harding, E. E. Hazen, R. M. Hedges, C. A. Hoeve, J. L Hogg, K. J. Irgolic, J. Laane, J. E. Leonard, J. H. Lunsford*, R. D. Macfarlane, P. S. Mariano, A. E. Martell (Head), E. A. Meyers, J. B. Natowitz, M. E. Newcomb, D. H. O'Brien, R. O'Connor, M. L. Peck, R. C. Pettersen, A. S. Rodgers, M. P. Rosynek, M. W. Rowe, E. A. Schweikert, A. I. Scott, B. L. Shapiro, F. Sicilio, T. T. Sugihara, Y. N. Tang, M. Tsutsui, T. M. Vickrey, R. L. Watson, R. C. Wilhoit, R. A. Zingaro, B. J. Zwolinski

Graduate work in chemistry is offered at both the master's and doctorate 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 has the opportunity to spend most of his time in research. The dissertation which results from this research must satisfactorily demonstrate (1) that the student is capable of independent and creative research in a specialized area of chemistry and (2) that the student has a superior knowledge and understanding of the area in which his research activities were performed. In addition, the student must demonstrate that he 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 his 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.

*Graduate Advisor

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, biophysical, bioorganic, and bioinorganic chemistry. Seven nuclear-related faculty, including five members of the Cyclotron Institute, provide one of the best graduate nuclear chemistry programs available in this country. The Thermodynamics Research Center has an international reputation for excellence. The Department also offers strong research programs in heterogeneous and homogeneous catalysis, analytical instrumentation, coordination chemistry, high temperature chemistry, organic and 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, infrared, ultraviolet, optical rotatory and circular dichroism spectrophotometers. Two new buildings bring the total space available for the work of the Department to over 200,000 sq. ft. For further details about programs, faculty, facilities, and financial aid, write to Arthur E. Martell, Head of the Department of Chemistry, for a descriptive brochure.

(Chem.)

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 including 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. Study of general principles of chemistry from quantitative standpoint with emphasis on thermodynamics and kinetics. Prerequisite: Graduate classification.

615. Organic Synthesis. (3-0). Credit 3. Application of organic reactions to synthesis of complex organic molecules. Includes 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. 639 or registration therein or approval of instructor.

619. Analytical Spectroscopy. (3-0). Credit 3. Modern analytical spectroscopic techniques. Topics covered include 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. Advanced survey of principles of chemical analysis with special emphasis on newer developments in field of analytical chemistry. Prerequisite: Chem. 317.

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.

624. Physical-Organic Chemistry. (3-0). Credit 3. Mathematical and quantitative investigation of organic chemical phenomena. Prerequisite: Chem. 609 or approval of instructor.

626. Thermodynamics. (3-0). Credit 3. Theory and applications of classical thermodynamic functions. Prerequisite: Chem. 324.

627. Diffraction Methods. (3-0). Credit 3. Diffraction methods for determination of molecular structure. Major emphasis placed on results of diffraction of X-rays by crystals, but related methods are also discussed. 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.

632. Intermediate Statistical Mechanics. (3-0). Credit 3. Continuation of Chemistry 631, with particular attention to recent developments and techniques for treating systems of interacting particles. Includes a deeper analysis of foundations, approach to equilibrium, real fluids, phase transitions, quantum statistics, transport phenomena and stochastic processes. Prerequisite: Chem. 631 or Phys. 607 or equivalent.

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 standing 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, emphasizing modern aspects of diffraction, magnetic resonance and vibrational methods. Prerequisites: 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. Electronic instrumentation of importance to the chemist in the generation, detection, amplification, modification, and presentation of chemical information. Typical modern instruments studied from design and operational standpoints after an introduction to electronics and electrical measurements. Prerequisite: Approval of instructor.

639. Instrumental Methods of Analysis. (3-0). Credit 3. Modern methods of instrumental analysis including spectroscopy, separations, electroanalytical and instrumentation. Emphasis on the use of these techniques for quantitative analysis. Prerequisite: Chem. 317 or approval of instructor.

640. Transition Metal Chemistry. (3-0). Credit 3. Chemistry of the subgroup B elements of the periodic table including the lanthanides and actinides. Special emphasis on coordination compounds. Prerequisite: Chem 641.

641. Structural Inorganic Chemistry. (3-0). Credit 3. Introduction to chemical bonding; valence bond and molecular orbital theory, ionic bonding, the hydrogen bond, and introduction to ligand field theory. Prerequisite: Chem. 462.

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 or organic chemistry including bonding and structure in organic chemistry, stereochemistry, reactive intermediates in organic chemistry, and transition state theory including kinetics and thermodynamic approaches. Prerequisite: 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 its 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 field of analytical chemistry. Methods will be discussed in terms of their 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. Discussion of 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.

656. Polymer Science II. (3-0). Credit 3. Selected topics in polymer synthesis, solution, and solid state properties. Prerequisite: Chem. 655.

657. Magnetic Resonance Spectroscopy. (3-0). Credit 3. Magnetic resonance and of 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 studied. Correlation between physical and chemical properties of organometallic compounds and position of the central metal atom in the periodic system emphasized. 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 will be considered, 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: Bi.Ch. 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. Will cover new developments, theory and established mechanisms. Prerequisite: Bi.Ch. 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. The classification of molecules into symmetry point groups and the use of character tables emphasized. Prerequisite: B.S. or B.A. in Chemistry.

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. Study of selected topics in an identified area of Chemistry. May be repeated for credit. Prerequisites: Graduate standing 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.

DEPARTMENT OF CIVIL ENGINEERING

CIVIL ENGINEERING: D. R. Basco, F. J. Benson, C. E. Buth, H. M. Coyle, C. L. Dudek, W. A. Dunlap, J. A. Epps, H. L. Furr, B. M. Gallaway, R. W. Hann, Jr., J. B. Herbich, T. J. Hirsch, C. M. Hix, R. M. Holcomb, D. L. Ivey, M. E. James, W. P. James, C. B. Johnson, M. D. Jones, C. J. Keese, A. H. Layman, W. B. Ledbetter, Y. K. Lou, L. L. Lowery, R. L. Lytton, D. McDonald*, A. R. McFarland, E. L. Marquis, J. E. Martinez, C. J. Messer, A. H. Meyer, R. M. Olson, R. E. Randall, T. D. Reynolds, H. E. Ross, N. J. Rowan, C. H. Samson, Jr. (Head), D. Saylak, R. A. Schapery, R. E. Schiller, Jr., J. F. Slowey, V. G. Stover, T. C. Su, R. E. Thomas, L. J. Thompson, R. D. Turpin, N. E. Walton, H. W. Wolf, C. E. Woods, D. L. Woods

OCEAN ENGINEERING: D. R. Basco, J. B. Herbich (Program Head), W. P. James, Y. K. Lou, R. E. Randall, R. O. Reid, R. E. Schiller, T. C. Su

Civil Engineering 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; 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; materials engineering; public works engineering; structural engineering and structural mechanics; transportation engineering; urban management; and urban planning.

Separate degrees are offered in Ocean Engineering.

No foreign language is required for the Ph.D. in Civil Engineering.

*Graduate Advisor

Ocean Engineering The graduate program in Ocean Engineering is broad-based and designed to fit the needs of an individual student. 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 and coastal sediment processes.

No foreign language is required for the Ph.D. in Ocean Engineering.

(C.E.)

601, 602. City Management. (1-2). Credit 2 each semester. Development of European and American cities, forms of city government, functions of city manager, administration of municipal affairs, organization of city departments, city finances, public utilities, fire prevention and protection, police administration, parks and playgrounds.

603. Stream Quality. (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 standing 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. Prerequisites: 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. Environmental Analysis for Urban Areas. (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. Environmental Design for Urban Areas (1-6). Credit 3. Design and operation of environmental engineering projects related to urban problems including solid waste collection and disposal, sanitary landfills and land application 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; and conceptual layout of street systems. Trends in urban development; site development with the emphasis on on-site circulation and relationship to the street system. Guidelines for the redevelopment of existing streets and the adjacent land are discussed. 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 Flexible Pavements. (2-0). Credit 2. Characteristics of pavement loads, stress analysis in pavements, design practices, construction, rehabilitation and maintenance. Prerequisite: C.E. 307.

617. Traffic Engineering: Characteristics. (2-3). Credit 3. Human, vehicular and traffic characteristics are examined as they relate to Driver-Vehicle-Roadway operational systems. Traffic studies and methods of analysis and evaluation are stressed. 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 are stressed. Prerequisite: CE 617 or approval of instructor.

620. Structural Design of Rigid Pavements. (2-0). Credit 2. Optimization of the design of rigid and flexible pavement systems. Principles of utility theory. Serviceability concept. Empirical and mechanistic structural subsystems. Economics, traffic delay, environmental deterioration, maintenance subsystems. Stochastic design of pavement. Prerequisite: C.E. 307.

621. Advanced Reinforced Concrete Design. (3-0). Credit 3. Review of 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. Selected topics including special cements, mix design, construction practices, pumping, quality control, lightweight concrete strength, curing, volume change, and ready-mixed concrete. Prerequisite: Approval of instructor.

624. Environmental Effects of Transportation Systems. (2-0). Credit 2. Interaction of traffic facilities with the adjacent land uses considering fundamental driver needs as well as aesthetic values in location and design of streets and highways. Noise, air pollution, roadway lighting and roadside beautification considerations are included.

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 are treated. Topics include safety improvement programs, sideslopes and ditches, breakaway devices, crash attenuation systems, and traffic 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. Topics include pipelines, pipe networks, storm-water collection systems, open channel flow, river modification, flood plain delineation, spillway, outlet works, energy dissipators, and water hammer. Prerequisite: C.E. 338 or approval of instructor.

629. Hydraulics of Open Channels. (3-0). Credit 3. Application of momentum and energy principles to advanced topics in uniform, nonuniform, gradually varied and rapidly varied flow problems. Backwater flow profile computation in steady flow. The method of characteristics applied to unsteady flows. Jeffreys-Vedernikov criteria. Flood routing calculations by advanced computer methods. Prerequisite: Approval of instructor.

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, built-up columns, lateral buckling of beams, torsional buckling of centrally loaded columns, bending of thin plates and shells. Prerequisites: Aero. 306 or C.E. 306; Math. 308.

634. Airport Planning and Design. (2-2). Credit 3. Planning and design of the airfield, study of functional terminal configurations and adjacent area land use problems. Airport siting, runway orientation, runway capacity, surface drainage, runway pavement design, terminal orientation, and ground access considerations are stressed.

636. City Street Design. (2-0). Credit 2. Street classification and function, obtaining the maximum potential from the surface street system and basic design criteria for city streets are discussed. Transportation systems management of the urban system is considered.

637. Pipeline Construction. (2-0). Credit 2. Survey of equipment and methods employed in the construction of cross-country petroleum pipelines, water aqueducts, corrugated metal culverts and underground concrete and cast-iron utility work. Prerequisite: C.E. 473 or approval of instructor.

638. Building Construction. (2-0). Credit 2. Take-off of material quantities; compilation of lump sum estimates of cost as well as consideration of building construction equipment, materials and methods in use today. Prerequisite: C.E. 473, 478 or approval of instructor.

639. Highway Construction. (2-0). Credit 2. Equipment and methods used in the construction of flexible and rigid highways. Topics include applied soils engineering, grading, flexible construction, surface treatments, materials location and production as well as consideration of the specific equipment and methods employed in the construction of hot-mix and portland cement highways. Prerequisite: C.E. 365, 473, Geol. 320 or approval of instructor.

641. Construction Engineering Systems. (3-2). Credit 4. Analytical tools for construction project planning, scheduling, and control; linear programming and simulation; applications of systems theory to construction situations and problems; decision analysis. Prerequisites: C.E. 642 or approval of instructor.

642. Construction Engineering Management. (3-0). Credit 3. Selected topics in construction planning and management, including 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.

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; study of selected case histories. Prerequisite: Approval of instructor.

645. Scientific Methods in Urban Engineering and Management. (2-3). Credit 3. Mathematical models for managerial decision-making in the urban situation; emphasis on subjects such as mathematical programming and simulation and their application to a wide variety of organizational settings; techniques for solving optimization problems encountered in public works organizations. Prerequisites: C.E. 384 or equivalent; Math. 308.

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. Soil Mechanics. (3-3). Credit 4. Introduction to physico-chemical 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. Soil Mechanics. (3-3). Credit 4. Site investigation; fundamentals of groundwater flow; Dupuit theory; principles of flow nets; numerical methods and conformal mapping; flow under and through earth structures; advanced theory of consolidation; secondary consolidation; numerical methods in consolidation; design of sand drains; field instrumentation. Prerequisite: C.E. 649.

651. Advanced Theory and Application of Soil Mechanics. (3-3). Credit 4. Review of the fundamentals of mechanics of deformable bodies. Application of theoretical continuum mechanics and approximate rheological equation for soils to slope stability, arching, bearing capacity, and earth pressure problems. Prerequisite: Math. 601 or registration therein.

652. Soil Dynamics. (3-0). Credit 3. Study of 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 210; 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 utilization 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. (2-3). Credit 3. Review of 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.

670. Urban Public Transportation Planning. (2-3). Credit 3. Cross-listed with Plan. 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 Plan. 672.

673. Urban Transportation. (2-2). Credit 3. Transportation system planning and evaluation; characteristics, cost, and application of all modes of transportation. Behavior patterns of transportation users. Alternative analysis of passenger transportation systems.

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.

679. Theory of Fluid Mechanics Models. (2-0). Credit 2. Dimensional analysis; model laws; mathematical techniques; applications to fluid mechanics and coastal engineering models; fixed-bed; movable-bed, geometric, and distorted 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. Review of 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. Special emphasis on 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. Emphasis placed on settlement and bearing capacity analysis of near-shore and off-shore foundations. Computer programs used to analyze axially-loaded piles, laterally-loaded piles, and sheet-pile walls. Prerequisites: C.E. 365, and approval of instructor. Cross-listed with O.E. 687

689. Special Topics in ----. Credit 1 to 4. Study of 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 Civil Engineering courses in applied mechanics such as elasticity, plasticity, continuum mechanics, etc., are listed in the section entitled Mechanics and Materials under Interdisciplinary Engineering.)

OCEAN ENGINEERING (O.E.)

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.

675. Coastal Engineering I. (3-0). Credit 3. Review of small amplitude wave theory and applications to engineering problems. Analysis of wave data. Wave forces on coastal structures. Wave run-up on uniform and composite beaches. Design of seawalls and breakwaters. Prerequisite: Approval of instructor.

676. Ocean Engineering. (3-0). Credit 3. Introduction to concepts of linear structural dynamic analysis, functional design of off-shore platforms, pipelines, floating structures and moorings. Study of load problems. Hydrodynamic phenomena including wind and current interaction, vortex shedding and wave forces; structure-fluid interaction models review of oil spill containment and collection methods. Prerequisite: 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.

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. Emphasis on 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. Prerequisite: Basic fluid mechanics, approval of instructor.

685. Problems. Credit 1 to 6 each semester. Investigation of special topics not within scope of thesis research and not covered by other formal courses.

686. Offshore and Coastal Structures. (3-0). Credit 3. Review of 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. Special emphasis on 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. Emphasis on settlement and bearing capacity analysis of near-shore and off-shore foundations. Computer programs used to analyze axially-loaded piles, laterally-loaded piles, and sheet-pile walls. Prerequisites: C.E. 365, and 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. Study of 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, C. J. Leabo, B. G. Rogers (Head).

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.

602. Mass Communication in a Dynamic Society. (3-0). Credit 3. Relationships between modern society and the media of mass communication, considered as organizations, institutions and systems; the rights, responsibilities, and characteristics of the mass media, the mass communication practitioner, the audience, and society.

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.

604. Analytical Reporting. (3-0). Credit 3. Development of analytical articles for mass and specialized media in specialized subject areas. Emphasis on applications of social science research methods for gathering and evaluating information. Critical study of writing and presentation techniques. Prerequisite: Jour. 690 or approval of Department Head.

605. Institutional Persuasion. (3-0). Credit 3. Public relations philosophy and methodology, utilizing the principles of persuasion and attitude change, as adapted to public and private institutions.

606. Economics and Management of the Specialized Press. (3-0). Credit 3. The business of managing a specialized publication, with emphasis on personnel, location and housing, revenue from advertising and circulation, printing, and effects of competition.

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 ---. (3-0). Credit 3. Investigation and analysis of trends and changing role of media with focus upon current and future problems and responses. May be repeated for credit.

690. Theory of Research. (3-0). Credit 3. Introduction to mass communication research methodology and techniques; identification and analysis of audiences; particular attention to utilization of literature and research findings. Prerequisites: Major in journalism or approval of Department Head.

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

DAIRY SCIENCE

See Animal Science

DEPARTMENT OF ECONOMICS

W. G. Adams, R. K. Anderson, L. Auernheimer, R. L. Basmann, R. C. Battalio, A. F. Chalk, A. S. DeVany, R. B. Ekelund, Jr., R. J. Freund, E. G. Furubotn, R. F. Gilbert, W. L. Gramm, W. P. Gramm, M. L. Greenhut, J. R. Hanson, II, H. O. Hartley, J. H. Kagel, S. C. Maurice, (Head), W. D. Maxwell, J. Meyer*, M. O. Reynolds, T. R. Saving, C. W. Smithson

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.

*Graduate Advisor

(Econ.)

601. History of Economic Thought. (3-0). Credit 3. Survey of the period 1776-1848. Special attention devoted to original works of Smith, Malthus, West, Ricardo and Mill. Prerequisite: Approval of Department Head.

602. History of Economic Thought. (3-0). Credit 3. Primary emphasis given to the emergence of marginal utility theory and to other British and Continental developments in neoclassical analysis. 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, emphasizing the 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. A systematic presentation of microeconomic theory which focuses on the 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. Study of the valuation and allocation of human resources. Topics: 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 is emphasized. Prerequisite: Econ. 607 or equivalent.

610. Human Resource Economics II. (3-0). Credit 3. Analysis of selected topics and labor markets including 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. Emphasis is on 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 are examined. 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 with particular reference to behavior of both individual and firm. Study of 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 course which entails application of micro and/or macro analytical tools to selected problem areas: such as 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. Examination of 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 including industrial and residential location analysis; regional delineation; factor mobility and commodity movements; interregional input-output models; income accounting, balance of payments, gravity models; and regional economic growth. Prerequisite: Approval of Department Head.

622. Regional Science II. (3-0). Credit 3. Regional economic analysis including 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.

623. Theories of Economic Development I. (3-0). Credit 3. Survey of nature and extent of economic development issues, review of theories that facilitate analysis, and examination of specific problems confronting less developed nations. Prerequisite: Econ. 330 or approval of instructor.

628. Urban Economics. (3-0). Credit 3. Economic analysis of structure, functions, and problems of urban areas with particular emphasis on 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.

631. Welfare Economics. (3-0). Credit 3. Study of basic concepts and propositions of welfare theory. Consideration of such topics as: Pareto optimality, social welfare functions, external economies, dynamic allocation theory, economic efficiency of alternative market structures. Selected policy issues considered from standpoint of welfare principles derived. Prerequisite: Econ. 607 or 629.

633. Theories of Economic Development II. (3-0). Credit 3. Continuation of Econ. 623 with emphasis on formal growth models and modern techniques of development planning. Prerequisite: Approval of instructor.

635. Monetary Theory. (3-0). Credit 3. Traditional as well as modern theories of money. Major emphasis on 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. Prerequisites: Econ. 410 or 611.

637. Monetary Policy. (3-0). Credit 3. Analysis of effect of monetary policy on aggregate economic activity and distribution of resources. Evaluation of the effectiveness of various policies and discussion of optimal policy in light of various institutional restrictions that exist. Prerequisite: Econ. 635.

638. Capital and Interest Theory. (3-0). Credit 3. Development of neoclassical capital theory from Bohm-Bawerk to present time, with emphasis upon the critics of neoclassical theory. Both production and time-preference approaches studied. Prerequisite: Econ. 630.

639. Economic Analysis of Regulated Enterprise. (3-0). Credit 3. Explore scope of governmental regulation in economy of United States, its evolution and development. Particular emphasis given to application of tools of economic analysis to problems posed by regulated enterprise. Prerequisite: Econ. 424 or approval of Department Head.

642. Comparative Economic Systems. (3-0). Credit 3. Impact of economic systems on various aspects of welfare, including per capita income, growth, equity, stability, etc. Special attention given to interrelations among property rights, incentives, and economic behavior. Analysis of the 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.

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. Analysis of the 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. Emphasis is on interpretation of the balance of payments and the adjustment to national and international equilibria, through changes in price levels, exchange rates, and national incomes. Other topics include: 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. Emphasis is on the classical and neoclassical models of international trade. Topics include: 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 including choice behavior experiments, survey research, planned economic environments and animal experiments. Prerequisite: Approval of instructor.

656. Studies in Experimental Economics II. (3-0). Credit 3. Application of experimental methods to economics including behavioral — environmental experiments in national economic systems and evaluation and interpretation of experimental studies. Major research paper in one area of application. Prerequisite: Econ. 655.

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

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

689. Special Topics in ----. (3-0) Credit 3. Study of selected topics in an identified area of economics. May be repeated for credit. Prerequisite: Approval of Department Head.

690. Theory of Economic Research. (3-0). Credit 3. The design of research experiments in various subfields of economics, and the evaluation of research results with the aid of examples taken from the current scientific literature.

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

See Agricultural Economics 603 and 633 for description of related courses.

ECONOMETRICS (Ecmt.)

660. Mathematical Economics. (3-0). Credit 3. Review of use of selected types of mathematical tools in economic theory. Prerequisites: Econ. 323.

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

662. 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.

663. 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.

664. 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 consent of instructor.

665. Econometric Theory and Programming. (3-0). Credit 3. A study of 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.

666. Model Building in Econometrics. (3-0). Credit 3. Further intensive study of 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.

667. Case Studies in Econometrics. (3-0). Credit 3. Primary emphasis given to extensions of dynamic theory and applications of theory and methods to significant dynamic economic problems. Prerequisites: Ecmt. 664, 665.

668. Economics of Risk and Uncertainty. (3-0). Credit 3. Methods used to introduce risk and uncertainty into various economic models, including analysis of behavior of individuals, firms and markets in risky situations. Prerequisite: Ecmt. 660.

669. Fundamental Mathematics for Economists. (3-0) Credit 3. Mathematics of nonlinear programming with emphasis on 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.

DEPARTMENT OF EDUCATIONAL ADMINISTRATION

R. I. Berridge, H. L. Hawkins, (Head), J. R. Hoyle, F. W. R. Hubert, J. F. McNamara, L. S. Richardson*, M. J. Sexton*, R. J. Stalcup, S. L. Stark, P. T. West

The Department of Educational Administration provides areas of study through a variety of options. 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 are included in the options. Flexibility in program planning provides adaptation to management in business, industry, and related professions.

Professional certification programs are offered for the superintendency, principalship, and middle administrators. (This includes 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 the superintendency.

Programmatically, the diversity of training and experience is for the principalship, or middle administrator, and the superintendency on the public school levels and the president, deanship, director, department head and professorship on the college/university level. Concentrated coursework 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, inner-city and multi-cultural studies, professional standards, and certification.

Administration of Higher Education — Professional preparation is offered persons in administrative positions in community-junior colleges, senior colleges, and universities. Extensive use is made of Texas A&M University-wide resources relating to student's objectives and the departmental requirements.

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.

Public Relations — This multidisciplinary graduate studies specialization in Educational Administration places special emphasis on communications. Supporting fields also include architecture, computer science, business, curriculum and instruction, English, industrial education, industrial engineering, psychology, philosophy, sociology, and urban and regional planning. It is designed to prepare students for positions as public relations specialists in education, business, government, and industry.

Research, Planning and Evaluation — This interdisciplinary research and development specialization involves graduate studies in Educational Administration and supporting fields, such as economic development, urban and regional planning, demography, management science, tests and measurements, operations research, statistics, and public administration. It is designed to prepare students to assume positions as research and development administrators, evaluation specialists, educational and policy planning analysts, and research professors in Educational Administration.

*Graduate Advisor

(Ed.Ad.)

606. Administration of Elementary and Secondary Schools. (3-0). Credit 3. Study of the organization and administration of elementary and secondary schools. Administration and supervision of curriculum and instruction.

608. School Finance and Business Management. (3-0). Credit 3. Study of 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. 606, 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.

613. The School Plant. (3-0). Credit 3. Present and future building and equipment needs of school units; efficiency of present plant, operation and maintenance, planning building program.

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. Also private, parochial, and adult education. Prerequisites: Ed.Ad. 606 or approval of Department Head.

616. Administration of Staff Personnel. (3-0). Credit 3. Personnel organization and administration in school systems. Relationship of individual to organization. Consideration of organizational health, staffing, renumeration, appraisal, ethics, welfare, 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. A study of the theory and practice of evaluation of instructional programs, personnel management and support services, and project operations, with special emphasis on the nature and preparation of evaluation designs and management of educational evaluation functions. Open to all graduate students in education.

621. Educational Planning/Futurism. (3-0). Credit 3. Skills to assist educational administrators in planning optimum programs for the future. System theory, planning models, futures methodology, operations research, manpower and human resource planning are the major topics. 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), discussion of today's issues. Prerequisite: Ed.Ad. 625.

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.

638. Current Issues in Community Education. (3-0). Credit 3. Current educational issues affecting public education including merging and alternative models of Community Education. Prerequisite: Educational Administration 641.

639. Processes In Educational Leadership. (3-0). Credit 3. Selected historical, philosophical, sociological 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. Will familiarize the student with the structure, purpose and strategies of community education as it relates to public school administration.

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

651. Orientation in Business Principles and Procedures. (3-0). Credit 3. Interdisciplinary survey utilizing management science and operations research procedures from various fields of business as a means to improve decision making and policy planning educational organizations. Special emphasis on roles of superintendent and school business official. Case studies. Field studies.

652. Educational-Governmental Relationships. (3-0). Credit 3. Interdisciplinary survey course utilizing various fields in political science, comparative government, 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 utilizing 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. Prerequisites: Master's degree; approval of Department Head.

655. Administration of Higher Education. (3-0). Credit 3. Survey of management principles in higher education. Functions in delegation, direction, operation, evaluation, and financial management applied to college and university administration.

656. Administration of Supervisory Personnel. (3-0). Credit 3. The administration of public school supervisory programs; the roles of administrators in the management of supervision; organization of the supervisory staff in small and large schools. Prerequisite: Approval of Department Head.

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. Prerequisites: Twelve hours of advanced education; approval of Department Head.

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 selected problem in field of educational administration. Prerequisite: Prior approval required.

689. Special Topics in ----. Credit 1 to 4. Study of selected topics in an identified area of Educational Administration. May be repeated for credit.

690. Theory of Educational Administration Research. (3-0). Credit 3. The design of research and inquiry in various areas of educational administration. Special emphasis on the 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 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 CURRICULUM AND INSTRUCTION

D. G. Armstrong, R. M. Bennett, J. K. Campbell, D. W. David, J. J. Denton, N. D. Fortney, D. Godwin, J. Ilika, D. L. Janke, G. R. Johnson*, J. B. Kracht*, P. Limbacher, J. E. Morris, J. H. Rollins, W. H. Rupley, A. C. Seaman, R. E. Shutes (Head), W. F. Stenning*

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 in Educational Curriculum and Instruction degrees.

The department offers specializations in early childhood, elementary, secondary, and higher education, in general curriculum and instruction, in reading, and in a variety of subject matter fields, including mathematics, science, language arts, and social studies. 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 they 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 course contents.

Information about prerequisites, research, or language requirements can be obtained from the departmental office. Requirements will be determined by the student's Advisory Committee.

*Graduate Advisor

(Ed.C.I.)

601. College Teaching. (3-0). Credit 3. Teaching strategies, research studies related to college settings, conditions of work, professional responsibilities, evaluation of students and instruction.

602. Cultural Foundations of Education. (3-0). Credit 3. Contributions of behavioral sciences applied as analytic tools in solving problems of curriculum and instruction.

603. Analysis of College Teaching. (3-0). Credit 3. Presentation of a series of behaviorally defined teaching skills. Skills practiced in five minute lesson (microteaching), which is videotaped and replayed for analyzation.

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 utilizing 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 with emphasis on 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.

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 is stressed in supervision of student teachers.

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 standing and 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 standing; 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 standing; approval of instructor.

618. Teaching Elementary School Mathematics. (3-0). Credit 3. Contemporary issues in teaching elementary school mathematics are considered with particular emphasis on the active learning instructional mode.

619. Teaching Basic Concepts of Mathematics. (3-0). Credit 3. A careful study of the content and pedagogy of selected contemporary mathematics programs for low achievers.

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 with particular attention emerging curricular alternatives.

630. Junior/Community College Curriculum. (3-0). Credit 3. Factors influencing the scope and sequence of the curriculum for Junior/Community colleges. Comprehensive Junior/Community college curriculum, major divisions of the curriculum, basic and applied fields, community services, student activities, library and new curriculum models.

637. Advanced Elementary School Methods. (3-0). Credit 3. Analysis of teaching — learning environments for the purpose of improving instruction. Instructional strategies are emphasized. Prerequisites: E.D.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. Special attention given to 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.

643. Current Issues in Elementary Education. (3-0). Credit 3. Current issues affecting the elementary school. Curriculum, instruction and organization are examined in light of current social and educational change. Prerequisites: Elementary Provisional Certificate or equivalent.

644. Curriculum Development. (3-0). Credit 3. Analysis of curriculum development. Bases of curriculum design. Study of problems of balance, scope, organization, sequence, selection, and articulation.

645. Society and Education in World Perspective. (3-0). Credit 3. Advanced study of comparative education with emphasis on the interrelationships among societal institutions and the particular roles that education plays in different cultures and political systems. Prerequisites: Ed.C.I. 402, 421 recommended.

646. Instruction Theory. (3-0). Credit 3. Theoretical basis for research and training in instruction. Systematic study of existing research on key factors influencing instructional effectiveness. Exploration of interaction among variables of instruction. Prerequisite: Ed.C.I. 675.

647. Curriculum Theory. (3-0). Credit 3. The theoretical basis for curriculum conceptualization, development, evaluation and implementation. The value and empirical basis of curriculum decision-making strategies for curriculum change. Prerequisite: Ed.C.I. 644.

649. Reading Instruction in High School and College. (3-0). Credit 3. Basic principles of reading instruction; nature and scope of total reading program; methods, materials, and organization of the developmental, corrective, and speed-reading programs in high school and college.

650. Foundations of Reading Instruction. (3-0). Credit 3. Psychological, linguistic, and physical factors related to reading performance; implications for content and teaching methods; appraisal of current research and related reading for teachers, supervisors, and reading specialists. Prerequisites: Ed.C.I. 649 and 674, or approval of instructor.

652. Parental Involvement in Early Childhood Education. (3-0). Credit 3. Dynamics of the family unit, school-home communication systems, legalities of parent participation in the school, parent involvement, parent training, and home bound programs. Special emphasis on development of programs with parents.

653. Classroom Management in Early Childhood Education. (3-0). Credit 3. Methods of classroom management, principles of child guidance, establishing positive educational environments, interpreting children's needs, and methods of discipline as related to teaching strategies in early childhood education. Prerequisite: Approval of instructor.

654. Organization and Operation of Early Childhood Education Programs. (3-0). Credit 3. Comprehensive survey of the various types of preschool centers serving the needs of young children, including a discussion of operating procedures, programs, and services provided. Includes investigation of experimental educational research projects now being conducted with young children.

655. Program Development for Early Childhood Education. (3-0). Credit 3. Teaches the students how to develop language-experience based curriculum guides specifically for young children. The instructional theory will be directed toward the development of language-experience based curriculum units. Prerequisite: Ed.C.I. 644.

662. Philosophical Theories of Education. (3-0). Credit 3. Study in depth of selected historical theories of education from Plato to Skinner. Emphasis on evaluating educational ends and means, with stress on the nature of knowledge, its acquisition, and transmission.

670. Social Studies in Elementary and Secondary Education. (3-0). Credit 3. Methodology course focusing upon the implementation, both practical and theoretical, of the objectives of social studies: current trends, resource materials, demonstrations of teaching methods.

672. Curriculum and Methodology of Language Arts. (3-0). Credit 3. Advanced methodology course for teachers of language arts courses and their supervisors. Emphasis on total curriculum development, attitudes and procedures for fostering developmental skills and creativity.

673. Analysis of Teaching Behavior. (3-0). Credit 3. Methods of gathering teaching behavior data. Use of computer for analyzing and interpreting data collected. Video-tape recording micro-teaching lessons.

674. Developmental Reading in the Elementary School. (3-0). Credit 3. Analysis of methods and materials of reading instruction in the elementary grades. Includes study of 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. Systematic analysis of variables influencing learner behavior and of approaches to optimization of teacher behavior. Prerequisite: E.Psy. 602 or 673 recommended.

676. Teaching Strategies: Critical Problems. (3-0). Credit 3. Analysis of Critical Issues in Curriculum and Instruction. Focus on solving educational problems through observation and evaluation. Developing plans to gather information to improve education systems will be stressed. Prerequisite: Approval of the instructor.

677. Strategies for Teaching the Disadvantaged. (2-2). Credit 3. Review of research concerning the cognitive and affective aspects of learning relative to students from low socioeconomic status backgrounds. Practical applications to curriculum and instruction explored.

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. Analysis of 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. Issues and developments in curriculum, methodology, supervision, and instructional materials, especially adapted for in-service teachers. Specific topics designated for each seminar. May be repeated for credit. Prerequisite: Bachelor's degree.

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. Study of 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.

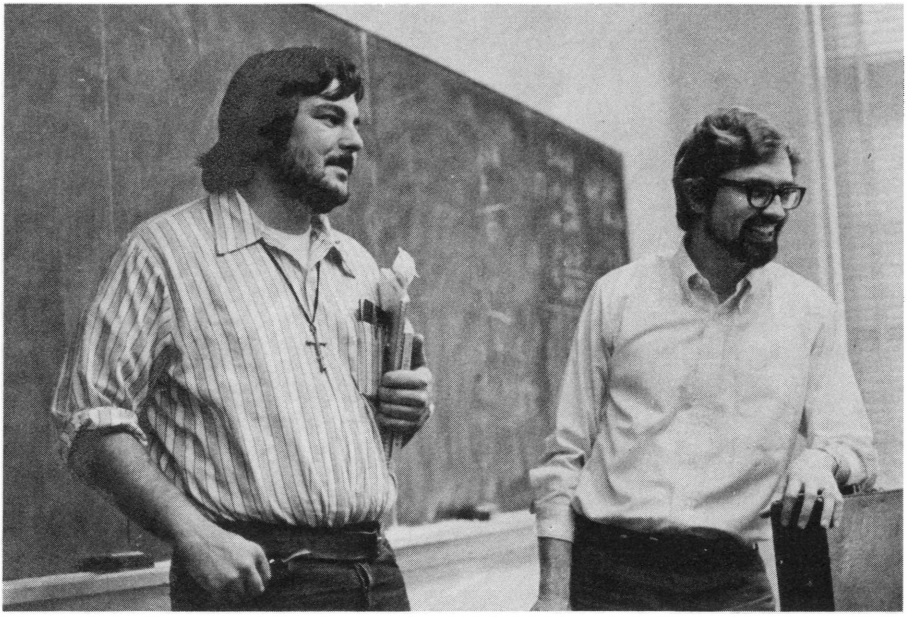
692. Professional Study. Credit 1 or more each semester. Approved professional study of project undertaken as the terminal requirement for Doctor of Education degree. Preparation of a Record of Study summarizing the rationale, procedure, and results of the completed project. Prerequisite: Approval of major advisor.

DEPARTMENT OF EDUCATIONAL PSYCHOLOGY

C. R. Anderson, M. J. Ash*, D. G. Barker, W. G. Birch, C. A. Borman, L. A. Boyd, B. S. Chissom, L. H. Hope, S. A. Kerley, J. J. Koldus, C. E. McCandless, W. R. Nash, R. R. Reilley, A. J. Roach (Head), D. Smith, W. F. Stenning, A. L. Tollefson

The Department of Educational Psychology offers doctoral preparation in two areas of specialization, Counseling Psychology and Psychological Foundations of Education. The Ph.D. is offered in Counseling Psychology and Psychological Foundations of Education, whereas the Ed.D. is offered only in Psychological Foundations of Education. The Counseling Psychology specialization is designed to prepare students as counseling psychologists in college and university counseling centers or other social service settings. Students in this specialization may also work toward careers as teachers in counselor education programs or as supervisors of counselors in large school districts. The specialization in Psychological Foundations of

*Graduate Advisor



Education prepares psychologists in the educational applications of human learning and development as well as in measurement and research methodology. Areas of emphasis within this doctoral specialization are school psychology and special education, including gifted and talented education. Students in this specialization usually seek employment as university teachers and researchers in educational psychology or as school psychologists.

M.Ed. and M.S. programs in Educational Psychology provide specializations in School Counseling or Special Education. These specialties prepare students for certification by the Texas Education Agency as school counselors, teachers of the language/learning disabled or as educational diagnosticians.

In conjunction with its training in all these specializations, the department operates Educational Psychology Services as a vehicle for both student preparation and as a service to the university, as well as to the public and its schools. The center provides a modern laboratory for practicum experiences in counseling and educational assessment.

Preparation as a professional in the various specialties 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 certificate or degree programs satisfy the demands of the screening committee for the specialization 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 specialization or to 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 program or specialization for which application is made. Students in all specializations will periodically have their total progress in professional development reviewed by a committee of the faculty offering that specialization to determine whether or not they shall be permitted to continue.

All new certificate or degree students are required to enroll in E.Psy. 682N, an orientation seminar for new students. They should enroll in this seminar during their first semester of studies.

Doctoral students must enroll in E.Psy. 682P, an orientation seminar for professionals in educational psychology.

The deadline for fall admissions to the doctoral specializations in counseling and school psychology is February 15. Admissions to these programs are announced on April 1. The deadline for admission to specializations in Foundations of Educational Psychology and Special Education is April 15. Admission to these programs are announced on May 1. Admissions to the Master's program are considered each semester.

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 specialization. Doctoral students pursuing the School Psychology specialization are required to have a full-time, academic-year internship.

Because of their professional training nature, enrollment in a number of courses is limited to students majoring in the department. Some courses are limited to students admitted to specific specializations. Approval by the department head is required for enrollment in these courses.

(E.Psy.)

602. Educational Psychology. (3-0). Credit 3. Scientific concepts of learning and the principle influences in learning process. Effects of development, aptitude, emotional and social maturation, and environment on learning.

610. The Exceptional Child. (3-0). Credit 3. Exceptional and handicapped individuals emphasizing 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.

612. Individual Assessment in Education. (3-0). Credit 3. Educational applications of individual assessment. Instruments studied include 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. 110, 622, Psy. 624 and approval of Department Head.

613. Individualized Teaching of Exceptional Children. (3-0). Credit 3. Teaching strategies for exceptional children. Management of educational data on individual pupils. Emphasis on collection, analysis, teacher interpretation of data and formulation of recommendations for educational change. Prerequisite: E.Psy. 611.

614. Laboratory in Educational Assessment and Diagnosis. (1-6). Credit 3. Evaluation of student test administration competencies and a minimum of 150 hours of supervised experience in administration, analysis and reporting of individual diagnostic instruments. Prerequisites: E.Psy. 612 and 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: E.Psy. 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 615 and approval of Department Head.

618. Psychological Services in the Schools. (3-0). Credit 3. Practices and procedures of the psychologist in the school setting. Special attention to ethical and legal considerations, professional relationships, and emerging trends and issues. Prerequisites: EPSY 410, PSY 306, and permission of instructor.

619. Gifted and Talented Children. (3-0). Credit 3. Analysis of psychological characteristics of gifted and talented children. Introduction to identification techniques, educational programs, instructional approaches, and special problems. Prerequisite: Permission 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 tests and performance in educational settings.

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, including a variety of self-report personality inventories with emphasis on the Minnesota Multiphasic Personality Inventory. Prerequisites: E.Psy. 622 and approval of Department Head.

629. 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.

631. Techniques of Counseling. (3-0). Credit 3. Methods of gathering, analyzing, and interpreting case data in counseling. Analysis of dynamics of counselor-counselee relationship. Interviewing techniques. Use of test results in counseling. Prerequisites: E.Psy. 622 or 660, Psy. 634, and approval of Department Head.

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. 660 and approval of Department Head.

634. Group Counseling. (3-0). Credit 3. Major contemporary approaches to group counseling. Focuses on the integration of theory, and practical applications. Prerequisites: EPSY 631 and 633 or equivalent.

635. Practicum in Group Counseling. (0-10). Credit 3. 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. 629, 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. Designed to provide preparation in experimental research design in educational studies emphasizing the application of statistical methods in these designs. Prerequisite: Six hours of statistics.

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.

660. Foundations of Guidance. (3-0). Credit 3. Philosophical, psychological and sociological concepts fundamental to guidance and related helping professions.

662. Issues and Trends in Guidance. (3-0). Credit 3. Recent research and developments affecting guidance as a profession. Special attention to 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. Stress on continuing counseling relationships with various, selected subjects. Prerequisites: E.Psy. 629, 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. Emphasis on 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 are emphasized. Observation and research will augment the theoretical framework.

669. The College Student. (3-0). Credit 3. Nature, needs and characteristics of American college students. Focusing on developmental tasks, peer group relations and impact of college environment on student development. Research from behavioral sciences considered.

670. Student Personnel Work in Higher Education. (3-0). Credit 3. Survey of student personnel services in higher education emphasizing principles, philosophy, and major theoretical issues. Organization and administration of specialty areas.

672. Theories of Counseling. (3-0). Credit 3. Comprehensive and intensive study of major theoretical positions in counseling, stressing 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 emphasizing their significance to modern education.

674. Verbal Learning and Verbal Behavior. (3-0). Credit 3. Current research in verbal processes in children and adults. Variables influencing verbal learning. Research on special language problems encountered by handicapped and culturally different children. Application of research findings to educational programs involving verbal learning. Prerequisite: E.Psy. 673.

675. Seminar in Developmental Counseling. (3-0). Credit 3. Intensive consideration of topics pertinent to professional activities of counseling psychologists. Special attention to ethical and legal considerations, emerging techniques, and program management. Prerequisites: E.Psy. 672, 664 and approval of Department Head.

676. Marriage and Family Counseling. (3-0). Credit 3. Basic concepts and techniques in marriage and family counseling. Emphasis on marital communication and growth relationships. Prerequisites: E.Psy. 631, 633 and approval of Department Head.

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. Recent developments, research and problems in selected areas of the departmental curriculum.

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 4. 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 twelve 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
h — 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. Involves 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. Study of 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.

DEPARTMENT OF ELECTRICAL ENGINEERING

P. E. Allen, A. K. Ayoub*, R. K. Cavin, III*, J. P. Claassen, B. K. Colburn, J. S. Denison*, A. J. Druce*, O. Eknoyan, J. D. Gibson, J. W. Howze*, A. E. Hyslop, S. K. Jones, W. B. Jones, Jr. (Head)*, J. S. Linder*, B. G. Mattox, P. S. Noe*, J. H. Painter*, D. L. Parker*, A. D. Patton*, W.A. Porter*, V. T. Rhyne*, S. Riter*, J. L. Stone*

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 and Doctor of Engineering degrees. 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. The Master of Engineering degree is accredited by the Engineers Council for Professional Development.

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 instru-

*Graduate Advisor

mentation systems. Interdisciplinary Engineering Programs are available with other areas of specialization. Electrical Engineering faculty and graduate students participate in the activities of the Remote Sensing Center, Data Processing Center, Center for Urban Programs, Space Technology Division, and other interdepartmental activities.

Well equipped laboratories are available for work in all of these areas. The special facilities and programs of the Institute for Solid State Electronics and the Electric Power Institute support research in graduate programs of Electrical Engineering graduate students in these areas. Student research in telecommunications, controls, and digital systems is aided by use of several available mini-computer and microcomputer facilities. DEC PDP-11/40 and LSI-11 systems allow students to gain hands-on experience in computerized analysis of dynamic and stochastic systems.

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. Analysis of linear, continous and discrete systems using time domain methods, Fourier, Laplace, and Z Transforms.

605. Linear Control Systems. (3-3). Credit 4. Study of the 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. Study of techniques available to analyze and synthesize nonlinear and discontinuous control systems. Topics include modern stability theory, time-varying systems, DF, DIDF, Lyapunov Theory, adaptive control, identification, and design principles for utilizing 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.

624. Electronic Circuits for Instrumentation and Computation. (3-3). Credit 4. Analysis and design of electronic circuits used in instrumentation and computation. Amplifiers, "and" circuits, "or" circuits, and "gate" circuits. Problems of drift compensation in DC amplifiers and closed-loop stability in multi-stage amplifiers treated in detail. Prerequisites: E.E. 326, 448, 457.

628. Linear System Theory. (3-0). Credit 3. Application of functional analysis and geometric concepts to the analysis and synthesis of control systems. Prerequisites: E.E. 605.

630. Electronic Instruments and Measurements. (2-3). Credit 3. For students other than electrical engineering majors. Study of electronic instrumentation and measurement techniques for graduate students in the fields of science and engineering. Concerned with the use and basic operation of oscilloscopes, AC and DC meters, power supplies, signal generators, amplifiers, digital circuits, and transducers as related to the field of measurements.

633. Optimum Control Systems. (3-0). Credit 3. Variational approach to the development of algorithms for the solution of optimum control problems. Topics include study of necessary and sufficient conditions, numerical methods, and analysis and comparison of optimal control results to classical theory. Prerequisite: E.E. 605.

637. Wave Guides and Cavities. (3-0). Credit 3. Application of Maxwell's equations to solution of guided electromagnetic fields. Studies in skin effect, rectangular wave guides, circular wave guides, cavities, and microwave networks. Prerequisite: E.E. 451.

638. Antennas and Propagation. (3-0). Credit 3. Application of Maxwell's equations to determine electromagnetic fields of antennas. Studies in radiation, directional arrays, impedance characteristics, aperture antennas. Prerequisite: E.E. 451.

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. Analysis of linear discrete time systems using time domain and transform approaches. Digital filter design techniques with digital computer implementations.

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. Prerequisites: 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. Prerequisites: E.E. 456 and 646 or equivalent probability background.

648. Electromagnetic Wave Propagation. (3-0). Credit 3. Study of electromagnetic surface waves; direct and ground-reflected space waves; tropospheric refraction, reflection, and scattering; ionospheric refraction, reflection and scattering. Prerequisite: E.E. 451.

650. Control of Dynamic Stochastic Systems. (3-0). Credit 3. Study of Optimum Stochastic Control, Estimation and Identification techniques with application to communication and control systems. Dynamic Programming algorithms are developed for the control of uncertain dynamic systems. Kalman filtering algorithms are developed in the text of state estimation for dynamic stochastic systems. Prerequisites: E.E. 646, E.E. 605.

651. Microprogrammed Control of Digital Systems. (3-0). Credit 3. Introduction to and historical background of microprogrammed control; contrast with wired-logic controllers; examples of microprogrammed control of digital computers and other digital systems; use of memory; design and construction of microprogrammed systems. Prerequisite: E.E. 448 or approval of instructor.

652. Digital Systems Design. (3-3). Credit 4. Topics in digital systems design including 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 including arithmetic unit design, control, and memory. High-speed addition, subtraction, multiplication and division; micro- and macro-programming; magnetic memory devices. Emphasis upon design with integrated circuit components, including MSI devices. Prerequisite: E.E. 448.

655. Asynchronous Switching Circuit Design. (3-0). Credit 3. Design of asynchronous sequential switching circuits, including primitive flow-tables, state reduction, state assignment, hazards and delay. Relationship of asynchronous to synchronous digital systems, emphasizing the need for race-free assignments in asynchronous design. Prerequisite: E.E. 448 or equivalent.

656. Physical Electronics. (3-0). Credit 3. Review of elementary quantum theory. Statistical mechanics. Gaseous electronics. Semiconductor theory. Dielectrics. Magnetic materials. Quantum electronics. Introduction to quantum devices, including the laser. Prerequisite: Graduate classification in electrical engineering or approval of instructor.

661. Modulation Theory. (3-0). Credit 3. Study of 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. Discrete-time Markov processes and Kalman filter. Bayesian, Maximum-likelihood, Maximum A Posteriori Probability, and Conditional-Mean estimation methods. Prerequisite: E.E. 646.

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

671. Solid State Devices. (3-0). Credit 3. Development of mathematical analysis and design of solid state devices. Studies in relationships of measurable electrical characteristics to morphology and material properties of solid state devices.

672. Solid State Device Modeling. (3-0). Credit 3. Systematic modeling of active and passive solid state devices. Ebers-Moll models, charge control models, and Linvill lumped models with emphasis on the latter and a theory for the systematic derivation of such models. Other nonlinear models also considered. Selected circuit applications.

673. Fundamentals of Microelectronics. (3-0). Credit 3. Fundamental study of microelectronic systems or integrated circuits, fabrication technologies, monolithic integrated circuits, hybrid integrated circuits (thin films, thick films, monolithic chips).

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.

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

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 standing.

DEPARTMENT OF ENGINEERING DESIGN GRAPHICS

R. E. Barr, J. T. Coppinger,* J. H. Earle (Head)*

The graduate program in engineering design graphics provides a supporting area for advanced degrees for those who are preparing for the teaching profession and industry.

Modern facilities and current equipment are available to enhance study and instruction. These facilities include a complete graphics library, a reproduction and visual aids center, photographic and darkroom facilities, a graduate study area, modernly equipped classrooms with closed-circuit television, and special equipment for each course.

*Graduate Advisor

(E.D.G.)

601. Advanced Industrial Drawing. (2-3). Credit 3. Pictorial systems — axonometrics, obliques, and perspectives. Shade and shadow theory. Study of industrial pictorial applications. Research and development of visual aids. Introduction to technical illustration. Prerequisites: E.D.G. 106, 127 or equivalent.

603. Advanced Machine Drawing. (1-6). Credit 3. Current engineering drawing practices, and the application of ANSI Standards. Metrication, tolerances of position and form, techniques of preparing standard types of working drawings.

607. Descriptive Geometry. (3-0). Credit 3. Research of early and current applications of descriptive geometry to technical problems. Development and study of new principles for advancement and improvement of teachers of current graphics curricula. Prerequisites: E.D.G. 106; I.Ed. 323 or equivalent.

611. Technical Illustration. (3-3). Credit 4. Introduction to commercial methods and materials of technical illustration. Preparation of illustrations for reproduction. Report illustration, illustrations for publication. Time-saving techniques and methods. Various media including airbrush renderings.

685. Problems. Credit 1 to 4 each semester. Special research problems to fit needs of individual student. Prerequisites: E.D.G. 106; I.Ed. 323; graduate classification; approval of instructor.

DEPARTMENT OF ENGINEERING TECHNOLOGY

C. A. Bertrand,* J. F. Botsford, T. W. Comstock, E. R. Glazener (Head), D. W. Morgan, D. A. Rice

The graduate program in Engineering Technology offers courses leading to the Master of Science degree in Industrial Technology. This program interfaces with engineering, psychology, the physical and biological sciences, business administration, and a number of other programs. Minors or supporting areas are permitted in these and other areas.

The Master of Science degree in Industrial Technology provides graduate level instruction for the individual seeking to better prepare himself for technical-management, production-supervision, technical sales, industrial sales management, and mid-management positions in industry. Instruction in the major department involves an in-depth, technical study of production and manufacturing related functions. Instruction in supporting areas provides opportunity for further development of a selected technical specialty, or to further broaden training in areas generally supportive of a selected technical specialty. The degree is intended primarily to add depth of an application oriented nature to related undergraduate programs, especially Industrial Distribution, Industrial Technology, and Engineering Technology. The degree may be planned for 32 semester hours, including a thesis or 36 hours without a thesis.

*Graduate Advisor

(E.T.)

604. Industrial Communications and Training Systems. (2-3). Credit 3. Industrial communications techniques including 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. Prerequisites: E.T. 404 or Approval of Department Head.

626. Machine Tool Production and Management. (2-3). Credit 3. Machine tool operations as applied to high volume production of metal goods. Evaluation, selection, and set up of tooling for operation of equipment to include the various production machine tools. Scheduling and metal goods production management practices will be investigated. Prerequisite: E.T. 326, or equivalent.

629. Industrial — Technological Supervision. (3-0). Credit 3. Modern industrial supervision techniques with regard to interpersonal relationships, societal changes and the effects of technological developments. Prerequisites: E.T. 429 or equivalent.

635. Industrial Automation and Cybernetics. (3-0). Credit 3. Principles and techniques of automating machine tool operations and industrial processes. Prerequisites: E.T. 403 or registration therein, E.T. 447 or equivalent.

636. Materials Technology. (2-2). Credit 3. Advanced study of characteristics and application of the newer materials of industry. Study of materials research techniques and materials-oriented product development. Prerequisite: E.T. 207 or approval of Department Head.

681. Seminar. (1-0). Credit 1 each semester. Group study and discussion of current developments and problems related to the various technology options. Films, reports, and discussions with industrial representatives. Prerequisite: Graduate classification.

685. Problems. Credit 1 to 4 each semester. Designed to allow Master's candidates to undertake and complete with credit limited investigations not within thesis research and not covered by other courses. Prerequisite: Graduate classification.

689. Special Topics in ---. Credit 1 to 4. Study of selected topics in an identified area of Engineering Technology. May be repeated for credit. Prerequisite: Approval of instructor.

691. Research. Credit 1 or more each semester. Research for thesis in technology option. Prerequisite: Graduate classification.

DEPARTMENT OF ENGLISH

S. L. Archer*, R. H. Ballinger, R. W. Barzak, D. A. Berthold, F. D. Burt, G. H. Cannon, P. Christensen, R. H. Costa, H. Esau, N. S. Grabo*, J. P. Guinn, Jr., H. E. Hierth*, P. C. Hunter, Jr., H. P. Kroitor, J. Loving, P. A. Parrish, L. Reynolds, D. H. Stewart (Head)*, D. W. Strommer, J. E. Van Domelen, E. C. Want, M. D. Whitburn

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.

The M.A. degree (thesis option) requires a minimum of thirty credit hours. The thesis may be written on a subject in English literature, American literature, or linguistics. An option exists whereby students may take additional course work in lieu of a thesis.

A minimum of sixty-four credit hours beyond the M.A., or ninety-four hours beyond the B.A., is required for the Ph.D. degree in English. The student's program must include a minor of twelve hours. The dissertation may be written on a subject in English literature, American literature, or linguistics.

*Graduate Advisor

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.

(Engl.)

603. Bibliography and Literary Research. (3-0). Credit 3. Introduction of basic techniques of research and scholarly procedure in English. Research reports.

605. Old English. (3-0). Credit 3. Identical with Ling. 605. Introduction to Old English literature and language (phonology, morphology, syntax, lexicon, and dialectology) through extensive reading of the literature of the period. Research papers. Credit cannot be given for both Engl. 605 and Ling. 605.

606. Beowulf. (3-0). Credit 3. Identical with Ling. 606. Literary and linguistic study of Beowulf. Prerequisites: Engl. 605, Ling. 610; or approval of instructor. Credit cannot be given for both Engl. 606 and Ling. 606.

609. Middle English. (3-0). Credit 3. Identical with Ling. 609. Introduction to Middle English literature and language (phonology, morphology, syntax, lexicon, and dialectology) through extensive reading of the literature of the period. Research papers. Credit cannot be given for both Engl. 609 and Ling. 609.

610. History of the English Language. (3-0). Credit 3. Cross-listed with Ling. 610.

612. Chaucer. (3-0). Credit 3. Identical with Ling. 612. A literary and linguistic study of Chaucer's works. Bibliographical reports and research papers. 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 seventeenth 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, Thomson, and Young, with emphasis on 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, Sheridan, Hume, and Gibbon, with emphasis on 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 eighteenth century to present. Research papers. Prerequisite: A course in Shakespeare.

621. Milton and His Contemporaries. (3-0). Credit 3. Poetry and prose of John Milton, with emphasis on **Paradise Lost.** Consideration of 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. Studies in 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. Studies in 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. Studies in major Victorian writers of poetry and nonfiction prose, with concentration on two or three authors each time 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. Study of major English novelists from 1740 to twentieth 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. Studies in dramatic literature of British Isles from 1880's to present, with some consideration of influence from the Continent. Representative dramatists: Wilde, Shaw, Pinero, Barrie, Galsworthy, Synge, O'Casey, Eliot, Fry, Osborne. Research papers.

649. Studies in the Twentieth Century: British Literature. (3-0). Credit 3. Selected authors since 1900: Yeats, Joyce, Huxley, and others. Emphasis upon 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. Emphasis on particular literary movement or literary form. Research papers.

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. Principles of 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. Identical with Ling. 662. Investigation of the phonological, morphological, syntactic, and lexical components of the English language; emphasis on transformational theory as well as traditional and structural grammar. 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. Analysis of 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; emphasis on 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. Prerequisite: Graduate classification or approval of Department Head.

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, Hawthorne, Poe, Whitman, Melville, 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. Study of major American poets — for example, Edward Taylor, Poe, Whitman, Emily Dickinson, Robert Frost — and a study of the influence of American poetry and American culture on each other. Research papers.

683. Theory and Practice of Literary Criticism. (3-0). Credit 3. Analysis of important theories of literary criticism for students of English and American literature with attention to 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. Study of selected topics in an identified area of English. May be repeated for credit. Prerequisite: Approval of Department Head.

690. Theory of English Research. (3-0). Credit 3. Theory of investigative research in areas of English (e.g. rhetoric-composition, linguistics, literature), with emphasis upon current research and its application. Evaluation of current research and its relation to programs. May be repeated for credit. Prerequisite: Approval of instructor.

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. Study of 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: Engl. 609 or approval of instructor.

605. Old English. (3-0). Credit 3. Identical with Engl. 605. Credit cannot be given for both Engl. 605 and Ling. 605.

606. Beowulf. (3-0). Credit 3. Identical with Engl. 606. Credit cannot be given for both Engl. 606 and Ling. 606.

608. General Linguistics: Syntax and Semantics. (3-0). Credit 3. Study of nature and structure of language; work in phonetics and phonemics, morphology, syntax, lexicography, and generative-transformational models. Prerequisites: Engl. 409 or approval of instructor.

609. Middle English. (3-0). Credit 3. Identical with Engl. 609. Credit cannot be given for both Engl. 609 and Ling. 609.

610. History of the English Language. (3-0). Credit 3. Inductive study of phonological, grammatical, and lexical history of English language, with brief discussion of some other Indo-European languages; kinds and principles of linguistic changes in general, as reflected in English. Prerequisite: Engl. 662 or approval of instructor.

612. Chaucer. (3-0). Credit 3. Identical with Engl. 612. Credit cannot be given for both Engl. 612 and Ling. 612.

624. Spanish and the Bilingual Movement. (3-0). Credit 3. Problems of Bilingualism with special reference to the Spanish-speaking child. Cross-listed with Span. 605.

625. Applied Linguistics: English as a Second Language. (3-0). Credit 3. Relevant linguistic principles and methodology in TESOL for non-native speakers of English; development, organization 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. Identical with Engl. 662. Credit cannot be given for both Engl. 662 and Ling. 662.

666. Language Varieties: Regional and Social. (3-0). Credit 3. Study of the methods and principles of linguistic dialectology, including 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: Engl. 465, 609 and 662; or approval of instructor.

667. Linguistics and Literature. (3-0). Credit 3. Study of 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 and 666; or approval of instructor.

669. Theory of Grammar. (3-0). Credit 3. Advanced linguistic theory, with extensive reading in technical literature; individual research culminating in solution of an original linguistic problem; stress on transformational theory. Prerequisite: Engl. 662.

DEPARTMENT OF ENTOMOLOGY

P. L. Adkisson, D. E. Bay, D. L. Bull, H. R. Burke, J. R. Cate, Jr., R. N. Coulson, R. E. Frisbie, O. H. Graham, R. L. Hanna*, J. A. Harding, K. F. Harris, M. K. Harris, R. L. Harris, L. L. Keeley, G. M. McWhorter, J. K. Olson (Acting Head)*, T. L. Payne, F. W. Plapp, M. A. Price, J. C. Schaffner*, J. W. Smith, Jr., W. L. Sterling, M. D. Summers, M. H. Sweet, G. L. Teetes, J. G. Thomas, H. W. Van Cleave, S. B. Vinson, J. K. Walker, Jr.

Work is offered for specializations in the various phases of entomological science including taxonomy, morphology, parasitology, physiology, toxicology, ecology, economic, forest and urban entomology. Adequate facilities are available for research in these fields including a well-equipped laboratory. Modern analytical equipment for biochemistry and insecticidal determinations, including radioisotope techniques, is available as well as apparatus for insecticide toxicity studies. Insect biologies may be studied under controlled conditions of temperature and humidity. A large working collection of insects 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. Specific requirements, in addition to the elementary undergraduate courses pertaining to various lines of major work, are dependent upon previous training and professional experience.

The Ph.D. requires either a comprehensive knowledge of one language, a reading knowledge of two, or a reading knowledge of one language plus approved broadening courses. These options may be met in a number of ways.

*Graduate Advisor

(Ento.)

601. Principles of Systematic Entomology. (3-0). Credit 3. Principles, methods and history of systematic entomology, including literature, study of 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 with special emphasis on the evolution of insects. Geological history of insects. Detailed study of the classification and relationships of the higher insect taxa. Prerequisite: Graduate classification in entomology or other biological sciences. (Offered in 1974-75 and alternate years thereafter).

605. Aquatic Entomology. (3-3). Credit 4. Principles and practices concerning aquatic entomology. Emphasis placed on 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.

606. Invertebrate Pathology. (3-3). Credit 4. General invertebrate pathology and microbiology, including noninfectious and infectious diseases of invertebrates, the biological relationships between microorganisms and invertebrates, and application of entomogenous photogens in entomology. Prerequisite: One course in microbiology.

607. Economic Entomology. (3-3). Credit 4. Biologies, economic importance and control of insects and other arthropods from a pest management viewpoint are stressed. Taught by instructors specialized in various aspects of entomology. For non-entomology majors only with special emphasis on the needs of County Agricultural Agents, Voc. Ag. Teachers and private consultants.

608. Principles of Biological Control. (3-3). Credit 4. Theory and practices relating to the role and utilization of natural enemies in arthropod population regulation; review and analysis of projects in biological control; systematics, biology, and behavior of entomophagous arthropods. Prerequisite: Ento. 302 or equivalent.

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 included. Prerequisite: Approval of instructors. (also listed as Agro. 610 & Pl.Pa. 610).

615. Insect Physiology. (3-3). Credit 4. Physiological processes of insects with emphasis on metabolism nutrition, neuro-endocrinology, nerve action, cell structure, respiration, circulation, excretion and flight. Functional integration and regulatory processes of total organism are stressed. 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 man, animals and plants, including the 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 man and animals. Prerequisite: Ento. 208 or equivalent.

619. Insect Toxicology. (3-3). Credit 4. Classification and properties of major types of insecticides including chemistry, metabolism and mode of action. Selectivity, use hazards, residues and resistance are considered. Environmental problems such as biological magnification, persistence, and effects on non-target organisms are stressed. Prerequisite: One course in organic chemistry, Ento. 615 or approval of instructor.

620. Insect Biochemistry and Endocrinology. (3-0). Credit 3. Emphasis on recent information and concepts in the area of insect biochemistry. Special emphasis on 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.

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.

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. Study of 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 (Head), W. E. Etter*, D. R. Fraser, J. C. Groth, J. D. Martin, C. A. Phillips, R. M. Richards, P. S. Rose

Graduate specialization in finance is offered leading to the degrees of Master of Business Administration, Master of Science and as a field of concentration for the Doctor of Philosophy in Business Administration. The M.B.A. specialization is designed to prepare students for professional careers in finance. The Ph.D. specialization is structured to prepare persons for teaching or research careers. Students not in M.B.A. or Ph.D. programs may take courses in finance if they have been accepted in a graduate program at TAMU and if they meet the prerequisites.

*Graduate Advisor

(Fin.)

630. Problems of Corporation Finance. (3-0). Credit 3. M.B.A. core course in finance. Designed to allow student to apply basic concepts of finance to solution of business problems. Skills with tools of financial analysis developed and refined, investment and financing decisions analyzed. Prerequisite: Graduate classification; approval of graduate advisor.

632. Investment Management. (3-0). Credit 3. Basic introductory course in finance. Student will become familiar with nature and functioning of securities markets. Various investment media discussed and tools for analysis of these media developed. Course focuses primarily on analysis of debt and equity securities. Alternative trading strategies are evaluated. Prerequisite: Fin. 652 or approval of instructor.

634. Theory of Finance. (3-0). Credit 3. Focuses on theoretical issues and problems of finance. Suited for doctoral or masters students who seek an in-depth understanding of theory underlying financial decision-making. Attention given to financial theory pertaining to investment, financing, and dividend decisions. Prerequisite: Fin. 652 or approval of instructor.

635. Financial Management for Engineers I. (3-0). Credit 3. External and internal factors affecting financial decision-making in the firm. Includes fundamental concepts of accounting and managerial economics. Prerequisite: Approval of advisor.

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

638. Management of Financial Intermediaries. (3-0). Credit 3. Purpose of course is to familiarize student with functioning of various institutions. Differences in the asset and liability structures of institutions are considered. Problems in financial intermediary management arising from changing economic conditions considered.

639. Real Estate Development Analysis. (3-0). Credit 3. Financial aspects of real estate development with emphasis on the project's investment characteristics and merits. Prerequisites: Graduate classification and approval of instructor.

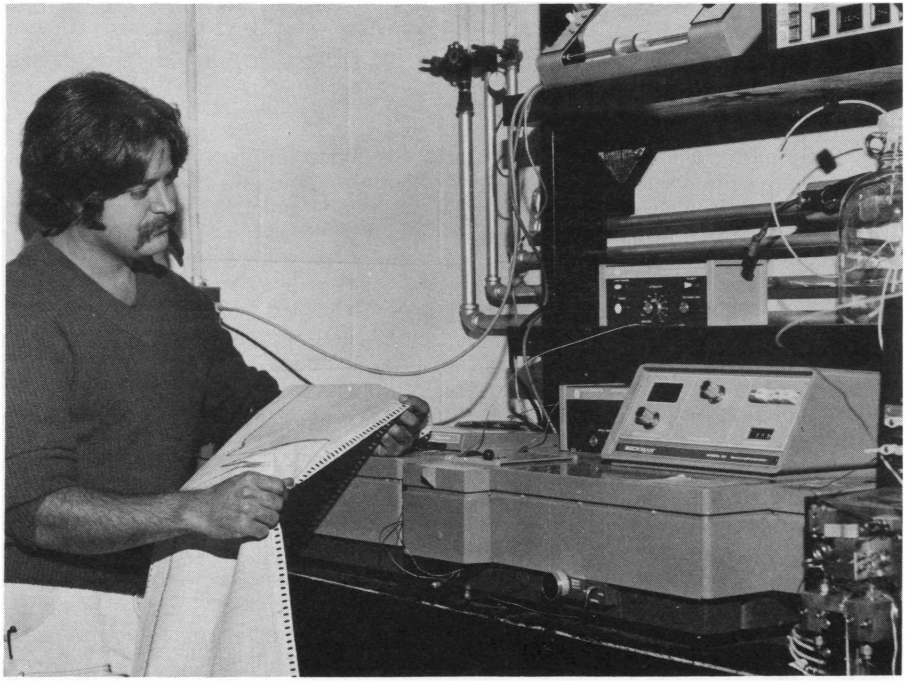
640. Analysis of Real Estate Investment Decisions. (3-0). Credit 3. Familiarizes student with financial aspects of real estate analysis and management. Analytical framework for investment decision-making developed. Timing and magnitude of relevant cash flows for investment analysis discussed as are tax aspects of real estate investment decisions. Specific types of investment properties considered. Prerequisite: Fin. 652 and Acct. 640 or approval of instructor.

642. Analysis of Money and Capital Markets. (3-0). Credit 3. Focuses on U.S. money and capital markets. Changes in the supply of and demand for money and capital studied as they influence the policies of financial intermediaries, fiscal and monetary authorities, and nonfinancial firms. Interest rates studied, including factors affecting their level and structure. Flow of funds in the U.S. economy considered. Prerequisite: Fin. 652 or approval of instructor.

645. International Finance. (3-0). Credit 3. Consideration given to problems confronted by financial managers of firms with international business operations. The differences between management of domestic and multinational firms examined. Exchange rate risks and political risks studied. Prerequisite: Fin. 652 or approval of instructor.

652. Financial Management. (3-0). Credit 3. Course designed for student with limited background in finance. A foundation course which introduces the concepts required in the M.B.A. core course. Finance function analyzed with particular attention focused on tools of financial analysis and on investment, financing, and dividend decisions. Emphasis placed primarily on mechanics of financial analysis. Prerequisite: Acct. 640 or approval of instructor.

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



670. Planning, Programming, Budgeting Systems. (3-0). Credit 3. Analytical techniques for identifying and selecting goals, developing alternative programs for reaching goals most efficiently, and measuring performance against costs of programs in both short-term and long-term contexts. Focus is on public sector of the economy. Prerequisites: Graduate classification and 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 finance.

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. Study of 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.

FOOD SCIENCE AND TECHNOLOGY

E. E. Burns, O. D. Butler, Z. L. Carpenter, A. B. Childers, C. R. Creger, C. W. Dill, T. R. Dutson, F. A. Gardner, N. D. Heidelbaugh, G. T. King, O. R. Kunze, W. A. Landmann, W. A. LePori, R. W. Lewis, D. B. Mellor, R. Nickelson, F. A. Orts, K. C. Rhee, K. S. Rhee, L. W. Rooney, L. H. Russell, G. C. Smith, D. A. Suter, V. E. Sweat, C. Vanderzant, J. D. Williams

The interdepartmental curriculum in food science and technology is administered through the office of the Dean 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 Science, 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. Minors in such areas 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 Master of Science degree. 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. Advanced study of chemistry of dairy foods and meats relating to their composition and characteristic properties important to their subsequent manufacture into food products. Prerequisite: Bi.Ch. 410 or 603. Cross-listed with D.S. 605.

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. Prerequisite: D.S. 326 or approval of Department Head. Cross-listed with D.S. 606.

607. Physiology and Biochemistry of Muscle with a Food. (2-2). Credit 3. Emphasizes biochemical, histological, anatomical, and physical 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. Cross-listed with D.S. 608.

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.

617. Experimental Techniques in Meat Science. (1-6). Credit 3. 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.

630. Cereal Grains for Human Food. (3-3). Credit 4. Includes discussion of 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. Laboratory includes 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. Discussion of dough structure and rheology and enrichment of cereal products. Prerequisite: Bi.Ch. 410. Cross-listed with Agro. 631.

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 emphasizing present and potential food applications of oilseed proteins. Prerequisites: Chem. 228, 317. Cross-listed with Agro. 634.

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. Cross-listed with Agro. 635.

644. Food Quality. (3-0). Credit 3. Advanced studies of physical, chemical, and biological properties of foods. Fundamental attributes of flavor, color, odor, texture. Esthetic, ethnic, and nutritional requirements. Role of additives. Regulatory standards and quality control regimes. Current techniques in food investigations. Cross-listed with Hort. 644.

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 will be emphasized. Cross-listed with An.Sc. 647.

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

T. E. Avery, R. D. Baker, R. L. Bury, R. S. Dewers, D. F. Durso, C. A. Hickman, P. R. Kramer, W. J. Lowe, R. G. Merrifield, W. K. Murphey (Head)*, T. L. Payne, E. J. Soltes, E. P. Van Arsdel, J. P. van Buijtenen

The objective of graduate education in the Department of Forest Science is to help interested students prepare themselves for those positions in forestry which require advanced training beyond that received at the baccalaureate level. Towards 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 is a professional program which is relatively broad in scope and which offers opportunities for student involvement in management and operational activities in the natural resource field. Candidates for the M.S. or Ph.D. degrees may pursue specializations in any of a number of disciplines related to forestry. These include ecology, economics, engineering (in cooperation with the Departments of Agricultural Engineering and Civil Engineering), entomology, genetics, mensuration, pathology, remote sensing, silviculture, soils and wood chemistry. Much of the course work in these specialized disciplines is available through other departments within the University.

Standards for admission to either of the master's degree programs, or to the doctoral degree program, are as described in this catalog. The only exception is that Ph.D. students are required to complete a qualifying examination prior to registration in the second semester. The examination is administered in the candidate's proposed area of specialization by an appointed faculty committee. Standards for graduation from either of the masters degree programs, or from the doctoral degree program, are also as described in this catalog. There is no uniform foreign language requirement for the Ph.D. degree in forestry.

All of the department's advanced degree programs are "unstructured" in terms of exact course content. This has the advantage of enabling degree candidates, with the advice and counsel of their graduate committee, to choose that set of courses which appears best suited to their background and educational aims.

*Graduate Advisor

(F.S.)

601. Forest Ecology. (3-0). Credit 3. Detailed study of forest communities and successions, interrelationships of various life forms of forest stands. Occasional field trips. Prerequisite: Approval of instructor.

602. Advanced Silviculture. (3-0). Credit 3. Study of advanced silvicultural methods, techniques and problems including current research and technical literature. Prerequisite: F.S. 305 or equivalent.

606. The Research Process. (3-0). Credit 3. Discussion of the 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.

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 C.E. 661.

681. Seminar. (1-0). Credit 1. For graduate students and staff members in forestry. Presentation and discussion of current scientific work in forestry and closely related subjects.

684. Professional Internship. Credit 1 to 4. The application of forestry principles in a working environment. Prerequisite: Limited to graduate students seeking a professional degree in forestry.

685. Problems. Credit 1 to 4 each semester. Designed for investigations not included in students' research for thesis or dissertation. Problems to be selected in some aspect of forestry.

689. Special Topics in ---. (3-0). Credit 3. Study of selected topics in an identified area of forestry. May be repeated for credit. Prerequisite: Approval of Department Head.

691. Research. Credit 1 or more each semester. Research in an approved aspect of forestry for thesis or dissertation credit.

GENETICS

E. C. Bashaw, C. R. Benedict, L. S. Bird, A. J. Bockholt, H. H. Bowen, T. C. Cartwright, J. W. Collier, G. A. Donovan, R. C. Fanguy, R. A. Frederiksen, P. A. Fryxell, C. E. Gates, J. R. Gold, F. W. Gould, G. E. Hart, E. C. Holt, N. M. Kieffer, R. J. Kohel, W. F. Krueger, H. O. Kunkel, C. R. Long, M. E. McDaniel, N. A. McNiel, C. W. Magill, J. M. Magill, G. A. Niles, L. M. Pike, H. J. Price, J. E. Puhalla, K. F. Schertz, G. L. Schroeter, J. D. Smith, O. D. Smith, N. A. Tuleen, J. P. van Buijtenen, D. F. Weseli

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 coursework is available in such specialized 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 forest genetics, animal breeding and plant breeding. Commonly used experimental organisms include bacteria and their viruses, Neurospora and other 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, 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 his research. The language requirement will be determined by the student's administrative department.

For course descriptions of the following, see the respective departmental listings.

ANIMAL SCIENCE
(An.Sc)

616. Quantitative Genetics II. (3-0). Credit 3.
628. Animal Breeding. (2-2). Credit 3.

PLANT SCIENCES
(Genetics, Gen.)

603. Genetics (4-0). Credit 4.
604. Genetics Laboratory. (0-3). Credit 1.
608. Genetics of Microorganisms. (3-0). Credit 3.
612. Population Genetics. (3-0). Credit 3.
613. Quantitative Genetics I. (3-0). Credit 3.
620. Cytogenetics. (3-0). Credit 3.
623. Special Topics in Genetics. Credit 1 to 3.
624. Statistical Genetics. (2-0). Credit 2.
625. Speciation. (3-0). Credit 3.
630. Cytogenetics Laboratory. (0-3). Credit 1.
631. Biochemical Genetics. (3-0). Credit 3.
633. Forest Genetics. (3-0). Credit 3.
634. Forest Genetics Laboratory. (0-3). Credit 1.
681. Seminar. (1-0). Credit 1.
685. Problems. Credit 1 to 4 each semester.
689. Special Topics in ---. Credit 1 to 4.
691. Research. Credit 1 or more each semester.

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, E. Cook, E. Doran, C. Kimber, C. W. Pennington (Head), J. Sonnenfeld*

Graduate work in geography is offered at both the master's and doctoral levels. The department has wide interests in man-environment relationships, and students are encouraged to work in physical, biological, and social sciences. Staff interests include cultural, historical, behavioral, resource, plant geographical, geomorphic, and economic studies. Graduate students are expected to be deeply involved with research work throughout their studies; most courses are taught as seminars requiring research papers rather than as lectures. For information concerning the Ph.D. language requirement, contact the graduate advisor.

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

*Graduate Advisor

(Geog.)

605. Processes in Cultural Geography. (3-0). Credit 3. The role of cultural processes in the evolving man-environment relationship, with an emphasis on innovation, diffusion, adaptation, and culture change. A foundations course for graduate work in geography.

606. Agricultural Origins and Dispersals. (3-0). Credit 3. Origin and spread of agriculture over the world. Single versus multiple origins. The several complexes: Near East, Far East, Africa, America. A research seminar. Prerequisite: Approval of Department Head.

607. Physical Geography of Early Man in America. (3-0). Credit 3. Application of physical earth science to the problem of the antiquity of man in America: paleoclimates and paleosols, eustatic sea level changes and coastal terraces, plus local field problems. A research seminar. Prerequisite: Approval of Department Head.

610. Geography of Water Transport. (3-0). Credit 3. Significance of boat types for cultural geography. Distribution and characteristics of great traditions: Western, Chinese, and Oceanic. Ambiguous traditions and their possible meanings. A research seminar. Prerequisite: Approval of Department Head.

612. Preclassical Seafaring. (3-0). Credit 3. Seafarers and watercraft of the ancient Near East and Mediterranean until ca. 700 B.C. Emphasis on 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.

614. Eastern Seafaring. (3-0). Credit 3. Culture history of people and watercraft of China, Southeast Asia, and Oceania. Principal emphasis on types, characteristics, origins, and spread of Chinese junks and Oceanic canoes. Research seminar. Prerequisite: Approval of Department Head. Cross-listed with Anth. 614.

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. Cross-listed with Anth. 615. Prerequisite: Anth. 612.

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. Cross-listed with Anth. 616. Prerequisites: Anth. 612, 615.

619. Man's Impact on His Environment. (3-0). Credit 3. Alterations by man of the landscapes, the atmosphere, and the waters of the earth; his interference with natural chemical cycles; his disturbance of ecological equilibria; his depletion of natural resources. Roles of technology and population growth. Ecoethics, environmental behavior and decision making. Prerequisite: Approval of Department Head.

620. Man and Nature. (3-0). Credit 3. Evolving views of man and nature; constraints on man's use of nature; natural hazards and environmental degradation; alternative consequences approach to resource 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. Studies on composition, local productivity, distributions, and plant migrations of taxa at different levels. Studies of man's impact may be included. The research seminar system is followed and the particular emphasis of the course varies from year to year. Prerequisite: Approval of Department Head.

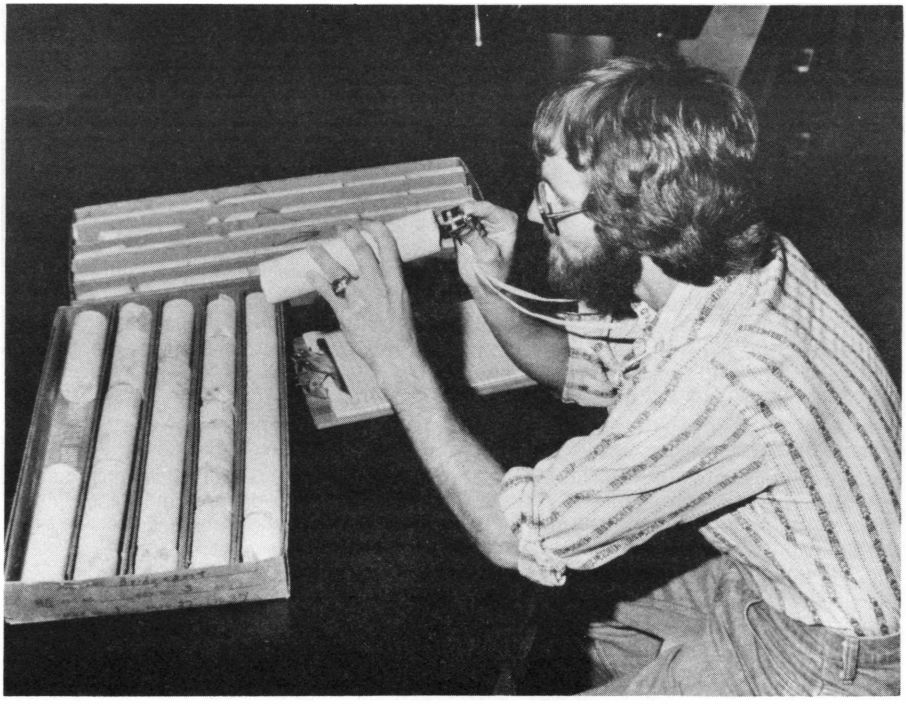
627. Coastal Geomorphology. (3-0). Credit 3. Description, geographical distribution, and evolution of coastal landforms. Emphasis on glacio-eustatic imprint and on landforms of Louisiana and Texas coasts. Floodplain development, terrace chronology, and evolution of estuaries, marshlands, and beaches. Man and coastal environments. Prerequisite: Three hours of advanced geology or physical geography or approval of instructor.

628. The Atmospheric Environment. (3-0). Credit 3. Atmosphere and its relation to man's activities; climate and its impact; air as a resource. Topics discussed with student participation. Prerequisite: Approval of Department Head.

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. Includes 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 Department Head.

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. The strategies of adjustment, control, and adaptation. Research paper. Prerequisite: Approval of Department Head.

650. Cultural Geography of the Caribbean. (3-0). Credit 3. Investigation of the patterns of distribution of the peoples of the Caribbean by cultural origin, technological level, and changing political affiliation. Prerequisite: Approval of Department Head.



670. Field Geography. (1-6). Credit 3. Advanced field methods. Documenting materials, reconnaissance, the field plan. Mapping traverse, base maps, and aerial photographs; recording techniques; interview procedures.

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. A course to enable graduate students with major or minor in geography to undertake investigations in various aspects of geography. Prerequisite: Approval of Department Head.

689. Special Topics in ---. Credit 1 to 4. Study of selected topics in an identified area of geography. May be repeated for credit.

690. Theory of Research. (3-0). Credit 3. Design of research in various subfields of geography and the evolution of research results with the aid of examples taken from current scientific literature.

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, R. R. Berg, E. F. Cook, M. Friedman, A. Hajash, Jr.*, J. W. Handin, E. R. Hoskins, W. H. Huang, C. B. Johnson, K. J. Koenig, J. M. Logan, C. C. Mathewson, T. J. Parker, D. K. Parrish, M. C. Schroeder, R. B. Scott, C. L. Seward, Jr., R. J. Stanton, Jr., D. W. Stearns (Head), T. T. Tieh

Graduate work in geology is offered at both the master's and doctoral levels. Programs are designed to provide the student with an understanding of the fundamentals of geology and of related disciplines. Research investigations comprise a significant part of each program.

Opportunities for research at both the M.S. and Ph.D. levels are available in ground-water investigations, sedimentation, clay mineralogy, paleontology and paleoecology, stratigraphy, structural geology, tectonophysics, petrology, field geology, engineering geology and geochemistry.

The Center for Tectonophysics provides unique opportunities for research in the following areas: design and analysis of scaled photomechanical models of structural processes; deformation of rock specimens under conditions which simulate the physical and chemical environment at depth in the earth's crust; use of specialized X-ray diffraction and microscopic techniques to study 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.

Engineering Geology is a graduate program in the Department of Geology leading to a Master of Science or Ph.D. degree in Geology. A Master's student generally has graduate course work in structural geology, stratigraphy, sedimentology, engineering geology, hydrology, soil and rock mechanics. Each student varies this basic program according to his own specific desires. Research interests include 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 are presently being carried out. A close research association exists with Civil Engineering, Urban Planning and the Center for Tectonophysics.

*Graduate Advisor

Professional jobs available at the B.S. level in geology are becoming fewer and fewer every year. Therefore, 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.

In addition to Graduate College requirements for the Ph.D., the student's committee chairman, with advice from the other committee members, shall determine on an individual basis the student's non-technical needs in either foreign language or other broadening areas.

(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 including 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. Study of 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. Systematic geologic surveying of selected areas. Prerequisite: Geol. 300.

612. Structural Geology. (3-0). Credit 3. Review of mechanical principles important to structural geology and study of experimental results relating to rock deformation followed by applications to natural deformation. Mechanisms, rather than geometries stressed. Primarily for students not concentrating in structural geology but who desire an advanced general course. Prerequisite: Approval of instructor.

614. Continuum Mechanics of Geologic Materials. (3-0). Credit 3. Continuation of Geop. 611. Basic principles in general continuum deformation problems. Development of constitutive equations and numerical methods used for geologic materials. Prerequisites: Geop. 611; Math. 308. Cross-listed with Geop. 614.

618. Sedimentology. (3-0). Credit 3. Mechanisms of transportation and deposition of ancient eolian, fluvial, and marine sediments. Dispersal and depositional patterns. The physical bases for sequences of textures, structures, and grain fabrics in sedimentary rocks. Prerequisites: Geol. 306; Math 307 or approval of instructor.

619. Petroleum Geology. (3-0). Credit 3. Properties of reservoir rocks; origin, migration, and accumulation of petroleum; geologic interpretation of borehole logs and fluid-pressure measurements and the role of hydrostatic and hydrodynamic pressures in oil accumulation. Prerequisite: Geol. 404 or approval of instructor.

620. Geology of Ground Water. (3-0). Credit 3. Principles of occurrence and movement of water beneath earth's surface, and influence of various geologic situations upon its behavior. Factors applying to estimates of supply. Engineering aspects of ground water. Prerequisite: Approval of instructor.

622. Stratigraphy. (3-0). Credit 3. Principles of correlating and naming stratigraphic units; interpretation of sedimentary environments based on composition, texture, and sedimentary structures; prediction of sandstone-body morphology of cored sections. Prerequisite: Graduate classification or approval of instructor.

629. Regional Geology of North America. (3-0). Credit 3. Study of the regional geology of North America by 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.

630. Urban Geology. (2-2). Credit 3. Fundamentals of engineering geology as applied to the planning, development and design of urban areas: including 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.

631. Geology in Engineering Construction. (3-0). Credit 3. Evaluation of 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.

632. Site Investigation. (3-0). Credit 3. Photogrammetry, photogeology, remote sensing, engineering geophysics and field methods applied to site investigations. Emphasis on the identification of geologic characteristics that are significant to engineering construction. Prerequisite: Graduate classification in Engineering or Geoscience.

633. Photogeology. (2-3). Credit 3. Application of black and white and color aerial photography to geology, with emphasis on landforms and geologic mapping and application of multi-spectral imagery, including infrared, multi-spectral photography, radar, and other techniques to the geologic environment. Prerequisite: Approval of instructor.

637. 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 are emphasized. Prerequisite: Approval of Department Head.

638. 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 are emphasized. Prerequisite: Approval of Department Head.

640. 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 with emphasis on diagenesis and weathering. Prerequisite: Approval of instructor.

646. Geology and Diagenesis of Clays. (2-3). Credit 3. Geologic significance and role of clay minerals and related phylosilicates in the depositional and diagenetic environments. Prerequisite: Approval of instructor.

650. Paleoecology. (2-3). Credit 3. Study of interrelationships of organisms and environment in the fossil record. Analysis of methods and criteria available for interpreting ancient environments. Critical review of classic studies and current research in paleoecology. Prerequisite: Approval of instructor. Offered in 1977-78 and alternate years thereafter.

652. Biogeology. (2-3). Credit 3. Analysis of major trends and processes in the evolution of life through geologic time. Interrelationships of biological and physical processes in earth history. The 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 1978-79 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 suits of igneous and metamorphic rocks. Prerequisite: Approval of instructor.

662. Sedimentary Petrology. (2-6). Credit 4. The 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: Geology 303 and 304 or approval of instructor.

663. Mineralogy. (2-6). Credit 4. Study of structure, chemistry, physical properties, and geological occurrence of minerals. Emphasis on 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. Prerequisite: 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.

667. Structural Geology II. (3-0). Credit 3. Application of theoretical and experimental results to problems in natural rock deformation. Study of structural mechanisms on the phenomenological, laboratory and natural scales with emphasis on the genesis of structural features in layered rocks. Prerequisite: 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.

690. Theory of Geological Research. (2-0). Credit 2. Theory and design of research problems and experiments in various sub-fields of geology. 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. Original research on problems in various phases of geology. Research for thesis or dissertation.

DEPARTMENT OF GEOPHYSICS

N. L. Carter (Head), D. A. Fahlquist, A. F. Gangi*, J. W. Handin, E. R. Hoskins, J. M. Logan, D. K. Parrish, T. W. Spencer, R. R. Unterberger

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, 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; radar and sonar probing in salt and potash to predict rock conditions in advance of mining; mining engineering and geophysics; and mineral resource development.

An AMDAHL 470 computer system is operated by the Data Processing Center for faculty and student research. The department operates a complete programmable calculator system including a plotter and a cassette tape unit. The research ship GYRE is available for research in the marine environment. Special department facilities include: a seismic field station equipped with telemetered output; an analog computer and a two-dimensional seismic modeling laboratory for study of elastic-wave propagation in earth structures and the radiation fields generated by brittle fracture; an exploration-type, 36-channel digital seismic recording system; a 30-kilowatt peak-power, low-frequency radar for long-range underground electromagnetic-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.

*Graduate Advisor

(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. Laboratory emphasizes analysis and interpretation of data from both marine and continental areas. Prerequisites: Math 122; Phys. 218, 219; or approval of instructor.

611. Geomechanics. (3-0). Credit 3. Development of continuum mechanics and its application to rock deformation. Rigid-body dynamics, emphasizing equilibrium and energy concepts. Strain and stress analysis of deformable bodies using tensor notation. Introduction to elasticity, viscoelasticity, plasticity and steady-state flow of rocks. Elastic stability, rupture and fracture concentrating on topics pertinent to the structural geologist and solid-state geophysicist. Prerequisite: Math. 307.

614. Continuum Mechanics of Geologic Materials. (3-0). Credit 3. Continuation of Geop. 611. Basic principles in general continuum deformation problems. Development of constitutive equations and numerical methods used for geologic materials. Prerequisites: Geop. 611; Math. 308. Cross-listed with Geology 614.

615. Experimental Rock Deformation. (2-3). Credit 3. The results of laboratory testing of mechanical properties of rocks at high pressure and temperature with emphasis on 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.

633. High Pressure/Temperature Geophysics. (3-0). Credit 3. Theories of the equations of state and their application to geophysics. Isothermal and vibrational formalisms, fourth-order theories, and shock waves. The theory of melting. Prerequisite: Phys. 302 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, 1979 and alternate years thereafter).

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. Study of the 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, 1978 and alternate years thereafter).

681. Seminar. (1-0). Credit 1. Discussion of subjects of current importance. Prerequisite: Graduate classification.

685. Problems. Credit 1 to 6 each semester. Designed to enable 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; 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

J. M. Chevrette, L. J. Dowell*, R. S. Hurley, G. T. Jessup, C. W. Landiss (Head)*, M. J. Little, R. A. Magill, E. Mamaliga, L. D. Ponder*, N. G. Schmidt, H. Tolson

Graduate study in health education and physical education is offered leading to the Master of Education, Master of Science, Doctor of Education and Doctor of Philosophy degrees. A foreign language is not required for the doctoral degree.

Graduate courses in health education and physical education have been designed to assist in the advanced preparation of master teachers, researchers and administrators in these two fields. A Professional Teaching Certificate for the State of Texas in these two fields may be earned in this department.

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.

*Graduate Advisor

grams 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.

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. Emphasis given to understanding man's sexuality as a health entity and as a source of creative energy and his total life development.

621. Principles of Health Education. (3-0). Credit 3. Background and development of health education as an applied science; foundations of personal health; health concepts and principles.

622. Issues and Trends in Health Education. (3-0). Credit 3. Current issues and trends in health 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. Consideration given to legislative and educational efforts in this area.

626. Health Careers. (2-2). Credit 3. Study of the 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. Prerequisite: H.E. 425. Cross-listed with P.E. 636.

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 utilized 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, 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. Study of 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.

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. A study of human behavior in sport and physical activity. Areas of study include: exceptional performances; sport and personality; movement perception; motivation in sports; and maturation and physical activity.

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.

610. Administration of Interschool Athletics. (3-0). Credit 3. Designed for school superintendents, principals, and athletic directors. Study of 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. Investigation and analysis of 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. Prerequisite: P.E. 627.

630. Mechanical Analysis of Motor Activity. (3-0). Credit 3. Analysis of human movement with emphasis on sports skills by application of principles of mechanics, kinesiology, and cinematographical analysis. Prerequisite: P.E. 627; approval of instructor.

633. Principles of Exercise and Physical Fitness. (2-2). Credit 3. Analysis of 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. (2-2). Credit 3. Critical study of tests and measurements; methods of constructing and evaluating tests. Prerequisite: P.E. 425. Cross-listed with H.E. 636.

637. Exercise Physiology. (2-2). Credit 3. Examination and critical analysis of current research in human performance and sport physiology. Analysis of the nature of cardiorespiratory fitness, muscular efficiency, and related topics. Prerequisite: Biol. 652, or approval of Department Head.

638. Ergonomics. (2-2). Credit 3. Examination of current methods of imposing work in the exercise physiology laboratory and current techniques for evaluating man's physiological responses to work. Critical analysis of current research in the area of work physiology with special emphasis on 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: Physical Education 406.

641. Motor Development. (3-0). Credit 3. Motor, physical, and neuromuscular development from prenatal periods to old age. Specific areas of study include stages of development, motor system, and development of specific movement patterns. Prerequisite: P.E. 406.

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. Study of 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, A. C. Ashcraft, G. E. Bayliss, R. A. Beaumont, K. L. Bryant, Jr., (Head), R. A. Calvert, H. C. Dethloff, B. D. Gooch, C. H. Hall, L. D. Hill,* W. J. King, Z. J. Kosztolnyik, A. P. Krammer, H. H. Lang, B. S. Ledbetter, H. M. Monroe, Jr., J. M. Nance, D. J. Pisani, H. C. Schmidt, D. E. Schob, B. M. Unterberger

Graduate study in history is offered leading to the degrees of Master of Arts 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 (colonial, early national, Old South, New South, the West, Civil War period, recent, social and intellectual, agricultural, economic, diplomatic, and Texas history), European history, Latin American history, military history, and the history of science.

Students will find acceptable minors in economics, education, English, 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 his major field; and for a minor at least 9 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.

*Graduate Advisor

Normally for the Ph.D. in American History the student shall demonstrate a reading knowledge of two (2) 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 (6) semester hours of graduate work outside the major and minor fields of study, completed after the filing of his degree program, may be substituted for one language.

(Hist.)

601. American Colonial Life and Institutions. (3-0). Credit 3. Study of the seventeenth and eighteenth century English American colonies. Prerequisite: Approval of Department Head.

603. The United States: Revolutionary Era, 1750-1789. (3-0). Credit 3. Structure of American Society; British policy; the revolutionary movement; independence; Confederation period; social, political and economic changes; diplomatic affairs. Prerequisite: Approval of Department Head.

604. The United States: Early National Era. 1789-1829. (3-0). Credit 3. Organization of the new government; the Federalist system; Jeffersonian democracy; the War of 1812; the New Nationalism; political, social, and economic problems; territorial expansion. Prerequisite: Approval of Department Head.

610. The Trans-Mississippi West. (3-0). Credit 3. Study of the West in American history. Emphasizes political, economic, social and cultural influences of frontier. Prerequisite: Approval of Department Head.

611. American Leaders. (3-0). Credit 3. Personalities and contributions of 36 American leaders from Samuel Adams to Dwight Eisenhower. 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, including scope, principles, practices, objectives, dangers, and lessons learned. Prerequisite: Approval of Department Head.

615. Growth of Spanish Institutions in America, 1492-1857. (3-0). Credit 3. Study of 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 United States 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.

621. The United States, 1877-1914. (3-0). Credit 3. Economic, social, political history of the U.S., 1877-1914, emphasizing 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 United States 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. Examination of the works of important historians from Herodotus to the present; consideration of schools, theories, and the function of history. Prerequisite: Approval of Department Head.

629. United States Historical Bibliography. (3-0). Credit 3. Acquaints the advanced student with the bibliographical sources and the nature and extent of materials for the study, interpretation, and writing of United States history. Prerequisite: Twelve advanced hours in United States history; or approval of Department Head.

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.

634. Reading Seminar in American Agricultural History. (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.

637. Reading Seminar in the Spanish Borderlands. (3-0). Credit 3. Prerequisite: Approval of Department Head.

638. Seminar in Medieval Europe. (3-0). Credit 3. Institutional and social cultural development in Medieval Europe, emphasizing 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 twentieth century. Prerequisite: Approval of Department Head.

642. Reading Seminar in Recent Asian History. (3-0). Credit 3. 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. The political history of the age will be supplemented by examination of economic and social institutions and of the Enlightenment. Prerequisite: Approval of Department Head.

677. Edwardian England. (3-0). Credit 3. A study of the political, social, cultural, economic, and diplomatic development of England, including Ireland, between 1900 and 1914. Prerequisite: Approval of Department Head.

685. Problems. Credit 1 to 3 each semester. Individual instruction in selected fields of history. Stresses reports and wide readings in field selected. Prerequisites: Eighteen hours of history and approval of Department Head.

689. Special Topics in ---. Credit 1 to 4. Studies of 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: Twelve hours of advanced history and approval of Department Head.

HORTICULTURAL SCIENCES

W. S. Barham (Head), H. H. Bowen, E. E. Burns, E. R. Emino, J. E. Larsen, W. N. Lipe, E. L. McWilliams, N. P. Maxwell, J. C. Miller, Jr., A. E. Nightingale, D. R. Paterson, L. M. Pike, J. B. Storey.

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. Advanced study of families, genera, species and cultivars of horticultural plants including identification, morphological variation, use and adaptability to climatic conditions in the Southwest. Specific problems in horticultural taxonomy, geography, biosystematics and genecology. Field trip required. Prerequisites: Botany 201, Horticulture 206 or approval of instructor.

610. Tropical Foliage Plants. (2-2). Credit 3. Intensive study of 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. Field trip required. Prerequisite: Hort. 320.

615. Greenhouse Problem Diagnosis. (2-2). Credit 3. Diagnosis of routine problems encountered in management and maintenance of greenhouse facilities. Problems involved in propagation, care, and analysis of plants grown in greenhouses for scientific investigations. Field trips required. Prerequisite: Graduate classification.

616. Plant Reproduction. (2-2). Credit 3. Basic scientific principles underlying highly technical practices involved in reproduction of ornamental, fruit and vegetable plants by asexual methods. Current developments in anatomical, morphological, and physiological factors involved in asexual plant regeneration. (see Hort. 614 for sexual propagation.) Field trip required. Prerequisite: Hort. 426.

617. Landscape Horticulture. (2-3). Credit 3. Relations of ornamental plants to environments. Study of 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. Study of selected topics in an identified area of floriculture. May be repeated for credit. Prerequisite: Approval of instructor.

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

HORTICULTURE

Advanced work in horticulture will be conducted with areas of specialization in fruit production, nut production, vegetable production, ornamental horticulture, and fruit, nut and vegetable processing. The minor work, which supports the thesis research, will usually include courses in at least two additional departments. 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 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. Environmental Relations of Fruit Plants. (3-3). Credit 4. Principles of nutrition, water, and tree size control related to management practices of fruit and nut trees. Practice in leaf analyses by atomic absorption spectrophotometry, plant water potential research, and growth regulator investigations. Field trip required. Prerequisites: Hort. 319, 401, 418 and Pl. Phy. 314.

602. Factors Influencing Fruit Production. (3-3). Credit 4. Influence of environmental factors and growth regulators on reproductive and vegetative growth of fruit and nut plants. Field and lab experiments with growth regulators. Study of systematics and crop improvement of fruit plants. Field trip required. Prerequisites: Hort. 319, 401, 418 and P.Phy. 314.

603. Structure of Vegetable Plants. (3-3). Credit 4. Morphological and anatomical features of important groups of vegetable plants related to production and progressive improvement of crop. Prerequisites: Hort. 304, 322.

604. Physiology of Vegetable Plants. (3-3). Credit 4. Nutrition, light, vernalization, seed treatment, water, and temperature related to fruit setting and vegetable production. Current developments in hormones, herbicides, and greenhouse vegetable production. Prerequisites: Hort. 322 and P.Phy. 314.

605. Orchard Management. (2-2). Credit 3. Application of recent advancements in breeding, nutrition, weed physiology, stress physiology, taxonomy, anatomy and mycology to orchard situations. Orchard management of pecans and peaches covered in detail. Pome and small fruits considered in survey manner. Practice in solving orchard management problems considering technological advancements. For non-majors only. Field trip required. Prerequisites: Hort. 319 and 418 or approval of instructor.

614. Vegetable Propagation. (2-3). Credit 3. Principles and practices of sexual propagation of horticultural plants including vegetables, ornamentals, and fruits. Factors affecting seed development, germination, and dormancy. Handling, storing, and processing of vegetable and flower seeds; the seed industry; breeding and trial gardens; seed certification, storage, and longevity. (See Flor. 616 for asexual propagation). Field trip required. Prerequisites: Gen. 301; Hort. 304, 322, 426; or approval of instructor.

615. Origin and Distribution of Horticultural Plants. (2-3). Credit 3. Study of origin, distribution, identification, classification, and description of horticultural crops. Importance of genetic knowledge to continued improvement of horticultural crops. Prerequisite: Hort. 304 and/or approval of instructor.

644. Food Quality. (3-0). Credit 3. Advanced studies on physical, chemical, and biological properties of foods. Fundamental attributes of flavor, color, odor, 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. Field trip required.

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 will be 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. Study of selected topics in an identified area of Horticulture. May be repeated for credit. Prerequisite: Approval of Department Head.

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

DEPARTMENT OF INDUSTRIAL EDUCATION

G. E.Baker*, J. L. Boone, Jr.*, M. L. Chastain, D. L. Clark*, F. E. Clark*, M. E. Dennis*, G. D. Gutcher*, D. L. Householder (Head)*

The Department of Industrial Education offers graduate programs leading to Master of Education, Master of Science, Doctor of Education, and Doctor of Philosophy degrees. Areas of specialization in industrial arts, vocational industrial education, educational technology, technical education, and traffic safety education are available within each degree program. A student may earn the professional teaching certificate in industrial arts for the state of Texas by completing course requirements through this department.

Graduate courses in industrial education are intended to provide the student the opportunity to develop the skills and knowledges generally required of industrial educators, researchers, program directors, and departmental administrators. Specific information concerning the requirements for each of the degrees and procedures for meeting those requirements is available from the department upon request.

*Graduate Advisor

EDUCATIONAL TECHNOLOGY

Graduate courses in educational technology are designed to provide a supporting field for doctoral students who are majoring in other disciplines, and to provide a major field for students who are seeking a Master of Education degree in educational technology. The courses stress a systems approach to the art of communication, with emphasis on the design of messages which make effective use of the latest technical equipment available. Internships are utilized to provide the student with relevant experiences in instructional communications. The courses are open to individuals who desire to improve their teaching skills or who intend to seek employment in schools, government or industry as media or communications specialists.

(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. Study of communications with emphasis upon senses of hearing and seeing in teaching-learning processes. Laboratory experiences in the selection, preparation, utilization 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. Utilization 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. Emphasis given to techniques of preparation and utilization of programmed slide sets, filmstrips, and motion pictures and their application in instructional systems.

631. Instructional Television. (3-0). Credit 3. Utilization 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.

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. Study of selected topics in an identified area of Educational Technology. May be repeated for credit. Prerequisite: Approval of instructor.

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.

INDUSTRIAL EDUCATION
(I.Ed.)

601. History of Industrial Education. (3-0). Credit 3. Study of leaders, movements, and agencies with special emphasis on economic, social, and philosophical factors which have contributed to development of industrial education in the United States.

602. Industrial Arts Administration and Supervision. (3-0). Credit 3. Problems of local director or supervisor of industrial arts.

603. Administration and Supervision of Vocational Industrial Education. (3-0). Credit 3. Problems of local director or supervisor of vocational industrial education.

604. Industrial Programs for Community Colleges and Technical Schools. (3-0). Credit 3. Study of kinds, purpose, size, accreditation, growth, and teaching problems in community colleges, technical institutes, and adult schools, with particular emphasis on organization and presentation of industrial subject material in these schools.

606. Organization of Industrial Education Departments. (3-0). Credit 3. Problems in determining type and size of industrial education program for various types and sizes of schools and colleges with plans for organization of each.

609. Innovative Programs in Industrial Arts. (2-3). Credit 3. Developing programs in industrial arts. Design and organizational strategies for teaching these programs.

614. Guidance Seminar. (3-0). Credit 3. Organization of occupational information, educational and vocational guidance, counseling case problems.

616. Methods of Teaching Industrial Education. (3-0). Credit 3. Selection and utilization of appropriate instructional strategies in industrial education.

618. Tests and Measurements in Industrial Education. (3-0). Credit 3. Study of testing and measuring devices and their application to industrial education subjects.

619. Related Subjects in Part-Time Cooperative Programs. (2-0). Credit 2. Organization and presentation of content material necessary in part-time cooperative programs, and direction of the study of students engaged in such programs.

621. Philosophy of Vocational Education. (2-0). Credit 2. Basic principles involved in development and operation of industrial education programs under state and federal vocational laws.

622. Philosophy of Industrial Arts Education. (3-0). Credit 3. Principles involved in development and operation of industrial arts courses and their purpose and function in the field of general education.

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.

627. Research and Development in Technical Education. (3-0). Credit 3. Problems related to administration of industrial education research programs. Methods of organizing and conducting teacher improvement programs including methods of conducting organized research.

628. Organization of Vocational Industrial Programs. (3-0). Credit 3. Methods of making surveys, determining needs for various industrial education programs, and organization of curriculum and classes according to state certification requirements.

635. Industrial Design and Development. (3-0). Credit 3. Advanced procedure in preparing teachers for industrial design and development. Historical review of design, effect of aesthetic, social, and economic factors on a design concept and relationship between function and production processes.

681. Seminar. (1-0). Credit I. General discussions of laws, legislation, certification, professional ethics, and other current problems relating to industrial education teaching professions. 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 utilized. 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. Study of selected topics in an identified area of industrial education. May be repeated for credit. Prerequisite: Approval of instructor.

690. Theory of Industrial Education Research. (3-0). Credit 3. Theory and design of research problems and experiments in various subfields of industrial education. Communication of research proposals and results. Evaluation of current research of faculty and students and review of current literature. May be repeated for credit. Prerequisite: Approval of instructor.

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

692. Professional Study. Credit 1 or more each semester. Approved professional study of project undertaken as the terminal requirement for Doctor of Education degree. Preparation of Record of Study summarizing the rationale, procedure, and results of the completed project. Prerequisite: Approval of major advisor.

SAFETY EDUCATION

The graduate program in Industrial Education offers an area of specialization in Safety Education for students seeking the Master of Education, Master of Science, Doctor of Philosophy, and Doctor of Education degrees. These programs interface with industrial education, engineering, psychology, business administration, the physical and biological sciences, educational curriculum and instruction, physical education, and educational administration. Minors or supporting areas are permitted in these and other areas. Safety education may be combined with industrial education to form a major field.

Graduate courses in safety education are designed to assist in the advanced preparation of master teachers in driver and traffic safety education; to prepare safety education supervisors and administrators; and to prepare safety education research and development specialists.

(Sa.Ed.)

601. Behavioral Factors in Traffic Safety. (3-0). Credit 3. A study of personality factors related to unsafe driving behavior. Special emphasis will be given to the effect of attitudes, motivations, and adjustment on behavior. The course will also include an investigation of principles and methods appropriate in identifying, understanding, and modifying unsatisfactory attitudes and behavior. Prerequisites: Sa.Ed. 427 and 428 or approval of instructor.

604. Alcohol and Traffic Safety. (3-0). Credit 3. An in-depth study of the relationship between the consumption of alcohol and its effect upon traffic safety and driving of motor vehicles. Special emphasis given to the role that traffic safety education can play in educating drivers to the risks and problems involved in drinking and driving.

608. Issues and Trends in Safety Education. (3-0). Credit 3. Critical analysis of current issues and trends in safety education. Emphasis on research and development affecting safety education profession. Prerequisite: Approval of instructor.

610. Administration of Safety Education Programs. (3-0). Credit 3. A study of safety education programs at national, state and local levels including the administrative, instructional and supervisory aspects of the programs. Basic emphasis on implementation.

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. Emphasis on planning and managing public information and community support program.

624. School and College Accident Prevention. (3-0). Credit 3. An in-depth study of accident prevention and control programs for educational institutions, with special emphasis given the human, environmental and legal factors effecting program development, implementation and management.

628. Professional Development in Safety Education. (3-0). Credit 3. An in-depth exploration of the problems of safety education at the university level. Review of related research. Emphasis on the development of representative model curricula for the preparation of safety education personnel. Prerequisites: Approval of instructor.

630. Traffic Safety Education Innovations. (3-2). Credit 4. An exploration of the broad spectrum of recent traffic safety education innovations. Particular emphasis will be placed upon their applications for improving the quality of classroom and laboratory instruction. Prerequisite: 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. Emphasis on 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, roadway, 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. Emphasis on the problem solving approach. 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. Study of selected topics in an identified area of Safety Education. May be repeated for credit. Prerequisite: Approval of instructor.

690. Theory of Research in Safety Education. (3-0). Credit 3. Theory and design of research problems and experiments relating to the various operational areas of safety education. May be repeated for credit. Prerequisite: Approval of committee chairman.

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 major advisor.

DEPARTMENT OF INDUSTRIAL ENGINEERING

INDUSTRIAL ENGINEERING: R. P. Beals*, G. L. Curry, J. R. Duncan, N. C. Ellis (Head), R. M. Feldman, J. W. Foster, III (Division Head), M. J. Fox, Jr., L. L. George, R. E. Goforth, J. P. Harper, J. K. Hennigan, G. L. Hogg, R. D. Huchingson, M. McDermott, D. T. Phillips, D. R. Smith

COMPUTING SCIENCE: J. A. Barnes, S. B. Childs, D. Colunga, D. D. Drew (Division Head), W. M. Lively*, S. S. Nelson, U. W. Pooch, D. B. Simmons, G. N. Williams

BIOENGINEERING: J. Canzoneri, W. A. Hyman, T. A. Krouskop, P. J. Sharpe, J. B. Smathers (Division Head)*, D. L. Stoner

INDUSTRIAL HYGIENE AND SAFETY ENGINEERING: D. E. Clapp, C. L. Gilmore, W. L. Johnston, R. B. Konzen* (Division Head), R. J. Vernon

*Graduate Advisor

The Graduate programs in the Department of Industrial Engineering are quite broad and are designed to develop the student's understanding in modern engineering principles, applications, and research. The department is organized to serve as the focal point for the academic programs in engineering dealing with man, man and machine, and man and his biological, natural and social environment. Courses are available in the areas of Human Factors Engineering, Labor Relations, Bioengineering, Industrial Hygiene and Safety Engineering, Computing Science, Operations Research, and Industrial Engineering. The master's degrees available at present in the Industrial Engineering Department are the Master of Engineering in Industrial Engineering and Bioengineering; Master of Computing Science; and Master of Science degree in Industrial Engineering, Bioengineering, Computing Science, Safety Engineering, and Industrial Hygiene. The degree of Doctor of Philosophy is available in Industrial Engineering, Bioengineering, and Computing Science. The Doctor of Engineering program offers areas of study which include Bioengineering and Industrial Engineering. The graduate courses listed below indicate the depth of work available in each of these areas.

The graduate research program within the Industrial Engineering Department is equally as broad as the academic program. Mission-oriented research is underway or has been conducted in such diverse areas as artificial intelligence and automation, behavioral and human factors engineering, bioengineering, management engineering, manufacturing engineering, service systems engineering, operations research and optimization, computer graphics, social and political systems engineering, medical engineering, computing science, software engineering, production design engineering, industrial operations, biomechanics, maintainability engineering, bionics, ecological systems engineering, industrial hygiene, safety engineering and labor relations.

Facilities for study and research are unequaled. An excellent, fully equipped Data Processing Center provides a laboratory for all students. In addition, research laboratories are available in the department in production engineering, bioengineering, industrial hygiene and safety engineering, numerical control and interactive graphics, computer hardware and software systems, medical engineeering, food engineering, ecological systems engineering, and maintainability engineering. These laboratories are excellently equipped and provide students with an exceptional research opportunity. Research projects are underway which provide students with the opportunity to obtain engineering experience 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 or Doctor of Engineering degree in the Department of Industrial Engineering.

BIOENGINEERING
(B.E.)

602. Instrumentation and Measurement in Biological Systems. (3-3). Credit 4. Information, extraction from biological systems with emphasis on interface matching. Transducers commonly used in bioengineering given as the interface between biological signals and instrumentation systems. Prerequisites: Phys. 219; E.E. 331 or equivalent; B.E. 401 or consent of instructor.

603. Information Processing in Bioengineering. (3-3). Credit 4. Methods for evaluating alternative approaches in computing systems for biomedical applications. Provides some familiarity with the wide variety of existing software and available programming resources. Cross-listed with Mgmt. 650.

605. Biological Application of Continuum Mechanics. (3-0). Credit 3. Mathematical modeling of mechanical behavior of solid, fluid and viscoelastic biological material systems. Modeling and analyzing, explaining and synthesizing such behavior. Prerequisites: B.E. 421, M.M. 460 or equivalent.

612. Experimentation. (2-3). Credit 3. General concepts forming the basis of the scientific method and design of experiments are considered. Analytical instrumentation and measurement methods useful in biomedical research are reviewed. Criteria for the selection, care and use of experimental animals and human subjects in biomedical research are discussed. 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.

633. Biochemical Thermodynamics. (3-0). Credit 3. Biochemical thermodynamics, kinetics and transport mechanisms. Integration of the classical statistical and informational aspects of thermodynamics as they relate to living systems. Prerequisites: B.E. 412, 452 or approval of instructor.

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 electro-physiological and biochemical processes, to the dynamic characteristics, and to the natural and artificial maintenance of homeostasis in living systems. Prerequisites: Bi.Ch. 410; B.E. 401; Math. 602; V.P.P. 323; or approval of instructor.

640. Biomembrane Transport Processes. (3-0). Credit 3. Theoretical approaches to quantification of transport in biological membranes, including integration of the structural, kinetic, molecular, methodological and comparative aspects of biological membrane transport processes. Prerequisite: B.E. 412, 452, Bi.Ch. 410 or approval of instructor.

651. Biochemical Engineering. (3-0). Credit 3. Integration of principles of engineering, biochemistry and microbiology, including 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 Ch.E. 651.

652. Enzyme Engineering. (3-0). Credit 3. Application of basic principles of life science and engineering technology, including large scale unit operations involved in production, isolation, immobilization, economical utilization of enzymes as well as optimization of enzyme reactor systems. Emphasis on 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 and Ch.E. 652.

673. Analysis of Biosystems. (3-0). Credit 3. Non-human biological systems, including structure and function from a systems engineering viewpoint. Derivation of rate kinetics from physical and chemical laws. Prediction of growth, development, reproduction and mortality of poikilothermic organisms under varying environmental conditions. Prerequisite: Approval of instructor.

674. Modeling of Biosystems. (3-0). Credit 3. Computer modeling of biological systems based on concepts introduced in B.E. 673. Physical sciences approach to modeling. Prerequisite: B.E. 673.

681. Seminar. (1-0). Credit 1. Designed to permit student to broaden his capability, performance, and perspective in biomedical engineering via a formal presentation of his own and by presentations from engineering, medical and veterinary professionals.

684. Professional Internship. Credit 1 to 6. Provides students with on-the-job 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. Designed to permit in-depth study in areas relating to specific student interests, recent advances and societal problems 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.

COMPUTING SCIENCE (C.S.)

602. Information Processing Languages. (4-0). Credit 4. Application of computers to information processing problems. Emphasis on programming of data processing problems in COBOL. Sorting, searching, decision tables, random access devices, and systems analysis. Note: This course may not be taken for graduate credit by computing science majors.

603. Assembly Language. (4-0). Credit 4. Computer architecture and system software through the assembly languages of a minicomputer and a large scale computer. Machine structure; assembly language; machine language; addressing techniques; and digital representation of data. Subroutine linkage; reentrant code; and macros. Assembly language programming assignments. Prerequisite: Knowledge of some programming language. Note: This course may not be taken for graduate credit by computing science majors.

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. 458, 602, 603, 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. 458, 602, 603 or equivalent.

613. Computer Software Systems. (3-0). Credit 3. Review of hardware/software evolution leading to 3rd generation operating systems. Study of 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. 603.

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. Prerequisites: CS 458, 602, 603.

615. Database Systems. (3-0). Credit 3. Study of data processing systems including 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. 603.

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. Emphasis on student development of a repertoire of computation techniques. Topics include 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. Includes consideration of both technical and managerial issues. Prerequisites: C.S. 612.

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. A critical discussion of 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. Prerequisite: C.S. 603.

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 are studied and their implementations on finite automata, pushdown automata and Turing machines are presented.

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. Prerequisite: C.S. 603.

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. Analysis of 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. 458, 602, 603, or equivalent.

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. Designed to permit in-depth study in areas relating to specific student interest, recent advances and societal problems in computing 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.

INDUSTRIAL ENGINEERING (I.En.)

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. 403, 416.

603. Human Relations in Industry. (4-0). Credit 4. 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 those encountered at the bargaining table. Introduction to foreign labor relations systems. Cross-listed with Mgmt. 650.

604. Advanced Work Measurement. (2-3). Credit 3. Advanced methods and studies in work measurement systems with emphasis upon applications; including time and motion study, work sampling, fatigue effects, predetermine time systems, methods and production standards development. Prerequisite: I.En. 304 or approval of instructor.

605. Materials Handling. (3-0). Credit 3. Analysis and design of integrated material handling systems, with emphasis on automatic storage and retrieval of unit loads, identifying and establishing boundary conditions on key parameters required to specify the desired system so that equipment vendors can design the appropriate hardware.

606. Collective Bargaining in the Public Sector (3-0). Credit 3. Status of collective bargaining in the public sector including Federal, state, county, and municipal levels. Special problems associated with such special groups as Federal employees, teachers, policemen and firemen, nurses, and other state, county, and municipal employees. Investigates the nature of grievances, and forms of impass resolution and their impact on the various collective bargaining and/or professional negotiations. Cross-listed with Mgmt. 651.

607. Research Topics in Labor Relations. (3-0). Credit 3. Cross-listed with Mgmt. 635.

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. 403 or I.En. 666.

610. Advanced Manufacturing Processes. (2-3). Credit 3. Quantitative study of the nontraditional material removal and forming processes. Emphasis given to the economic aspects as well as to theory and industrial applications. Processes covered include electro chemical machining, electrical discharge machining, high energy forming, as well as 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. Cross-listed with Mgmt. 652.

612. Design by Reliability. (3-3). Credit 4. Quantitative reliability analysis in engineering design. Reliability methods applicable to design are component reliability determination, system reliability model analysis, life testing stress/strength analysis, and fault tree analysis.

613. Process Control and Optimization. (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: Stat. 212 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 (3-0). 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. Prerequisite: I.En. 315 or equivalent.

616. Advanced Industrial Analysis. (3-0). Credit 3. Combines concepts of experimentation and analysis with those of industrial control and design. Methodologies applicable to experimental design for industrial experimentation and non-parametric description of engineering processes. Emphasis upon the application to real world formulations and analysis of industrial problems. Prerequisite: 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 620 or equivalent.

618. Maintainability Engineering II. (3-0). Credit 3. Basic stochastic processes necessary to deal with advanced problems in reliability, maintainability, and other related areas. Topics include Markov decision theory, optimal stopping problems, renewal theory, and semi-Markov decision theory. Prerequisites: I.En. 613, 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 are applied to industrial and production forecasting problems. Prerequisite: I.En. 613 or equivalent.

620. Principles of Operation Analysis. (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, game theory, and queuing theory. Prerequisite: I.En. 314, 320 or equivalent.

622. Applied Linear Programming. (3-0). Credit 3. Designed to provide students with 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.

623. Nonlinear and Dynamic Programming. (3-0). Credit 3. Designed to provide student with an 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. Emphasis on application of methods to problems in operations research and industrial engineering. Prerequisites: I.En. 320.

624. Applied Distribution and Queuing Theory. (3-0). Credit 3. Queuing theory and its applications including single and multiple channels, priorities, balking, batch arrivals and service, and selected non-Markovian topics. Applications emphasized including statistical inference and design and control of queues. Prerequisites: I.En. 613, 620 or equivalent.

625. Applications of Simulation Technology. (3-0). 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. GASP IV stressed as a primary simulation language, but also includes fundamentals of GPSS, SIMSCRIPT, and Industrial Dynamics. Prerequisites: I.En. 620 and C.S. 201 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. Involves selection and use of an efficient technique. Computer solution procedures. Selected readings in the current literature. Prerequisites: Four courses within the I.En. 620 and 660 series.

627. Engineering Analysis for Decision Making. (3-0). Credit 3. Designed to provide student with principles and application of techniques in analysis of decision processes involving engineering systems under uncertainty. Introduces student to areas of utility and information theory as related to quantification of information for decision making. Prerequisites: I.En. 314, 620, 622, 628.

628. Applied Game Theory. (3-0). Credit 3. Provides student with understanding of mathematics associated with game theory and proficiency in recognition, definition, and solution of all types of applied game theory problems. Covers application of this methodology in operations research, military operations research, and industrial engineering problems. Prerequisite: I.En. 620.

629. Engineering Optimization. (3-0). Credit 3. Coverage of 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. Provides the student a basic understanding of the theory and practice of human factors engineering. Topics are presented within the framework of man as a functioning system and his requirements when incorporated in hardware and software systems.

631. Engineering Man-Machine Interface II. (3-0). Credit 3. Designed to enlarge student's understanding of the man-machine interface and to develop the capability of applying human performance data in the design of man-machine systems (controls, displays, and workplace).

632. Human Factors Engineering in System Design. (3-0). Credit 3. Develops within the student the capability of functioning as a human factors engineer in the system design and development environment. Included are 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. Prerequisite: I.En. 637.

634. Man-Machine Systems Engineering. (3-0). Credit 3. Provides the student with an 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. Designed to provide a background of understanding and relevant data to students concerned with the design of man-machine systems. The value of including a man in the system rests upon his unique ability to translate sensed data into meaningful command signals. Prerequisite: I.En. 630 and 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.

637. Human Factors Engineering. (3-0). Credit 3. Human factors methods, models, and problem areas including a study of human performance and criteria for work in stressful environments.

638. Human Operator as a Systems Controller. (3-0). Credit 3. Provides the student with an understanding of the theory and application of the human control process in both manual and automatic control systems, giving him a capability to develop human factors engineering requirements for the design of control systems. Prerequisite: Approval of instructor.

639. Engineering Biotechnology. (3-0). Credit 3. Designed to investigate the current methods and techniques of simulation and measurement of human engineering variables and further explore new ideas for possible contribution to the advancement of the art course. Content varies from one semester to another, but research ability and originality will be emphasized. Prerequisite: Enrollment in Ph.D. program.

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 including an analysis of the factors involved in obtaining conditions of minimum cost, maximum production and maximum profit are included. Prerequisite: I.En. 454 or equivalent.

660. Design and Control of Engineering Management Systems. (3-0). Credit 3. Survey of analytical methods for optimal design, operation, and control of engineering management systems. Techniques in analysis of complex engineering systems. Methodology for determining optimal operating criteria.

661. Network-Based Planning and Scheduling Systems. (3-0). Credit 3. Deterministic and stochastic network flow analysis, with emphasis on both 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 will be included as well as a number of real-world models. Extensive use will be made of computerized algorithms. Prerequisite: I.En. 613, C.S. 201 or equivalent.

662. Planning Technology. (3-0). Credit 3. Advanced forecasting and planning techniques in the design of strategic planning systems. Corporate objectives, financial planning models, material requirements planning, manpower planning, and corporate planning. Technological forecasting, critical path method for project planning and control, and PERT applied in real-world institutions.

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 are covered 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. 620 or equivalent.

665. Advanced Production Control. (3-0). Credit 3. Production scheduling and inventory control problems; variety of special problems and solution techniques. Review of calculus, stochastic processes and convexity. Economic theory of production. Prerequisites: I.En. 314 or 315 or equivalent.

666. Cost Estimating, Engineering Economy and Planning. (3-0). Credit 3. 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.

675. Integrated Logistics Support. (3-0). Credit 3. Provides background material which will allow the student to serve as logisticsnspecialist on a design team. The course concentrates on the development of management and engineering concepts relating to I.L.S. of systems. These concepts emphasize the design for performance and support. The concepts highlight a balanced consideration between operation, economic, and logistics factors.

681. Seminar. (1-0). Credit 1. Opportunity to present research in a professional atmosphere. Presentations are not restricted to thesis or problem research. Presentations found unacceptable by faculty representative must be repeated with a different subject. Acquaints the student with departmental research activities and procedures in documenting research. Normally taken the first semester in graduate program.

684. Professional Internship. Credit 1-6. Professional internship provides 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. Investigation of 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. Permits 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. Provides a solid foundation in the general concepts and techniques of safety engineering upon which more detailed and advanced applications may be based, in particular, applications of safety principles to industrial and commercial systems are discussed and the concept of designing optimally safe systems is introduced.

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 process as a specialist in safety engineering. Accident prevention and human factors principles are brought to focus upon specific problems of accident elimination as related to the man-machine system design. Emphasis placed upon operator/maintenance technician factors such as sensory perceptions, physical characteristics, physiological and mental stress, etc., as design considerations.

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 are focused on specific problems of loss exposure as related to the facility design and operation. Emphasis on both protective procedures and methods of preventing loss of man and facilities.

674. System Safety Engineering. (3-0). Credit 3. Current system safety engineering analysis techniques including 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. Fire resistance, flame spread, fire protection principles; flammable liquids, gases, solids, dusts, chemicals and explosives; public and private extinguishing equipment and methods, including automatic extinguishing systems.

678. Problems in Safety Engineering. (2-0). Credit 2. Utilizes 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 required.

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. The recognition of environmental stresses present in man-machine systems and the effect of these stresses on health, safety, and performance of man. Chemical, physical (heat stress, noise, radiation), ergonomic, and biological stresses. Principles of epidemiology applied to occupational diseases discussed.

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. (2-3). Credit 3. Evaluation of environmental stress factors present in man-machine 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: I.En. 680 or approval of instructor.

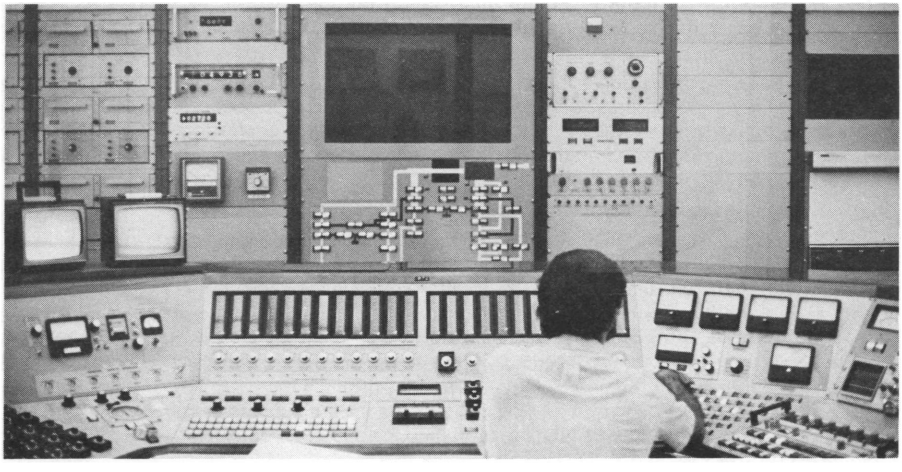
683. Evaluation and Control of the Occupational Environment. (3-3). Credit 4. Detection, evaluation and control of chemical, physical, and biological health hazards prevalent in manufacturing, construction, and mercantile operations. Procedures and operations with guest speakers and field trips to local industry. Prerequisites: I.En. 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 and psychological aspects of noise and evaluation and control of the noise problem in the environment. Source, path, and level of noise are considered; acoustical properties of materials; damage-risk criteria for hearing; and criteria for noise and vibration in communities, buildings, and vehicles.

689. Special Topics In ---. Credit 1 to 4. Study of selected topics in an identified area of Safety Engineering. 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.



INTERDISCIPLINARY EDUCATION

A. B. Campbell*, R. A. Fellenz*, J. F. McNamara*, D. F. Seaman* (Head and Coordinator, Adult and Extension Education), R. J. Swinney*‡

Interdisciplinary Education in the College of Education provides the setting for a series of graduate programs which draw upon the resources of several academic departments within the University. The graduate programs in Vocational Education and in Adult and Extension Education provide for the professional preparation and training of administrators, supervisory personnel, staff development specialists, vocational guidance personnel, planning and evaluation specialists, teachers, curriculum specialists, and research personnel.

In addition to utilizing appropriate courses from other departments of the University, these comprehensive graduate curricula also include selections from a series of specially designed courses in Interdisciplinary Education described in this section.

*Graduate Advisor

‡Faculty from several other departments in the College of Education also teach Id.Ed. courses and serve as committee members and graduate advisors.

(Id.Ed.)

601. Principles of Vocational Education. (3-0). Credit 3. Principles of vocational education stressing the development, social and economic values, purposes, scope, and nature of the different programs of vocational education existing today.

605. Organization and Administration of Vocational Education. (3-0). Credit 3. The administration of comprehensive vocational education programs emphasizing the 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. Study of 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. Emphasis on the process of curricular development and improvement using a systems approach.

617. Cooperative Training Program. (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 will be required.

630. Adult Learning. (3-0). Credit 3. Research and theory in adult learning. Factors influencing the adult learning process.

632. Methods of Adult Education. (3-0). Credit 3. Theory and practice of teaching in adult education. Emphasis on standard techniques as well as more innovative strategies, including programmed instruction, simulation, and micro-teaching.

633. Adult Literacy Education. (3-0). Credit 3. Important aspects of implementing literacy programs for adults, including funding, recruiting, placement, counseling, and using community resources.

634. Teaching of Adult Basic Education. (3-0). Credit 3. Practical oriented study of the general knowledge, skills and techniques essential to the teaching of the undereducated adult.

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 are considered as well as potential solutions.

638. Contemporary Issues in Adult Education. (3-0). Credit 3. Analysis of some of the most pressing contemporary issues facing adult educators. Emphasis on 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. Emphasis on 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. Emphasis on organizing, financing, publicizing, staffing and evaluation.

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. Emphasis upon educational implications of specific needs and current educational programs to meet those needs.

650. History and Philosophy of Cooperative Extension. (3-0). Credit 3. A study of the 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 with special reference to the role of education. Particular attention will be given to social, economic and political aspects.

661. Management of Family Resources. (3-0). Credit 3. Principles of management of financial and other family resources. Emphasis on 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, implementation and evaluation of educational programs in housing.

663. Utilization of Paraprofessionals. (3-0). Credit 3. Use of paraprofessionals in education and other fields and methods of recruitment, training, supervision and administration of paraprofessionals. Emphasis on methods and techniques of utilizing paraprofessionals in educational programs among disadvantaged clientele.

664. Volunteer Staff Development. (3-0). Credit 3. Principles of volunteer staff development and utilization in adult and youth education programs.

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.

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. Students with undergraduate degrees in other fields such as mathematics or science with an acceptable understanding of engineering fundamentals are invited to participate in the program. The principal programs under Interdisciplinary Engineering include areas of specialization in activation analysis, mechanics and materials, and systems engineering. Other degree programs may be tailored to suit a student's desires subject to Graduate College regulations and the approval of the student's committee. The Doctor of Philosophy language requirement will be determined by the student's Advisory Committee. Students interested in this program should contact Dr. Richard E. Thomas, Associate Dean of Engineering, Zachry Engineering Center.

(Itd.E.)

671. Professional Engineering Ethics and Practice. (2-0). Credit 2. Engineering professional practice with emphasis on 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. Study of 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 Dr. Walter Haisler, Room 113, Old Engineering Building.

(M.M.)

601. Theory of Elasticity (3-0). Credit 3. Study of 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.

602. Vectors and Tensors in Mechanics. (3-0). Credit 3. Unified study of continuous media using vectors and tensors.

603. Foundations of Solid Mechanics (3-0). Credit 3. Fundamental description of displacement, stress and strain mechanisms in deformable solids. Major effort directed toward microscopic theory; comparision of macroscopic analysis. Prerequisite: Math 601.

604. Mechanics of Viscous and Elastic Fluids. (3-0). Credit 3. Study of basic dynamics and kinematics of viscous and visco-elastic fluids. Newtonian, non-Newtonian, and viscoelastic fluids are considered. Fundamentals of tensor analysis are included and are utilized in generalizing rheological equations of state. Prerequisite: Math 601. Cross-listed with Ch.E. 640.

605. Energy Methods. (3-0). Credit 3. Study of principle of virtual work, Rayleigh-Ritz method, Reissner's Variational Theorem. Applications to linear and nonlinear problems in mechanics. Prerequisite: Math 601 or registration therein.

606. Shock Waves in Continuous Media (3-0). Credit 3. Theory of one-dimensional shock wave propagation in gases, liquids and solids. Numerical techniques and the method of characteristics are applied to shock tubes, water pipes and the impact of elastic and plastic systems. The mechanism of wave transmission and reflection in layered materials is used to predict shock wave amplification and attenuation. Prerequisites: Math 601 or registration therein.

607. Flow and Fracture of Solids (3-0). Credit 3. Study of flow theories and fracture mechanisms of crystalline solids. Elasticity, materials science applications to engineering. Dislocation theory, fracture, creep, and fatigue.

609. Materials Science. (3-0). Credit 3. Detailed study of structure and properties of solid materials. Prerequisites: Graduate classification; approval of instructor.

613. Principles of Composite Materials. (3-0). Credit 3. Atomic, molecular, micro/macrostructure studied with respect to physical and mechanical properties of composite materials. Includes plastic, metallic, and ceramic matrices reinforced with continuous and discontinuous fibers, whiskers, and particulates. Mechanical and chemical interactions, failure modes, interface, fabrication techniques, and structural design concepts. Prerequisite: Approval of instructor.

614. Classical Elasticity. (3-0). Credit 3. Cartesian tensors, kinematics of deformation, kinetics of continuous media, elastic constitutive law, linearization of basic equations, fundamental problems of linear elasticity and properties of solutions, torsion and bending of rods.

632. Structural Stability. (3-0). Credit 3. Buckling of columns, frames, arches, rings, plates, and shells, lateral and torsional buckling of beams, Newmark's method, equilibrium method, Rayleigh-Ritz, variational principles. Galerkin method, Treffetz method, review of current literature. Prerequisites: Math 308; approval of instructor.

633. Theory of Plates and Shells. (3-0). Credit 3. Small-deflection thin plate theory for plates of various shapes and support conditions, bending of anisotropic plates. Plates under combined lateral loads and in-plane forces. Large deflection thin plate theory, theory of shells, stability of plates and shells. Prerequisite: Math 601 or registration therein.

636. Theory of Thermal Stresses. (3-0). Credit 3. Basic study of heat conduction, thermoelasticity and thermoinelasticity as related to thermal stresses. Prerequisites: M.M. 601; approval of instructor.

640. Theory of Shells. (3-0). Credit 3. Continuation of study of theory of shells introduced in M.M. 633. Limited to study of linear shell theory. Equations formulated using Lame's surface parameters. Membrane analysis, bending analysis, and shallow shell theory. Prerequisites: M.M. 633.

641. Plasticity Theory. (3-0). Credit 3. Theory of perfectly plastic yield and flow of two and three-dimensional bodies. General theory of shear lines, velocity fields, and limiting lines are developed for problems of incipient, steady, and pseudo plastic flow. Prerequisite: Math 601 or registration therein.

645. Application of the Theory of Shells. (2-0). Credit 2. Specialization of general shell equations to certain classical geometries and methods of solution. Problems of shell dynamics and anisotropic shells. Prerequisite: Math 601.

647. Theory of Finite Element Analysis. (3-0). Credit 3. Finite elements of a continuum; plane stress and plane strain; bending of plates; axi-symmetric stress analysis; three-dimensional stress analysis; isoparametric finite elements; recent developments; use of several finite element computer programs to solve typical structural problems. Prerequisite: M.M. 467 or equivalent; or approval of instructor.

650. Dynamic Fluid-Solid Interactions. (3-0). Credit 3. Advanced topics of the dynamic interaction between fluid and solid systems with applications to space vehicles, nuclear reactors, heat exchangers and structures in general. Topics include hydroelasticity, hydrostatic divergence, flow induced vibrations, instability, and compliant surfaces. Prerequisite: Math 601 and 602 or approval of instructor.

651. Viscoelasticity of Solids and Structures. I. (3-0). Credit 3. Linear, viscoelastic mechanical property characterization methods, time-temperature equivalence, multiaxial stress-strain equations. Viscoelastic stress analysis: the correspondence principle, approximate methods of analysis and Laplace transform inversion, special methods. Static and dynamic engineering applications. Nonlinear behavior. Prerequisite: Approval of instructor.

652. Viscoelasticity of Solids and Structures II. (3-0). Credit 3. Thermodynamics of linear and nonlinear viscoelastic materials. Nonlinear constitutive equations based on thermodynamics. Application to civil and aerospace engineering materials and structures. Viscoelastic fracture. Prerequisite: Approval of instructor.

689. Special Topics in ---. Credit 1 to 4. Study of selected topics in an identified area of Mechanics and Materials. May be repeated for credit. Prerequisite: Approval of instructor.

SYSTEMS ENGINEERING

Systems Engineering is the 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. Degree programs 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 Dr. William B. Jones, Jr., Electrical Engineering Department, Zachry Engineering Center.

(Sy.En.)

601. Systems Engineering. (3-0). Credit 3. Study of processes and patterns of systems engineering, a discipline concerned with planning, organization, and management of programs for developing large, highly complex systems.

610. System Characterization. (3-0). Credit 3. Study of concepts and techniques of characterizing systems and subsystems to facilitate their analysis and design. Prerequisite: Itd.E. 601.

620. Preliminary System Design. (3-3). 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 Standing.

622. Computer-Aided Design. (3-0). Credit 3. 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 Standing.

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.

689. Special Topics in ---. Credit 1 to 4. Study of selected topics in an identified area of Systems Engineering. May be repeated for credit. Prerequisite: Approval of instructor.

DEPARTMENT OF LANDSCAPE ARCHITECTURE

D. B. Austin (Head), H. L. Garnham, F. Klatt, Jr.*, R. A. Moore, M. D. Murphy

The Department of Landscape Architecture offers a graduate program leading to the degree of Master of Landscape Architecture. The program is intended to develop capabilities beyond those acquired at the undergraduate level. It offers educational opportunities not found in daily practice. The work is conducted in an atmosphere which encourages individual investigative effort into the ramifications of landscape conservation and related aspects of land development. Emphasis is placed on the necessity of collaborative professional efforts in the solution of all environmental design problems.

*Graduate Program Coordinator

(Land.)

613. Urban Design I. (2-4). Credit 3. Cross-listed with Arch. 613.

614. Urban Design II. (2-4). Credit 3. Cross-listed with Arch. 614.

615. Urban Design III. (2-12). Credit 6. Cross-listed with Arch. 615.

616. Urban Design IV. (2-12). Credit 6. Cross-listed with Arch. 616.

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 with special emphasis of production of plans and reports. Prerequisite: Graduate classification in Landscape Architecture.

630. Land Development Principles. (1-6). Credit 3. Importance of regional landscape concepts. Ecological studies, landscape conservation studies, recreation potential; methods of bringing about logical regional development to create more pleasant environments in which to live. Prerequisite: Graduate classification in Landscape Architecture, Architecture, Urban and Regional Planning, Civil Engineering, Recreation and Parks, Sociology, Geography, Forest Science, Wildlife and Fisheries Science or Economics.

631. Land Development Techniques. (1-6). Credit 3. Continuation of Land. 630 with special emphasis on interprofessional collaborative efforts. Prerequisite: Land. 630.

667. Development Feasibility and Design. (3-4). Credit 5. Cross-listed with Arch. 667 and Plan. 667.

681. Seminar. (1-0). Credit 1 each semester. Analysis and criticism of selected landscape architectural projects. Includes 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 8 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. Study of 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.

DEPARTMENT OF MANAGEMENT

R. B. Abel, R. Albanese*, H. Chamberlain, D. Hellriegel, (Head), G. D. Keim, J. E. Pearson, J. I. Reynolds, G. H. Rice, Jr., J.L. Sandstedt, J. L. Seymour, A. W. Smith, B. D. Stone, Jr., T. F. Urban**, D. D. Van Fleet, A. V. Wolfe

Graduate study in management is offered leading to the Master of Business Administration, the Master of Science in Management, and the Doctor of Philosophy in Business Administration with a major in Management. Depending upon the student's needs and career aspirations, students may emphasize their coursework and studies in the General Management area or in areas of specialization such as Organizational Behavior and Theory, Personnel and Labor Relations, or Marine Resources Management.

Graduate students in other programs may take courses offered by the department. However, graduate students who are classified as "Code 6" students may not enroll in graduate level courses in management unless preceded by special permission.

Information on graduate programs in Business and Management is available from the Director of Graduate Programs of the College of Business Administration.

*Doctoral Student Counselor
**Master's Student Counselor

(Mgmt.)

609. Management Seminar. (3-0). Credit 3. Alternative forms of organization. Organization-environment interface, organization design, authority/responsibility relationships, intergroup power and conflict, and organizational decision making, planning, and controlling processes. Prerequisite: Mgmt. 655 or equivalent.

610. Business and Society. (3-0). Credit 3. Role of business in contemporary society emphasizing 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. (3-0). Credit 3. Legal problems and mechanisms for maintaining the environment, including 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 utilization of personnel, including human resource planning, recruiting, selection, training and management development, compensation, performance evaluation, labor relations and health and safety. Prerequisite: Mgmt. 655 or equivalent.

622. Staffing. (3-0). Credit 3. Foundations and operating aspects of staffing in various types of organizations. Analysis of constraints and legal requirements affecting personnel selection, including sources of personnel, job descriptions, job specifications, interviewing, testing, assessment centers, and affirmative action requirements. Prerequisite: Mgmt. 620 or equivalent.

623. Wage and Salary Administration. (3-0). Credit 3. Managerial analysis of the role of employee compensation in different types of organizations, including 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. Prerequisite: Mgmt. 620 or equivalent.

624. Seminar in Human Resources. (3-0). Credit 3. Seminar is tailored to needs and interests of students. Emphasis on individual research projects. Prerequisite: Mgmt. 620 or equivalent.

625. Management Training In Industry. (3-0). Credit 3. Content and processes of training and development, including 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. Prerequisite: Mgmt. 620 or equivalent.

630. Behavior in Organizations. (3-0). Credit 3. Techniques, theory, and research are presented to develop human and conceptual skills needed for individual and managerial effectiveness in organizations. Topics include work motivation, leadership, group and intergroup relations, problems solving styles, conflict, and interpersonal communication. Prerequisite: Mgmt. 655 or equivalent or approval of instructor.

633. Organization Change and Development. (3-0). Credit 3. Complexity and dynamics of change in organization; assessing different strategies for creating change within an organization; examining different roles of change agents; and identifying strategies for building in the capacity for change in organizations. Prerequisite: Mgmt. 630 or equivalent.

634. Seminar In Organizational Behavior. (3-0). Credit 3. Seminar in specific behavioral topics of interest to participants, including behavioral reinforcement, motivation, attitude theory and development, creative organizations, group models and process, and interpersonal effectiveness. Prerequisite: Mgmt. 630 or equivalent.

635. Research Topics In Labor Relations. (3-0). Credit 3. Analysis of interaction between unions and management, role of government in labor relations, and conflict resolution processes. Selected labor or manpower problems of current importance. Cross-listed with I.En. 607. Prerequisite: Graduate classification.

643. Legal Relationships. (3-0). Credit 3. Basic legal relationships and issues encountered by managers and organizations, including American legal system, court system, selected areas of contract law, and law of negotiable instruments. Prerequisite: Graduate classification.

644. Law and Agriculture. (3-0). Credit 3. Cross-listed with Ag.Ec. 644.

650. Human Relations In Industry. (4-0). Credit 4. Cross-listed as I.En. 603.

651. Collective Bargaining In the Public Sector. (3-0). Credit 3. Cross-listed as I.En. 606.

652. Arbitration Procedures In Work Practices. (3-0). Credit 3. Cross-listed as I.En. 611.

655. Survey of Management. (3-0). Credit 3. Managerial processes, behavioral processes, management information systems, and personnel processes. Typical topics include planning and controlling, organizing, decision making, information systems, staffing and performance evaluation, motivation, groups, leadership, and organizational efficiency and effectiveness. Prerequisite: Graduate classification.

661. Marine Resources Management. (3-0). Credit 3. Problems and issues of public and private sector management of the ocean resources. Topics include management aspects of fisheries, mariculture, ocean mining, off-shore oil and gas production, marine construction, marine service industries, marine transportation, ports, and waterways. Prerequisite: Mgmt. 655 or equivalent or permission of instructor.

662. Marine and Coastal Zone Law. (3-0). Credit 3. Maritime, constitutional, and international law principles relevant to major legal problems involved in developing and using marine and coastal zone resources. Topics include sovereign rights, eminent domain, public ownership, public access, common property, riparian, and navigational rights. Prerequisite: Graduate classification.

663. Legal Environment of Business. (3-0). Credit 3. Public sector environment of business; including legal, social, political, and ethical considerations. Topics include regulation, taxation, public policies; administrative agencies, receivership and bankruptcy, law in business and society, and social policy and legal institutions. Prerequisite: Graduate classification.

664. Coastal Zone Management. (3-0). Credit 3. Environmental, social, political, economic, and legal aspects of the management of the natural resources of the coastal zone are studied. Uses by man and various coastal zone management programs are analyzed and compared. Prerequisite: Mgmt. 655 or equivalent or permission of instructor.

672. Management Information Systems. (3-0). Credit 3. Integrative overview of data processing and management information systems with emphasis on 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. Theories of 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, examined with particular attention to areas in need of further research. Prerequisite: Mgmt. 630 or equivalent or permission of instructor.

680. Business Policy. (3-0). Credit 3. Top level decision making within the business firm. Emphasis on corporate strategy, policy formulation, and implementation. Use of cases, business games, and research projects. Should be taken during last semester of M.B.A. program. Prerequisite: Graduate classification.

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.

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 Management 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.

688. Doctoral Seminar. (3-0). Credit 3. Advanced study of the academic discipline of management. Emphasis on theoretical and research developments and controversial issues in the management literature. Prerequisite: Doctoral classification.

689. Special Topics in ---. Credit 1 to 4. Study of 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. Design of research projects and the development of theory in the several management specializations. Typical topics include research designs, data collection methods, inductive and deductive theorizing, hypothesis formation, empirical indicators, and ethics of research. Prerequisite: Advanced graduate classification.

691. Research. Credit 1 or more each semester. Research for thesis or dissertation. Prerequisite: Graduate classification.

DEPARTMENT OF MARKETING

C. M. Futrell, S. M. Gillespie (Head), R. T. Hise, C. W. Lamb, Jr., J. U. McNeal*, W. M. Pride, D. E. Stem, H. G. Thompson, Jr.

Graduate work in marketing offers an M.B.A. and an M.S. in Marketing as well as a field of concentration for the Ph.D. in Business Administration. The M.B.A. or the M.S. requires approximately 36 hours presuming an undergraduate degree in Business Administration. Undergraduates from other fields will be required to take some preparatory courses.

The M.S. degree concentrates almost entirely on marketing courses, while the M.B.A. emphasizes other functional areas of Business Administration in addition to marketing.

*Graduate Advisor

Marketing courses are open as electives to students in other disciplines where prerequisites are met. Prerequisites in all courses include the approval of the instructor and graduate classification.

The Ph.D. language requirement is determined by the student's Advisory Committee, but usually does not entail a foreign language.

(Mktg.)

649. Survey of Marketing. (3-0). Credit 3. Marketing functions and strategies from managerial point of view. Emphasis on essential concepts and role of marketing in the economy.

650. Analyzing Consumer Behavior. (3-0). Credit 3. Examines theoretical and empirical material on consumer behavior, including personality, social class, and perception by consumers. Prerequisite: Mktg. 649 or equivalent.

655. Marketing Communications: Personal. (3-0). Credit 3. Considers such functions as personal selling, public relations and customer service. Prerequisites: Mktg. 649 or equivalent.

656. Marketing Communications: Non-Personal. (3-0). Credit 3. Analyzes communication processes, diffusion of innovation and promotion activities: advertising, packaging, sales promotion, and publicity. Prerequisite: Mktg. 649 or equivalent.

665. Research for Marketing Decisions. (3-0). Credit 3. Methodology related to problems in marketing decision making; primary and secondary research methodology and analytical techniques for measuring consumer attitudes, advertising effectiveness, etc. Prerequisite: Mktg. 649 or equivalent, and a basic statistics course.

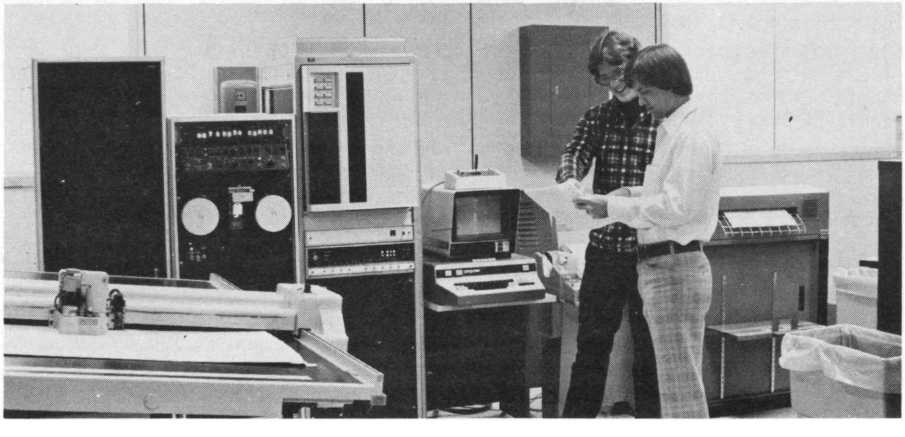
671. Product Innovation. (3-0). Credit 3. Understanding of consumer needs and translating them into new products and services whose design and presentation convey satisfaction of these needs. Prerequisite: Mktg. 649 or equivalent.

673. Service and Public Marketing. (3-0). Credit 3. Marketing concepts and strategy as applied to professional and public organizations such as health services, public services, educational, political and charitable organizations.

675. Marketing Management. (3-0). Credit 3. National and multinational marketing as it relates to over-all business objectives. Marketing activities integrated with other business functions, analysis strategy, and tactics. Prerequisites: Graduate classification in business administration; Mktg. 649 or equivalent.

677. Multinational Marketing Management. (3-0). Credit 3. Theoretical and empirical materials on multinational marketing including nature and justification of international trade, analysis of environments faced by multinational firms and formulation of multinational marketing strategy. Prerequisite: Marketing 649 or equivalent.

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



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

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

689. Special Topics in ---. Credit 1 to 4. Study of selected topics in an identified area of marketing. May be repeated for credit.

690. Theory of Research in Marketing. (3-0). Credit 3. Design of research in the various subfields of marketing and the evaluation of research results using examples from the current research literature. May be repeated for credit. Prerequisite: Graduate classification in marketing.

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

DEPARTMENT OF MATHEMATICS

O. G. Aberth, G. D. Allen, D. L. Barrow, G. R. Blakley (Head), J. R. Boone, I. Borosh, J. D. Bryant, C. K. Chui*, S. A. Fulling, S. C. Garrison, L. F. Guseman, D. J. Hartfiel, A. M. Hobbs, T. R. Kiffe, C. J. Maxson*, A. Nachman, F. J. Narcowich, N. W. Naugle, W. L. Perry, H. W. Pu, G. B. Purdy, W. Rundell, S. P. Slinker, K. C. Smith, P. W. Smith, M. J. Stecher, A. H. Stroud, L. Swanson, L. B. Treybig, J. R. Walton, J. D. Ward

The Department of Mathematics offers courses from which a graduate student may choose an appropriate sequence for an advanced degree in mathematics. It also furnishes proper mathematical preparation for graduate students majoring in other departments. It requires the knowledge of one foreign language for the Ph.D. Degree. The exact form of the requirement is available in writing from any departmental advisor.

*Graduate Advisor

(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. Prerequisite: 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. Prerequisite: 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, LP-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. Convergence of methods and error estimates. Math 609 and 639 are intended to be a two semester introduction to numerical analysis for graduate students with no previous knowledge of numerical analysis. Prerequisite: Knowledge of computer programming (FORTRAN).

610. Numerical Methods in Partial Differential Equations. (3-3). Credit 4. Introduction to numerical methods for solving partial differential equations. Finite difference methods for parabolic, elliptic and hyperbolic equations and systems; the numerical method of characteristics for hyperbolic equations. Stability and convergence of methods; error bounds. Prerequisite: Math. 417 or 609.

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 I. (3-0). Credit 3. Vector spaces, determinants, matrix algebra, similarity relation and unitary similarity relation, applications. Prerequisite: Math. 304 or approval of instructor.

616. Vector Spaces and Matrices II. (3-0). Credit 3. Perturbation theory, numerical techniques for finding eigenvalues and eigenvectors, selected topics. Prerequisite: Math. 615.

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 product, Weierstrass factorizations theorem, Mittag-Leffler's theorem, normal family, Riemann mapping theorem, analytic continuation, Picard's theorems and selected topics. Prerequisite: Math. 617.

620. Fourier Series and Allied Topics. (4-0). Credit 4. Trigonometric series, group structure, convolution algebras, kernels and summability, L^2 functions, Riesz-Fischer Theorem, positive definite functions, the Bochner Theorem, pointwise convergence. Prerequisite: Math. 608 or registration therein.

622. Laplace Transforms. (4-0). Credit 4. Fundamental theorems concerning Laplace transforms. Applications to ordinary and partial differential equations, difference equations, and integral equations. Prerequisite: Math. 601.

625. Matrix Algebra and Tensor Calculus. (4-0). Credit 4. Elementary matrix operations, canonical forms, special matrices, characteristic roots, tensor concept, covariance and contravariance, metric tensors, Christoffel's symbols, covariant differentiation. Prerequisite: Math. 405 or 601.

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 I. (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 I. (3-0). Credit 3. Abelian groups, homomorphisms, Sylow theorems, permutation groups. Prerequisites: 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).

641. Modern Analysis I. (4-0). Credit 4. Sequences, Infinite Series, Limits and Metric Spaces, Continuous Functions, Topology of Euclidean Spaces, Derivatives, Riemann Integrals, Improper Riemann Integrals, Riemann — Stieltjes Integrals. Prerequisite: Math 122 or equivalent.

642. Modern Analysis II. (4-0). Credit 4. Elementary functions, sequences and series of functions, Lebesgue integrals, Fourier series, summability methods, L^e theory, selected topics. Prerequisite: Math 641 or equivalent.

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.

645. Geometry I. (3-0). Credit 3. Linear algebra and geometry; affine and projective geometry. Prerequisite: Math. 416.

651. Optimization I. (3-0). Credit 3. Study of 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. Study of 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. Difference calculus, interpolation with remainder theory, Tschebychef, Bernoulli and Euler polynomials, introduction to difference equations. Prerequisite: Math. 308.

681. Seminar. (1-0). Credit 1. Reports and discussions of topics of current interest in mathematics. Reports to be prepared by the participants.

685. Problems Credit 1 to 4 each semester. A course 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. Study of selected topics in an identified area of Mathematics. May be repeated for credit. Prerequisite: Approval of instructor.

690. Theory of Mathematical Research. (3-0). Credit 3. Discussion and evaluation of current research in mathematics. May be repeated for credit.

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

DEPARTMENT OF MECHANICAL ENGINEERING

R. B. Agarwal, R. M. Alexander, S. A. Anderson, M. P. Boyce, W. L. Bradley, L. R. Cornwell, L. A. Hale, E. S. Holdredge, F. W. Holm, R. E. Holmes, G. R. Hopkins* (Head), P. E. Jenkins, C. F. Kettleborough, T. J. Kozik*, R. E. Martin, T. A. Noyes, J. V. Perry, Jr., J. G. Raczkowski, H. R. Thornton, G. C. Tolle

The graduate program in mechanical engineering is designed to prepare a student to work in the more technical phases of this field. The courses are planned not only to give certain factual information but to emphasize fundamentals and methods, to clarify principles, to indicate their applicability in a growing field, to develop a rational analysis from basic fundamentals, and to develop skill in the formulation of solutions to engineering problems. Instrumentation and research techniques are emphasized.

The student is allowed to choose his courses so as to specialize in the fields of heat power, mechanical design, applied mechanics, structural mechanical design, applied mechanics, turbomachinery, metallurgy and materials. Laboratory facilities are available for graduate study and research in materials and metallurgy, stress analysis including photoelasticity, vibrations, turbomachinery, internal combustion engines, refrigeration, heat transfer, fluid flow, and computer theory.

In lieu of a foreign language requirement for the Doctor of Philosophy program in Mechanical Engineering, the student is required to absorb a broadening program of 6 to 12 hours of non-technical courses. The courses will be agreed upon by the student and his Advisory Committee early in his program.

*Graduate Advisor

(M.E.)

601. Advanced Machine Design. (3-0). Credit 3. Advanced problems in design to include 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, including economic availability of fuels, government regulations, combustion, and thermodynamic cycle analysis from both a first law and second law point of view. Both fossil fuel and nuclear plants considered.

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. Includes 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. Study of analytical, graphical, and approximate methods of solving problems common to engineering design. Dimensional analysis and model study, design of experiments. Statistical analysis and interpretation of test data including derivation of empirical equations. Prerequisite: Math. 308.

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. Prerequisite: A course in differential equations and graduate classification.

613. Engineering Dynamics. (3-0). Credit 3. Three dimensional study of dynamics of particles and rigid bodies with emphasis placed on application to engineering problems. Introduction to lagrange equations of motion and Hamilton's principle. Prerequisites: Math. 308, M.E. 213.

615. Advanced Engineering Thermodynamics. (3-0). Credit 3. Theories of thermodynamics and their application to the more involved problems in engineering practice and design. Topics involving equilibrium, Gibbs' function, nonideal gases, and various equations of state are covered. Second law analysis and statistical theory emphasized. Prerequisite: M.E. 328 or equivalent.

617. Mechanical Vibrations. (3-0). Credit 3. Linear theory of vibrations of finite number of degree of freedom systems via Lagrange equations. Engineering applications emphasized. Prerequisites: Math. 308, M.E. 213.

620. Experimental Stress Analysis. (2-3). Credit 3. Review of 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. Emphasis is given to the basic techniques of experimental stress analysis and the related equipment.

621. Fluid Mechanics. (3-0). Credit 3. Study of 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 are stressed.

623. Two-Phase Flow. (3-0). Credit 3. Current status of two-phase flow technology for application to design. Covers basic one-dimensional treatment of two-phase flow; detailed analysis of flow of suspended particles, bubbles, and mists; analysis of slug and annular flows; measurement techniques. Prerequisite: Undergraduate course in fluid mechanics.

626. Lubrication Theory. (3-0). Credit 3. Development of Reynolds equation from Navier-Stokes equation for study of hydrodynamic lubrication theory as basis for bearing design. Application to simple thrust and journal bearings and pads of various geometries. Study of 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.

627. Heat Transfer-Conduction. (3-0). Credit 3. Mathematical theory of steady-state and transient heat conduction. Solution of the governing differential equations by analytical and numerical methods; applications to various geometric configurations. Prerequisites: C.S. 458 or equivalent; Math. 601 or registration therein; M.E. 461.

628. Heat Transfer-Convection. (3-0). Credit 3. Mathematical theory of convection energy transport. Applications to the design of heat-transfer apparatus are included. Prerequisites: Math. 601 or registration therein; M.E. 461.

629. Heat Transfer-Radiation. (2-0). Credit 2. 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.

632. Field Computations in Engineering. (3-0). Credit 3. Application of numerical methods to design problems associated with flow of fluids, heat and stress. Emphasis on application to physical design problems. Prerequisites: Math. 601; graduate classification.

634. Two-Phase Heat Transfer. (3-0). Credit 3. Presents current state of the art in heat transfer situations involving liquid-to-vapor or vapor-to-liquid phase changes relevant to heat exchanger design. Prerequisite: M.E. 461 or equivalent.

645. Advanced Gas Dynamics. (3-0). Credit 3. Analysis of 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, including concepts, formulation, and methods of solution associated with vibrational problems concerning plates and shells. Anisotropic media, variable thickness and implane forces are considered. Prerequisite: M.E. 617 or equivalent.

649. Nonlinear Vibrations. (3-0). Credit 3. Exact and approximate solutions to nonlinear differential equations in mechanical vibrations, including 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. Prerequisite: A course in differential equations and graduate classification.

650. Random Vibration. (3-0). Credit 3. Study of 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: ME 459.

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.

602. Vectors and Tensors in Mechanics (3-0). Credit 3.

603. Foundations of Solid Mechanics (3-0). Credit 3.

604. Mechanics of Viscous and Elastic Fluids (3-0). Credit 3.

605. Energy Methods (3-0). Credit 3.

606. Shock Waves in Continuous Media (3-0). Credit 3.

607. Flow and Fracture of Solids (3-0). Credit 3.

609. Materials Science (3-0). Credit 3.

610. Thermodynamics of Materials (3-0). Credit 3.

611. Physical Metallurgy (3-0). Credit 3.

612. Materials in Design (3-0). Credit 3.

613. Principles of Composite Materials (3-0). Credit 3.

614. Classical Elasticity (3-0). 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.

645. Application of the Theory of Shells (2-0). Credit 2.

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.

DEPARTMENT OF METEOROLOGY

K. C. Brundidge (Head), P. Das, D. Djuric, D. M. Driscoll, G. A. Franceschini, J. F. Griffiths, W. K. Henry, G. L. Huebner, Jr., V. E. Moyer*, R. C. Runnels, J. R. Scoggins, A. H. Thompson

Degrees of Master of Science and Doctor of Philosophy are offered in meteorology in addition to the Bachelor of Science degree. In addition to the Graduate College requirements, doctoral candidates must pass (B average) at least 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 modern, 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. Also, most graduates in science or engineering may qualify for a graduate degree in meteorology by scheduling approximately two extra semesters of work. Programs may be organized to provide specialization in certain applications such as marine, agricultural, radar, dynamical and numerical, physical, and synoptic meteorology and in 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 benefiting life and human endeavor, such as in weather forecasting. The greatest uses of weather information and forecasts have been in aviation, space exploration and travel, and in the general public interest. Increasing rewards are being found in applications to agriculture, shipping, engineering, civil and industrial planning, health and travel, recreation, space exploration, and related sciences.

Persons with B.S. and M.S. degrees in meteorology typically obtain employment with the National Weather Service or other government agencies as well as with industrial organizations, or they may enter the meteorological branch of one of the military services. Their responsibilities most likely would be in the accumulation and analysis of weather data and in weather prediction. 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, others are available in the College of Geosciences for working at sea or a coastal location.

*Graduate Advisor

(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. Study of 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. Study of advanced methods of measurement in geoscience with emphasis on meteorological parameters. Prerequisite: Met. 615 or approval of instructor.

625. Applied Climatology. (3-0). Credit 3. Practical applications of climate to other disciplines and study of methods used for this coordination. Prerequisite: Met. 425 or approval of instructor.

635. Reading Seminar in Dynamic Meteorology. (3-0). Credit 3. Group examination of pertinent papers in current literature; designed to confront students with recent developments for critical evaluation. May be repeated once for credit. Prerequisite: Met. 435 or approval of instructor.

636. Dynamic Meteorology. (3-0). Credit 3. Baroclinic and barotropic instability; general circulation; tropical systems. Prerequisite: Met. 435. (Offered in 1973-74 and in alternate years thereafter.)

637. Numerical Weather Prediction. (3-0). Credit 3. Numerical solution of meteorological equations, problems with time 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: 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 cloud and precipitation processes. 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 science or engineering.

648. Cosmic Meteorology. (3-0). Credit 3. Continuation of Met. 647. Properties and processes of interplanetary medium, atmospheres of other planets, cosmological implications in planetary environments. Prerequisite: Met. 647.

651. Meteorological Analysis. (0-6). Credit 2. Analysis of mesoscale and tropical systems; Fjortoft graphical integration method; single station analysis; Sutcliffe and other development theories. Prerequisite: Met. 452.

655. Satellite Data in Meteorology. (3-0). Credit 3. Meteorological satellite programs of the United States 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. 452 or approval of instructor.

656. Tropical Meteorology. (3-0). Credit 3. Tropics as energy source for global circulation, structure and dynamics of the inter-tropical convergence zone, easterly waves and tropical cyclones; role of cumulus-scale convection — CISK. Current topics. Prerequisite: Met. 452.

657. Mesometeorology. (3-0). Credit 3. Theory and structure of mesoscale weather systems and their relation to larger and smaller scale systems. Prerequisite: Met. 453 or approval of instructor. (Offered in 1974-75 and alternate years thereafter.)

658. Synoptic Meteorology. (3-0). Credit 3. Examination of structure of macroscale atmospheric disturbances. Procedures for forecasting their development. 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. (Offered in 1975-76 and alternate years thereafter.)

662. Atmospheric Diffusion and Air Pollution. (3-0). Credit 3. Theories of atmospheric diffusion and transport from continuous point, volume, line, and other sources; survey of air pollution in cities; meteorological and climatological conditions associated with air pollution. Prerequisite: Met. 661 or approval of instructor. (Offered in 1975-76 and alternate years thereafter.)

665. Micrometeorology. (3-0). Credit 3. Earth-atmosphere interface processes with special emphasis on exchange concepts and resulting modifications to wind, temperature, and moisture. Prerequisites: Math. 308; Met. 445. (Offered in 1974-75 and alternate years thereafter.)

666. Agricultural Meteorology. (3-0) Credit 3. Application of physical concepts of meteorology to problems arising in agriculture, with study of meso- and micro-climates and their modification. Prerequisite: Met. 465 or approval of instructor.

667. Atmosphere-Ocean Interaction. (3-0). Credit 3. Physical aspects of processes of exchange across air-sea interface and their effects on the boundary layers; influence of ocean on weather and climate. Prerequisite: Meteorology 445 or equivalent or approval of instructor.

668. Engineering Meteorology. (3-0). Credit 3. Accuracy of instrumentation and representativeness of meteorological data; standard and reference atmospheres; atmospheric turbulence; representation of atmospheric parameters for engineering applications. Prerequisite: Math 308 or equivalent. (Offered in 1974-75 and alternate years thereafter.)

681. Seminar. (1-0). Credit 1. Presented by students and faculty and 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, J. A. Dabbs, A. M. Elmquist (Head), W. Koepke*, O. L. Naudeau, T. A. O'Connor, H. Puppe, K. C. Richards, L. Stavenhagen

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 (French 601, 602, and 685; German 603, 604, and 685; and Russian 609, 610, and 685) are not normally approved for graduate degree credit.

The Master of Arts program requires a minimum of thirty credit hours including six hours for a required thesis. The program offers a concentration 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.

Graduate work will prepare the student for professional work in the language, for teaching positions, or for pursuing further graduate studies. A high competence in the Spanish language is required.

Prerequisites: Admission to the Graduate School and an undergraduate degree in Spanish or an equivalent competence in Spanish language and literature.

*Graduate Advisor

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. 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. Prerequisite: Fren. 601 or approval of Department Head.

685. Problems. Credit 1 to 4. 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. 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. Prerequisite: Germ. 603 or approval of Department Head.

685. Problems. Credit 1 to 4. Directed individual study of selected problems in the field of German. Prerequisite: Approval of Department Head.

RUSSIAN
(Russ.)

685. Problems. Credit 1 to 4. 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. Cross-listed with Ling. 624.

606. Spanish Language in Texas. (3-0). Credit 3. A study of 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.

635. Contemporary Spanish-American Prose. (3-0). Credit 3. Intensive study of life and works of a selected Spanish-American novelist. Conducted in Spanish. Prerequisite: Twelve hours of advanced Spanish courses.

636. Contemporary Spanish Prose. (3-0). Credit 3. Intensive study of life and works of a selected Spanish novelist. Conducted in Spanish. 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 Quijote 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 with emphasis on outstanding poets of the twentieth 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, especially the novel and of 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, including 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. Study of 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

R. G. Cochran (Head)*, R. A. Fjeld, R. R. Hart*, R. D. Neff*, J. D. Randall*, J. B. Smathers*, R. S. Wick*

The rapid growth in the field of nuclear engineering has created a great demand for trained nuclear engineers. The nuclear engineer is concerned with the release, control and utilization 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 for the benefit of mankind. Consequently, the nuclear engineer will be involved in many of the most challenging technological problems of tomorrow, such as providing adequate low cost energy for our vast urban and industrial complexes, desalting the water of the oceans, designing the propulsion and power systems for man's exploration and utilization of space and sea.

The Nuclear Engineering Department offers the Master of Engineering, Master of Science, Doctor of Engineering and Doctor of Philosophy degrees. Admission to the program 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 are encouraged which include a minor field of study. This minor field would normally include graduate study in the area of the student's baccalaureate degree. If the Baccalaureate degree is Nuclear Engineering then the student with the advice of his Committee will select a suitable minor area of study.

The Nuclear Engineering Department does not have a foreign language requirement for the Ph.D. degree. However, an individual student's Advisory Committee Chairman may require knowledge in a foreign language if it contributes to the educational goals of the student.

The facilities available for instructional and research purposes include a radiation measurements laboratory, a sub-critical reactor laboratory, AMDAHL 470 V/6 digital computer (equivalent to an IBM 370/168) and an analog computer, a radiochemistry laboratory, a low power nuclear reactor, a 14 Mev 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

This program is offered as a specialized area of study by the Department of Nuclear Engineering and 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.

*Graduate Advisor

A student is required to spend his initial academic year taking formal coursework in the Department of Nuclear Engineering and in other cooperating departments of the University. The summer is then 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. Then at least one more semester is normally required to finish coursework and complete a research project for the Master of Science Degree.

Graduate studies in health physics may also be undertaken in Biophysics in the Department of Biochemistry and Biophysics by students whose academic background is more oriented toward biology and chemistry.

(N.E.)

601. Nuclear Reactor Analysis. (3-0). Credit 3. Neutron energy spectra in infinite homogeneous media. Boltzmann Transport equation. Diffusion approximation. Multigroup and Fermi Age criticality for base homogeneous reactors. Reflected homogeneous reactors. Prerequisites: NE 404 or equivalent; Math 601 or registration therein.

602. Nuclear Reactor Analysis. (3-0). Credit 3. Resonance absorption. Heterogeneous reactors. Reactor kinetics. Temperature coefficients. Perturbation theory. Prerequisite: NE 601.

603. Fast Reactor Analysis. (3-0). Credit 3. Fast neutron interactions, neutron spectra, criticality calculations, reactivity effects: void effects, Doppler effects, expansion effects. Kinetics and dynamics, comparison with thermal reactors, engineering safeguards. Breeding ratio, doubling time, fuel cycle economics. Comparison of coolants: Na, steam, gas. Discussion of existing fast reactor experiments. Prerequisite: Approval of instructor.

605. Nuclear Measurements Laboratory. Credit 3. Basic techniques of nuclear measurements discussed and practiced. Behavior of neutrons in multiplying and nonmultiplying media observed. Extensive use made of nuclear reactor. Prerequisite: NE 601 or registration therein.

606. Reactor Experimentation. (2-3). Credit 3. Extension of N.E. 605. 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. Prerequisites: N.E. 605

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, NE 417, or permission 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.

610. Design of Nuclear Reactors. (4-0). Credit 4. Applies 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 permission 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. Prerequisite: Math 308 and 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. Prerequisites: NE 409.

618. Nuclear Control Systems. (3-0). Credit 3. Reactor kinetics and fundamentals of servo-control developed and applied to nuclear reactor. 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. Designed to present application of nuclear reactor systems to field of power production, utilizing general fields of thermodynamics and heat transfer, along with special problems arising from nuclear system. Prerequisites: M.E. 323 or 327; N.E. 601 or registration therein.

623. Analytical Nuclear Engineering I. (3-0). Credit 3. Unified treatment of mass, momentum, and energy transport with applications to nuclear engineering sources. Velocity and temperature distributions in laminar and turbulent flow. Liquid metal heat transfer. Flow and thermal stability. Prerequisites: Math. 601 or registration therein; M.E. 344, 346 or 461; or approval of instructor.

624. Analytical Nuclear Engineering II. (3-0). Credit 3. Unified analytical treatment of heat conduction in solids and thermal stress phenomena with application to nuclear energy sources. Transient heat conduction in solids. Isothermal elasticity. Thermoelasticity. Viscoelasticity. Plasticity. Prerequisites: Math. 601 or registration therein; N.E. 623 or approval of instructor.

625. Nuclear Reactor Theory. (4-0). Credit 4. Advanced treatment of neutron transport theory. Methods of solution of integrodifferential and integral Boltzmann equations and their adjoints. Multigroup diffusion and transport theory. Prerequisites: Math. 602; N.E. 602.

626. Nuclear Reactor Theory. (4-0). Credit 4. Continuation of N.E. 625. Variational principles for discrete and continuous eigenvalues. Milne problem and Wiener-Hopf techniques. Serber-Wilson and Feynman methods. Spatially independent and dependent slowing-down theory. Current advanced techniques in vector theory. Prerequisite: N.E. 625.

629. Numerical Methods in Reactor Analysis. (3-0). Credit 3. Solution of variable dimensions multigroup P calculations. In addition, Monte Carlo techniques, reactor kinetics, fuel cycle and reactor life study approximations will be presented. Prerequisite: Approval of instructor.

630. Analysis of Isotopic Enrichment. (3-0). Credit 3. Development of general cascade equations for isotopic enrichment; analysis of the ideal cascade, squared off cascade, close separation cascade approximations. Discussion of various processes used to achieve enrichment and application. Prerequisite: N.E. 404 or approval of instructor..

631. Reactor Fuel Reprocessing. (3-0). Credit 3. Engineering analysis of characteristics of fission products in irradiated reactor fuel, properties of reactor fuel materials; various methods used to reprocess spent fuels. Prerequisite: N.E. 404 or approval of instructor.

679. Practical Applications of Radiological Safety I. (1-6). Credit 3. Intensive and comprehensive lecture and practical training in radiological safety operations. Includes radioactive license application,review, and compliance. Major emphasis on 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 with student reaching point where he can design and conduct radiation surveillance operations on his own with no immediate supervision. Prerequisite: N.E. 679.

681. Seminar. (1-0). Credit 1. Special topics in nuclear engineering not covered by formal course work. Whenever possible, guest lecturers will discuss topics which they have personally investigated. Prerequisite: Graduate classification.

685. Problems. Credit 1 to 4 each semester. Offered to enable students to undertake and complete limited investigations not within their thesis research and not covered by any other courses in curriculum. Prerequisite: Graduate classification.

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

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

DEPARTMENT OF OCEANOGRAPHY

L. D. Berner, Jr., T. J. Bright, W. R. Bryant, J. D. Cochrane, R. Darnell, S. Z. El-Sayed*, D. A. Fahlquist, S. Gartner, R. A. Geyer, C. S. Giam, T. W. C. Hilde, T. Ichiye, L. M. Jeffrey*, D. M. McGrail*, W. D. Nowlin, Jr. (Head), L. H. Pequegnat, W. E. Pequegnat, B. J. Presley, R. O. Reid, R. Rezak, W. M. Sackett, D. R. Schink, M. R. Scott, T. W. Spence*, T. K. Treadwell, Jr., A. C. Vastano, J. H. Wormuth

Degrees. Degrees of Master of Science and Doctor of Philosophy are offered in oceanography.

Oceanography. Oceanography is the study of the oceans and their boundaries. Effective study of the subject requires thorough previous training in one of the basic sciences, such as biology, chemistry, geology, geophysics, mathematics, meteorology, physics, or in engineering. Therefore, most academic work in oceanography is conducted at the graduate level. Oceanography may be utilized in solving certain problems arising in fisheries work, offshore oil and gas operation, navigation, prevention of beach erosion, certain aspects of weather forecasting, extraction of raw materials and fresh water from the sea, marine construction, coastal sanitation, military operations, fresh water supply, and many other activities.

Four areas of specialization are offered in oceanography at Texas A&M University: biological, chemical, geological/geophysical and physical oceanography. Prerequisites required are the equivalent of a B.S. degree in one of the basic fields and some work in each of the other basic fields. All students are expected to have had mathematics through integral calculus, at least one year of physics and chemistry, and at least one survey course in biology and geology in addition to the usual amount of coursework in their major field of science.

To qualify for an advanced degree in oceanography, the student must learn how to apply his training in his basic science to the marine environment. This requires a combination of principles and methods and a certain body of knowledge unique to oceanography. He is expected to develop an interest in the other marine sciences.

Facilities and Participation in Research. Graduate students often take an active part in one or more of the research contracts sponsored in the Department of Oceanography by industry and by state and federal agencies. In addition to departmental campus facilities, others are available in the College of Geosciences, and for working at sea and at several coastal and offshore locations.

*Graduate Advisor

Required Courses. Ocn. 602, 608, 620, 630 and 640 are required of all graduate students taking advanced degrees. Two hours of Ocn. 681 are required of all graduate students who are candidates for the degrees of Master of Science and Doctor of Philosophy. A reading knowledge of one modern foreign language is required. Further information is available from the department.

(Ocn.)

600. Survey of Oceanography. (3-0). Credit 3. General survey of the scientific framework of oceanographic study. Consideration of the applications of ocean research to social and economic problems and the interrelations between the ocean disciplines and other fields of study. Prerequisite: Approval of instructor.

602. Ocean Research and Operational Techniques. (1-5). Credit 3. Technical, operational and legal aspects of sea-going research operations. Planning and executing ocean research operations. Practice in techniques and equipment regularly used aboard ships; familiarization with acquisition and processing of data. Prerequisite: Approval of instructor.

604. Biological Oceanography Cruise. Credit 2. Specialized experience in research methods and analysis in biological oceanography via preparation for and participation in a research cruise of at least two weeks duration under the supervision of a Texas A&M oceanography faculty member. May be taken for credit up to twice for M.S. candidates and four times for Ph.D. candidates. Prerequisite: Approval of instructor.

605. Chemical Oceanography Cruise. Credit 2. Specialized experience in research methods and analysis in chemical oceanography via preparation for and participation in a research cruise of at least two weeks duration under the supervision of a Texas A&M oceanography faculty member. May be taken for credit up to twice for M.S. candidates and four times for Ph.D. candidates. Prerequisite: Approval of instructor.

606. Geological Oceanography Cruise. Credit 2. Specialized experience in research methods and analysis in geological oceanography via preparation for and participation in a research cruise of at least two weeks duration under the supervision of a Texas A&M oceanography faculty member. May be taken for credit up to twice for M.S. candidates and four times for Ph.D. candidates. Prerequisite: Approval of instructor.

607. Physical Oceanography Cruise. Credit 2. Specialized experience in research methods and analysis in physical oceanography via preparation for and participation in a research cruise of at least two weeks duration under the supervision of a Texas A&M oceanography faculty member. May be taken for credit up to twice for M.S. candidates and four times for Ph.D. candidates. Prerequisite: Approval of instructor.

608. Physical Oceanography. (3-2). Credit 4. Observations, instruments; physical properties of seawater. Property distributions; characteristics of water masses; heat budget. Kinematics; gravity, pressure, hydrostatics, stability. Horizontal flow; Coriolis force, geostrophy; friction, wind drift; general circulation. Wave motions; tides. Prerequisites: Math. 122 or 210; Phys. 219.

609. Physical Oceanography. (3-0). Credit 3. Kinematics of fluids, systematic derivation of the equations of motion and continuity; general integral relations; thermodynamic considerations of seawater; non-equilibrium transfer processes and the second law of thermodynamics. Prerequisites: Math. 601; Met. 435 or Ocn. 608 (concurrently).

611. Theoretical Physical Oceanography. (3-0). Credit 3. Reynolds equations of motion; scaling analysis, Ekman layers; application of vorticity equation to ocean circulation; meanders and Rossby waves; inertio-gravity waves and other wave phenomena in the ocean including boundary waves. Prerequisites: Ocn. 608 and 609.

612. Elements of Ocean Wave Theory. (3-0). Credit 3. Theories of simple harmonic surface waves, capillary waves, and internal waves. Wave energy, propagation, modification in shallow water. Superposition, waves of finite height. Offered in 1977-78 and alternate years thereafter. Prerequisites: Math. 601; Ocn. 608; or approval of instructor.

614. Dynamics of the Ocean and Atmosphere. (3-0). Credit 3. Unified linear perturbation theory of rotating stratified fluids with application to internal waves in the ocean or atmosphere. Energy considerations, characteristic modes of motion, approximate methods of analysis. Offered in 1976-77 and alternate years thereafter. Prerequisites: Math. 602; Ocn. 611.

615. Long Waves and Tides. (3-3). Credit 4. Free and forced surges, seiches, effect of variable depth, WKB and Rayleigh-Ritz methods. Method of characteristics, bores, Kelvin and Stokes waves, oceanic tides, cooscillating tides, storm tides. Offered in 1977-78 and alternate years thereafter. Prerequisites: Math. 602; Ocn. 609.

617. Theories of Ocean Circulation. (3-0). Credit 3. Theories of wind-driven circulation, Sverdrup solution, frictional and inertial boundary domains, energy and vorticity considerations, role of stratification and bathymetry, theories of thermohaline circulation, model experiments. Offered in 1977-78 and alternate years thereafter. Prerequisite: Ocn. 611 or approval of instructor.

618. Underwater Sound. (3-0). Credit 3. Introduction to basic concepts, units and calibration. Sonar systems — sources, arrays, processing, and self-noise; medium — thermal structure of sea, velocity of sound profiles, ray analysis, transmission losses, ambient noise and reverberation; and target characteristics — echo structure and characteristic sounds. Prerequisite: Math. 601 or equivalent.

619. Marine Boring and Fouling Problems. (3-0). Credit 3. Nature of biofouling communities discussed together with suggested new control methods. Relationships between fouling and chemical pollution abatement are studied. Industrial cognizance of both fouling and borer activities is examined. Offered in 1977-78 and alternate years thereafter. Prerequisite: Ocn. 620 or approval of instructor.

620. Biological Oceanography. (3-0). Credit 3. Critical analysis of contribution of biological science to our understanding of sea. Discernible interrelationships between organisms and physicochemical parameters emphasized. Prerequisite: General prerequisites for oceanography.

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 1976-77 and alternate years thereafter. Prerequisite: Ocn. 620 or equivalent.

623. Marine Zooplankton. (2-3). Credit 3. Descriptive material on zooplankton populations of the worlds oceans. Feeding, growth, reproduction and predator-prey interrelationships are covered. 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 with emphasis on physical and chemical factors which affect plankton production. Study of phytoplankton-zooplankton relationship, sampling problems. Prerequisite: Ocn. 620 or equivalent.

625. Deep-Sea Pelagic and Demersal Fishes. (2-3). Credit 3. Study of the taxonomy, life histories, special adaptations and distribution of the mesopelagic, bathpelagic and abyssal deep-sea fishes. Prerequisites: Ocn. 620; approval of instructor for non-oceanography majors.

626. Organic Cycles of the Sea. (3-0). Credit 3. Treatment of 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: Ocn. 620.

627. Ecology of the Continental Shelf. (3-0). Credit 3. An analysis of the environments, populations, and communities of the continental shelf. Interactions of the shelf with the estuaries and the deep sea will be discussed, and attention will be given to man's impact on the shelf ecosystems. Prerequisite: Ocn. 620.

628. Biology of Coral Reefs. (2-2). Credit 3. A consideration of the 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.

631. Geological Oceanography. (3-0). Credit 3. Transport and deposition of marine sediments, marine shorelines, environmental characteristics and processes. Offered in 1978-79 and alternate years thereafter. Prerequisite: Undergraduate major in geology or approval of instructor; Math. 209 and 210 or equivalent.

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 1977-78 and alternate years thereafter. 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 1977-78 and alternate years thereafter. Prerequisite: Approval of instructor.

635. Techniques in Geological Oceanography. (2-2). Credit 3. Review of 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. 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. Lecture emphasis is on biostratigraphic concepts, and on systematics (including ecology and evolution), morphology and distribution of microfossil groups. Laboratory emphasis is on techniques and biostratigraphic utilization. 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 including barotropic and baroclinic fluids, inertio-gravitational and planetary waves; quasi-geostrophic circulation. Offered in 1976-77 and alternate years thereafter. Prerequisite: Consent of instructor.

639. Lithophycology. (2-3). Credit 3. Morphology, taxonomy, and ecology of calcareous algae and stromatolites with emphasis on their role as builders of limestones. Laboratory work includes identification of both recent and fossil species. Offered in 1976-77 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 including: thermodynamics of electrolyte solutions, absorption, diffusion, and the carbonate system. Offered in 1977-78 and alternate years thereafter. Prerequisite: degree in chemistry or approval of instructor.

642. Marine Chemistry of the Nutrients Elements. (2-3). Credit 3. Descriptions of the nutrient element cycles in the sea: inputs; biological interactions; use as tracers; removal processes. Emphasis is on silicon, phosphorus, nitrogen. Offered in 1978-79 and alternate years thereafter. Prerequisite: Oceanography 640 or consent 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. Prerequisites: 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. The origins, fates and distribution of organic compounds in contemporary marine environments and in recent and ancient sediments will be emphasized. Specific analytical techniques will also be outlined. 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 are developed to predict the future viability of the ocean with particular emphasis on the Gulf of Mexico. Prerequisite: Approval of instructor.

651. Meteorological Oceanography. (3-0). Credit 3. Interaction between the ocean and atmosphere. Description of the major features of the two systems. Heat budget, teleconnections between ocean and atmosphere, El Nino and related phenomena. Prerequisites: Met. 445 or Ocn. 608.

652. Ocean Boundary Layer Problems. (3-0). Credit 3. Theory of turbulent transfer of momentum, heat and moisture. Mechanics of turbulence, dispersion, methods of analysis of stochastic time sequences. Offered in 1976-77 and alternate years thereafter. Prerequisites: Ocn. 611; Stat. 601.

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.

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. Deals with 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. Study of selected topics in an identified area of Oceanography. May be repeated for credit. Prerequisite: Approval of instructor.

691. Research. Credit 1 or more each semester. For thesis or dissertation. Topic subject to approval of Department Head.

DEPARTMENT OF PETROLEUM ENGINEERING

J. C. Calhoun, Jr., P. B. Crawford, S. A. Holditch, J. W. Jennings*, W. J. Lee, R. A. Morse*, W. J. McGuire, J. S. Osoba*, W. D. Von Gonten (Head)*, R. L. Whiting*

Graduate work in petroleum engineering is offered at both the master's and doctoral levels. On the master's level, courses are offered with the primary aim of giving the student a fundamental understanding of 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 the problems encountered in drilling and producing wells, and research on these problems is encouraged.

On 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

*Graduate Advisor

relationships, core analysis and interpretation, secondary recovery and model reservoir studies. Equipment is also available for investigating problems arising in subsurface engineering and in handling and formulating drilling fluids. Much special equipment has been provided for the study of reservior 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.

Another important area of specialization is laboratory and field tests of insitu lignite gasification.

Students are encouraged to become proficient in the programming and utilization of the high-speed digital computer in engineering and research.

(Pet. E.)

601,602. Drilling and Completing Wells. (3-3). Credit 4 each semester. Advanced study of problems encountered in drilling and completing of oil and gas wells. Prerequisite: Approval of Department Head.

603,604. Advanced Reservoir Engineering. (3-3). Credit 4 each semester. Petroleum reservoir engineering with emphasis on the development and use of numerical models for simulating field and well performance. Prerequisite: Approval of Department Head.

605. Phase Behavior of Petroleum Reservoir Fluids. Credit 2 to 4 each semester. Pressure, volume, temperature, composition relationships of petroleum reservoir fluids. Prerequisite: Approval of Department Head.

607. Recovery Methods. Credit 2 to 4 each semester. Methods of increasing recovery of petroleum from petroleum reservoirs. Prerequisite: Approval of Department Head.

608. Well Logging Methods. (2-3). Credit 3. Advanced study of well logging methods for determining nature and fluid content of formations penetrated by drill. Prerequisite: Approval of Department Head.

681. Seminar. (1-0). Credit 1 each semester. Study and presentation of papers on recent developments in reservoir mechanics. 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., H. J. McCann, Jr., J. J. McDermott (Head)

(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.

671. Ethics for the Professional. (2-0). Credit 2. 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 1-3. Directed studies in specific problem areas in philosophy.

689. Special Topics in ---. Credit 1 to 4. Study of selected topics in an identified area of Philosophy. May be repeated for credit. Prerequisite: Approval of instructor.

(Hum.)

611. Library Science: The Research Library. (0-2). Credit 1. To acquaint beginning graduate students with general resources and specialized reference materials in research libraries.

DEPARTMENT OF PHYSICS

T. W. Adair, III, (Acting Head), 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, P. J. Green, II, J. S. Ham, J. C. Hiebert, G. W. Kattawar, R. A. Kenefick, W. P. Kirk, J. A. McIntyre, J. M. Moss, K. Nagatani, D. G. Naugle*, L. C. Northcliffe, G. N. Plass, J. F. Reading, S. P. Rountree, W. M. Saslow, H. A. Schuessler, R. A. Schorn, R. Shakeshaft, R. E. Tribble, B. J. VerWest, D. H. Youngblood

Offerings in physics enable graduates in physics, mathematics, chemistry or engineering to prepare either for a career of research and teaching at a university or research and development at an industrial or government laboratory.

Physics 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 Physics 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.

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 theory of elementary particle interactions, quantum field theory, nuclear physics, low temperature physics, solid state physics, superconductivity, atomic physics, scattering theory, astronomy, radiative transfer, atmospheric physics, cosmic ray physics, and quantum electronics. Special research facilities include a nuclear reactor presently operating at 100 kilowatts, an 88-inch cyclotron, a 4096K byte Amdahl 470v/6 digital computer, and ^{3}He-^{4}He refrigerator for millikelvin studies.

(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. 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 approval of instructor.

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 are 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 are applied to problems in quantum mechanics. Prerequisites: Phys. 412 and 416, Math. 311 and 312 or equivalents.

616. Methods of Theoretical Physics II. (3-0). Credit 3. Green's Functions and Sturm-Liouville theory are applied to the differential equations of wave theory. The special functions of mathematical physics are studied. Numerical techniques are introduced. Conformal mapping and the Schwarz-Christoffel transformation are applied to two dimensional electrostatics and hydrodynamics. Prerequisites: Phys. 412 and 416, Math. 311 and 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 and with band effects included; lattice vibrations and phonons; thermal properties; and 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, 412, 606 and 607 or approval of instructor.

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.

625. Nuclear Physics. (3-0). Credit 3. Nuclear models, nuclear spectroscopy, nuclear reactions, electromagnetic properties of nuclei with emphasis on topics of current interest. Prerequisite: Phys. 428 and 606.

626. Atomic and Space Physics. (3-0). Credit 3. Plasmas in space; atomic spectroscopy; solar terrestrial relations, radiative transfer; space spectroscopy. Prerequisites: Phys. 412, Math. 311.

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, Phys. 624 or approval of instructor.

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 He^3 and He^4; the finite nucleus. Prerequisite: Phys. 624 or approval of instructor.

637. General Relativity. (3-0). Credit 3. Spacetime geometry and measurement; Riemannian geometry; Newton's and Einstein's Theory of Gravitation; static and stationary gravitational fields; solutions of Einstein's field equations; motion of particles; elements of relativistic hydronamics; gravitational waves. Prerequisites: Phys. 601, 603 or equivalent.

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.

643. Topics in Astrophysics. (3-0). Credit 3. States of matter, interaction of radiation and matter, statistical equilibrium, local thermodynamic equilibrium, spectral line formation, particle and gas dynamics, relativistic astrophysics, nucleosynthesis. Prerequisites: Phys. 420, 603, 606 and 607.

644. Low Temperature Physics. (3-0). Credit 3. Quantum behavior of matter at extremely low temperatures with emphasis on the production of low temperatures in the laboratory, superfluidity in ^{3}He and ^{4}He and magnetic properties. Prerequisites: Phys. 606, 607 and Phys. 424 or 617 or approval of instructor.

645. Nuclear Theory. (3-0). Credit 3. Topics of current interest, e.g., multipole theory of electromagnetic interaction, shell model, and collective model of nucleus, and models of nuclear reactions. Prerequisites: Phys. 606, 625.

646. Intermediate Energy Nuclear Physics. (3-0). Credit 3. Topics of current theoretical and experimental interest including particle-particle scattering, particle-nucleus scattering, symmetries, polarization analysis; multiple scattering, nuclear structure studies and dynamical models. Prerequisite: Phys. 624.

648. Cosmic Rays. (3-0). Credit 3. Phenomenology and theory of contemporary cosmic ray physics with emphasis on subjects of current research interest. Prerequisites: Phys. 603, 606; approval of instructor.

650. Radiative Transfer. (3-0). Credit 3. Derivation of equation of transfer for both scalar and Stokes vector representations; principles of invariance; symmetry relations; numerical techniques for general laws of scattering applicable to gases, clouds, and aerosols; application to planetary atmospheres. Prerequisites: Phys. 416, Math. 308, 311.

654. Low Temperature Physics. (3-0). Credit 3. Quantum behavior of matter at extremely low temperatures with emphasis on the thermal and electronic properties of solids including superconductivity. Prerequisites: Phys. 606, 607 and 617 or 424, or approval of instructor.

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, highlighting the feedback between ideas in physics and the surrounding culture. Laboratory techniques for teaching classical physical concepts are presented.

660. Evolution of Physics. (2-2). Credit 3. Continuation of Phys. 659. Traces the evolution of physics in the 20th century, including the birth and development of quantum physics, relativity and nuclear physics. Laboratory techniques for teaching modern physical concepts are presented.

665. Concepts of Modern Physics. (3-0). Credit 3. Physical phenomena of contemporary interest are studied with specific attention to physical concepts. Areas considered include 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 are emphasized.

681. Seminar. (1-0). Credit 1. Examination of subjects of current importance. 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. Study of 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.

DEPARTMENT OF PLANT SCIENCES

A. A. Bell, C. R. Benedict, L. S. Bird, T. E. Boswell, J. Craig, G. A. Donovan, R. A. Frederiksen, A. S. Garay, C. E. Gates, J. R. Gipson, R. S. Halliwell*, J. M. Halloin, G. E. Hart, C. W. Horne, R. E. Hunter, H. E. Joham (Head), D. L. Ketring, N. M. Kieffer, S. D. Lyda, N. A. McNiel, C. W. Magill, R. E. Meyer, C. S. Miller, P. W. Morgan*, R. J. Newton, R. E. Pettit, R. D. Powell, H. J. Price, J. E. Puhalla, D. W. Rosberg, H. W. Schroeder, D. H. Smith, J. D. Smith*, L. R. Smith, R. H. Smith, R. D. Stipanovic, W. H. Thames, Jr., R. W. Toler, E. P. Van Arsdel, B. Villalon, N. G. Whitney, J. R. Wild

The Department of Plant Sciences offers the Master of Science and Doctor of Philosophy degrees in Genetics, Plant Breeding, Plant Pathology, and Plant Physiology. In their thesis and dissertation research, students carry out research utilizing facilities located on campus and/or at one of the Research Centers.

In addition to possessing a competent command of English, Ph.D. candidates must complete the foreign language requirement in one or two approved languages. For complete information on the options available, prospective students should contact the Department of Plant Sciences.

The Department of Plant Sciences offers two options in its Master of Agriculture degree program: Plant Protection and Plant Sciences. The Master of Agriculture is a non-research 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 Master of Agriculture degree program.

*Graduate Advisor

GENETICS SECTION

Genetics occupies a central position in biology, and many of the most significant research developments in the life sciences have occurred in this dynamic discipline. Facilities are available to support graduate student specialization in the fields of bacterial genetics, biochemical genetics, cytogenetics, forest genetics, fungal genetics, developmental genetics and population genetics.

An unusual opportunity exists for graduate students to develop multidisciplinary approaches involving genetics, plant pathology and plant physiology within the department.

Programs in genetics are supervised by members of the Genetics Faculty. For a listing of all genetics courses and of the interdepartmental Genetics Faculty, please refer to the Catalog listing under Genetics.

(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. Required for genetics majors. Prerequisite: Gen. 301.

608. Genetics of Microorganisms.(3-0). Credit 3. Contributions to the understanding of genetics which have come from studies of microorganisms, including bacteria, viruses, fungi, protozoa and lower algae. Emphasis will be placed on areas of special interest to the students enrolled. Prerequisite: Gen. 301 or equivalent.

612. Population Genetics. (3-0).Credit 3. A 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, effectsof systems of mating, genetic covariance and threshold effects. Prerequisites: Gen. 612 and Stat. 652.

620. Cytogenetics. (3-0). Credit 3. Examination and analysis of variation in chromosome structure, behavior, and number, and study of developmental and evolutionary effects of this variation. Prerequisite: Gen. 603.

623. Special Topics in Genetics. Credit 1 to 3. Content will depend upon interest of students and specialty of instructor. Lecturers who have attained distinction in genetics or related fields will conduct course offered when such lecturers are in residence.

624. Statistical Genetics. (2-0). Credit 2. Probability as applied to genetic systems, derivation of genetic expectations, theory of inbreeding, estimation and testing of genetic parameters, statistical aspects of quantitative inheritance. Prerequisites: Gen. 603; Stat. 652.

625. Speciation. (3-0). Credit 3. Study of the processes of organic evolution, particularly as they operate in the differentiation of populations and the origin of species. Prerequisite: Gen. 603 or approval of instructor. (Offered in 1976-77 and in alternate years thereafter.)

630. Cytogenetics Laboratory. (0-3). Credit 1. Study of variation in chromosome morphology, behavior and number based on observation and analysis of meiosis and mitosis in appropriate organisms. Prerequisite: Gen. 620 or registration therein. (Offered in 1977-78 and in alternate years thereafter.)

631. Biochemical Genetics. (3-0). Credit 3. Study of genetic control of cellular metabolism. Mechanism of gene action, genetic capacity for biosynthesis. Gene-enzyme relationships; chemical nature of agents of heredity. Prerequisites: Bi.Ch. 410 or 603; Gen. 301.

633. Forest Genetics. (3-0). Credit 3. Specialized study of genetics as applied to forest trees; forest tree improvement and forest tree breeding, with emphasis on genetics of conifers, especially pines. Prerequisite: Gen. 603. (Offered in 1977-78 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. (Offered in 1977-78 and in alternate years thereafter.)

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.

689. Special Topics in ---. Credit 1 to 4. Study of selected topics in an identified area of genetics. May be repeated for credit. Prerequisite: Approval of instructor.

690. Theory of Research in Genetics. (3-0). Credit 3. Design of research experiments in various subfields of Genetics and evaluation of research results using examples taken from current scientific literature. May be repeated for credit. Prerequisite: Approval of instructor.

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

PLANT PATHOLOGY SECTION

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, as well as majors and minors in the plant sciences. 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 standpoint of plant breeder, plant pathologist and entomologist. Team taught with each discipline represented. Roundtable discussion of assigned readings and lectures included. Prerequisite: Approval of instructors.

616. Methods in Plant Pathology. (2-6). Credit 4. Familiarization with standard principles, techniques, and equipment used in investigation of plant disease and plant pathogens. Prerequisite: Pl.Pa. 301 and 303 or equivalent.

617. Parasitism in Plant Disease. (3-3). Credit 4. Critical review of literature on parasitism, mechanisms of host defense, and host-parasite interactions. Theoretical aspects of parasitism stressed. Prerequisite: Pl.Pa. 301 and 303.

618. Bacterial Plant Diseases. (2-3). Credit 3. Detailed study of bacterial diseases of fruit and vegetable crops, field crops and ornamental plants, with special emphasis upon nature of the disease, dissemination of the pathogen, and methods of control. Prerequisite: Pl.Pa. 301 and 303 or equivalent. (Offered in 1973-74 and in alternate years thereafter.)

619. Forest Pathology. (3-3). Credit 4. Life histories of representative tree diseases. Concept of parasitism, physiological relationships, epidemiology and control of forest tree diseases. Prerequisite: Pl.Pa. 301 and 303 or approval of instructor. (Offered in 1974-75 and in alternate years thereafter.)

620. Plant Viruses. (2-3). Credit 3. Study of nature and properties of plant viruses and plant virus diseases. Prerequisite: Pl.Pa. 301 and 303 or equivalent. (Offered in 1973-74 and in alternate years thereafter.)

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. Intensive study of both fundamental and practical aspects of more important and representative diseases of field crops. Plant disease problems peculiar to extensive cultivation methods will be stressed. Prerequisite: Pl.Pa. 301 and 303.

624. Diseases of Fruits, Vegetables and Ornamentals. (2-3). Credit 3. Study of various disease inciting agents responsible for fruit, vegetable, and ornamental diseases. Emphasis upon fungal identification, host-parasite physiology, pathogen dissemination and control of the pathogen. Prerequisite: Pl.Pa. 301 and 303 or equivalent. (Offered in 1974-75 and in alternate years thereafter.)

625. Plant Pathogenic Fungi. (2-4). Credit 4. Plant pathogenic fungi associated with vegetables, field crops, trees, ornamentals, grasses and weeds. Emphasis on identification of fungi in relation to the disease symptoms. Prerequisite: Biology 353, Pl.Pa. 301 and 303 or equivalent.

681. Seminar. (1-0). Credit 1 each semester. Reports and discussions of topics of current interest in plant pathology, including 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.

690. Theory of Research in Plant Pathology. (3-0). Credit 3. Research inquiry and discussion of experimental design, theoretical techniques and scientific methodology in conducting scientific research. Recording, evaluating, 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.

PLANT PHYSIOLOGY SECTION

Plant physiology is a key discipline in man's efforts to understand and use plants. It is a basic science with great applied value. Perhaps the most significant role for plant physiology is in joint efforts with plant breeders and pathologists to improve the productivity of crop plants. Awareness of both interdisciplinary and independent roles is incorporated into the section's training areas. Modern, well equipped laboratories and greenhouses are available to students. Active research programs in phytohormones and bioregulating systems, mineral nutrition, productive efficiency including carbon metabolism and transport, environmental and stress physiology, air pollution, crop growth simulation modeling, plant cell and tissue culture, harvest-aid chemicals and growth regulators, intergrated pest management, and the physiology of disease, insect, pollutant, and stress resistance. Excellent support is available from chemistry, biochemistry, genetics, plant pathology, statistics, biology, soils and other related disciplines.

(P.Phy.)

605. Plant Metabolism. (3-0). Credit 3. Intermediary metabolism of the major classes of plant compounds, dark and light CO_2 fixation, respiration and bioenergetics. Prerequisites: Chem. 228; P.Phy. 314.

606. Physiological Plant Chemistry. (3-0). Credit 3. Advanced course dealing with chemical constitution of plants and inter-relationship of various types of plant constituents. Topics included are nitrogen metabolism, oligosaccharides and the biochemistry of terpenes, flavones, sterols and alkaloids. Prerequisites: Chem. 228; Bich. 603 or P.Phy. 605; P.Phy. 314.

607. Physiology of the Fungi. (3-3). Credit 4. General course in physiological activities of fungi, including growth and development, nutrition, intermediary metabolism, reproduction and physiology of parasitism. Prerequisite: Biol. 353 or approval of instructor. (Offered 1977-78 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.

611. Plant Nutrition. (3-0). Credit 3. Inorganic nutrition of plants, including 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.

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.

613. Plant Growth and Development. (3-0). Credit 3. Course dealing with growth, differentiation, and development of higher plants. Comprehensive study of vernalization and photoperiodism as well as discussion of hormones and biological rhythms. Prerequisite: P.Phy. 314.

681. Seminar. (1-0). Credit 1 each semester. Reports and discussions of topics of current interest in plant physiology including 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.

689. Special Topics in ---. Credit 1 to 4. Study of 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, evaluating, 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,* W. A. Dixon, J. A. Dyer, G. M. Halter, R. S. Hambrick, S. A. Kirkpatrick (Head), J. L. Payne, K. H. Ro, B. W. Robeck, W. P. Snyder, G. C. Swanson, P. P. Van Riper, E. P. Veblen, A. Vedlitz, H. J. Woods

Graduate study in political science is offered leading to the degree of Master of Arts. 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) and as preparation for still more advanced work in the discipline.

There are opportunities for specialization in the areas 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.

A major 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

*Graduate Advisor

non-thesis plan — requires at least 36 semester hours of course work, 24 of which must be in political science plus a minimum of 6 hours in a supporting field; here a comprehensive examination is mandatory.

A minor in political science requires at least 9 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.

In program formulation there is unusual flexibility within the minimal constraints outlined above. The initiative for selection of a student's graduate committee lies with the student and he and the committee together design a suitable program.

Prerequisites: While there are no precise course prerequisites for entry into a graduate 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 head of the department prior to entering into the admissions process. On language requirements and other relevant matters see especially the general discussions of the Master of Arts degree and of financial assistance elsewhere in this announcement.

(Pol.S.)

601. Components of Political Inquiry. (3-2). Credit 4. Research designs, data collection, models, and conceptual frameworks as used in the social sciences, especially political science. Required for Political Science majors. Prerequisite: Six hours of advanced social science or approval of instructor.

606. American Government and Politics. (3-0). Credit 3. For graduate students in other disciplines. Form and process in American national, state and local government, with emphasis on the U.S. and the Texas constitutions, the underlying democratic theory, problems of political power, and the needs of those professionals and others who must understand and function in a political environment. Satisfies teacher certification requirements. Prerequisite: Six hours of advanced social science or approval of instructor.

607. The Politics and Governments of Texas. (3-0). Credit 3. Political, constitutional, structural and administrative forms, processes and issues in Texas state and local governments. Emphasizes the knowledge required by citizens, professionals and others who need to understand and work successfully in the range of governments within the Texas environment. Prerequisite: Six hours of advanced social science or approval of instructor.

610. Parties and Group Politics. (3-0). Credit 3. Nature of the American political process: party system, structure and organization; interest groups, influence and regulation; nominations, campaigns, and elections; comparative party systems; the political environment. Prerequisite: Six hours of advanced social science or approval of instructor.

614. The American Presidency. (3-0). Credit 3. The office of President of the United States; its place in the constitutional and political system. Emphasis on modern experience and current problems of the office. Prerequisite: Six hours of advanced social science or approval of instructor.

615. Legislative Process and Behavior. (3-0). Credit 3. Study of Congress and state legislatures with emphasis on recent research findings and relevant theoretical frameworks. Prerequisite: Six hours of advanced social science or approval of instructor.

618. Urban Political Systems. (3-0). Credit 3. Studies in urban politics, party structure and activities, voting behavior, power structures and current political problems. Prerequisite: Six hours of advanced social science or approval of instructor.

619. Reading Seminar in Urban Government and Administration. (3-0). Credit 3. Involves directed work in depth on selected problems in urban government, organization, and administration through study of the relevant literature; reports and seminar discussions. Prerequisites: Six hours of advanced social science or approval of instructor.

620. Comparative Political Systems. (3-0). Credit 3. Comparative study of national political systems, with an emphasis on cross-national relationships and techniques of analysis. Prerequisite: Six hours of advanced social science or approval of instructor.

621. Comparative Foreign Policies. (3-0). Credit 3. Major theoretical approaches to the study of foreign policy. Examines and compares the policies of a number of different type states with the United States, including a consideration of the internal and external factors which influence policies.

625. Politics in the Communist Bloc. (3-0). Credit 3. Emphasizes politics, ideology, and political development in and among major communist nations and their relationships with communist satellite countries, major Western democracies, and non-aligned nations. Prerequisites: Six hours of advanced social science or approval of instructor.

627. China in World Politics. (3-0). Credit 3. Analysis of formulation, substance and conduct of Chinese foreign policy. Special attention given forces shaping Chinese behavior in the area of international politics. Prerequisite: Six hours of advanced social science or approval of instructor.

629. Latin American Politics. (3-0). Credit 3. Intensive survey of current research literature on Latin American politics. Focus is on Latin America as a general entity and on selected countries and institutions. Prerequisite: Six hours of advanced social science or approval of instructor.

630. Theories of International Politics. (3-0). Credit 3. Review of the literature of international politics, including security politics, the development of nations, international law, organization and integration. Prerequisite: Six hours of advanced social science or approval of instructor.

632. International Law. (3-0). Credit 3. Nature and sources of international law, recognition, jurisdiction on high seas, rights and immunities of states and persons in foreign courts, law of international claims, law of war and neutrality. Prerequisites: Six hours of advanced social science or approval of instructor.

634. Issues in War and Peace. (3-0). Credit 3. Consideration of causes of war, arms control, national security, defense policies, and related issues involved in war and peace among nations and political systems. Prerequisite: Six hours of advanced social science or approval of instructor.

636. Politics and Development of the Non-aligned Nations. (3-0). Credit 3. Examines the political issues involved in development and modernization of non-aligned nations. Prerequisite: Six hours of advanced social science or approval of instructor.

643. Theory and Practice of Public Administration. (3-0). Credit 3. Theory, process, and structure of management in the public sector, including the military and education, as well as comparisons to business. Emphasis on internal management of a public agency — federal, state or local — in a political setting.

645. Politics, Policy and Administration. (3-0). Credit 3. Studies the 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. Prerequisite: Six hours of advanced social science or permission of the instructor.

647. Public Policy Design and Evaluation. (3-0). Credit 3. Problems and methods in the design and evaluation of public policies and programs. Considers both quantitative and qualitative approaches. Prerequisite: Six hours of advanced social science or permission of the instructor.

651. Reading Seminar in Political Theory. (3-0). Credit 3. Involves directed work in depth on selected problems in political theory through the study of relevant literature; reports and seminar discussions. May be repeated for credit. Prerequisite: Pol. S. 454 or 456 or equivalent or approval of instructor.

653. Criminal Law and Procedure. (3-0). Credit 3. Intensive study of U.S. criminal codes, especially that of Texas, and their historical development. Elements of all crimes will be matched with the direct and circumstantial evidence necessary to identify an offense. Major crimes will be followed through criminal procedure within the judicial process. Prerequisite: Pol. S. 356 or equivalent or permission of instructor.

655. Law and Society. (3-0). Credit 3. Considers the broader aspects of law with emphasis upon the meaning of law, its purpose, functions, origin, nature, and history as well as the interactions of law and society. Law is examined as a system and a social device central to the governing of society. Prerequisite: Six hours of advanced social science or approval of instructor.

656. Due Process of Law and Law Enforcement Procedures. (3-0). Credit 3. The concept of due process is developed in a constitutional context and applied to the theory and practice of law enforcement and to the methodology, techniques, and administration of police work. Police and prosecution procedures are measured against the requirements of due process of law. Prerequisite: Pol. S. 356 or equivalent or permission of instructor.

657. Jurisdiction, Evidence and Remedies in Judicial Process. (3-0). Credit 3. Analysis of the power, process and outputs of state and federal courts with emphasis upon the management of court dockets and the efficacy of the process and judgments used in the extension of judicial remedies. Consideration also given to the common law rules of evidence. Prerequisite: Pol. S. 653 or 656 or equivalent or permission of instructor.

659. Policy and Administration in Law Enforcement Systems. (3-0). Credit 3. Major law enforcement and judicial process systems in the United States from the point of innovations in the management of police, prosecution and defense functions and in court administration. Prerequisite: Pol. S. 653 or 656 or equivalent or permission of instructor.

660. Political Behavior. (3-0). Credit 3. An analysis of the major approaches to the study of political behavior, personality and politics, political socialization, and the social, cultural, and economic characteristics of advanced political activists. Prerequisite: Six hours of advanced social science or approval of instructor.

662. Political Leadership and Elites. (3-0). Credit 3. Examines the political behavior and motivations of leaders and elites, primarily in modern mass societies. Prerequisite: Six hours of advanced social science or approval of instructor.

681. Seminar. (1-0). Credit 1. Discussion of topics of current research interest in Political Science with emphasis on promising areas of research opportunity. Prerequisite: Approval of Graduate Advisor.

685. Problems. Credit 1 to 6 each semester. Individual instruction in selected fields of Political Science. Will stress reports and wide reading in field selected. Prerequisite: Approval of instructor.

689. Special Topics in ---. Credit 1 to 4. Study of selected topics in an identified area of political science and public policy. May be repeated for credit. Prerequisite: Approval of instructor.

690. Theory of Research in Political Science. (3-0). Credit 3. Theory and design of research problems, studies, and experiments in various subfields of political science and evaluation of research methodologies and results using examples from current literature. 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

J. R. Cain*, C. R. Creger*, R. C. Fanguy*, T. M. Ferguson*, F. A. Gardner*, W. F. Krueger (Head)*, D. B. Mellor*, L. O. Rowland, Jr.*, C. B. Ryan

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 successful poultry production 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 feeding, breeding, physiology, pathology, heating, ventilation, 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.

Through cooperation with the Departments of Agricultural Economics, Biochemistry and Biophysics, Biology, and the Genetics Section of the Department of Plant Sciences, the department is in a position to offer graduate work leading to the Master of Agriculture, Master of Science and Doctor of Philosophy degrees with areas of specialization in poultry genetics and breeding, poultry nutrition and feeding, avian physiology, environmental physiology, incubation, production and management, poultry processing and marketing, and poultry product development.

(P.S.)

603. Avian Incubation and Embryology. (3-3). Credit 4. Embryonic development of bird eggs under both commercial and experimental incubation conditions. Developmental processes are evaluated relative to various environmental and genetic parameters. Prerequisite: P.S. 308 or equivalent.

604. Trends in Poultry Technology and Management. (3-2). Credit 4. Intensive literature review and in-depth analysis of special topics in poultry science; may include advanced environmental physiology, endocrinology and reproduction, birds as models for biomedical research, efficiency economics, management innovations, etc. Topics offered in summer include effective use of poultry in teaching, poultry projects and demonstrations, poultry oriented youth programs, recent advances in the industry, etc. Prerequisites: P.S. 201, 425, or equivalent.

609. Avian Physiology. (3-3). Credit 4. Study of basic physiological principles pertaining specifically to avian species. Chicken used as laboratory animal. Vascular, digestive, neural, respiratory, and reproductive systems will be stressed. Prerequisites: Biol. 433; approval of instructor.

611. Poultry Processing and Distribution Technology. (3-2). Credit 4. Poultry and egg composition, mechanisms of poultry and egg quality preservation effects of storage environments, time and product treatment. Evaluation of commercial methods of product assembly, processing, distribution and quality control. Evaluation of physical, microbiological, functional and chemical methods of quality determination. Cross-listed with F.S.T. 611.

613. Concepts of Breeding Systems. (3-0). Credit 3. Relating avian breeding system concepts to population dynamics. Measuring selection accuracy and efficiency as reflected in genetic improvement of quantitative traits utilizing various breeding systems, general and specific combinability, diallel crossing and synthesizing new special purpose lines. Prerequisite: Approval of instructor.

615. Avian Nutrition. (3-0). Credit 3. Covers metabolism and nutritional requirements of domestic fowl including proteins, carbohydrates, fats, minerals, vitamins and related feed additives. Prerequisites: Chem. 228 or 232; P.S. 411 or approval of instructor.

681. Seminar. (1-0). Credit 1 each semester. Intensive review of literature on feeding, breeding, incubation, marketing, and management. Development of familiarity with journals, organizations, agencies and personnel working on poultry problems. May be repeated as many semesters as desired. Prerequisite: Graduate classification.

684. Professional Internship. Credit 1 to 4. Work-study program, for students interested in a Master of Agriculture degree in Avian Science. Students expected to prepare a scholarly report acceptable to Graduate Committee.

685. Problems. Credit 1 to 6 each semester. Intensive study of newer principles and methods in various specialized fields of poultry science — breeding, nutrition, physiology, market technology. Prerequisite: Approval of Department Head.

689. Special Topics in ---. Credit 1 to 4. Study of selected topics in an identified area of poultry science. May be repeated for credit. Prerequisite: Approval of instructor.

691. Research. Credit 1 or more each semester. Research methods and techniques in breeding, nutrition, physiology, marketing, management and products technology. Students must conduct experiments in one of these fields. Design of experiments, collection, analysis and presentation of experimental data. Designed for thesis or dissertation credit.

DEPARTMENT OF PSYCHOLOGY

B. O. Bergum, A. E. Bourgeois, A. J. Casey, L. B. Christensen, R. A. Dunckley, R. B. Evans, A. D. LeUnes, M. G. McGee, C. J. Martin, (Head), L. C. Shine II, D. J. Woods

The Department of Psychology offers graduate studies leading to the Master of Science degree. Graduate programs are available in general-experimental, industrial and pre-clinical. The programs are designed to train students for Ph.D. work at other institutions or for employment in the field of psychology upon completion of the M.S. degree. Students majoring in psychology receive field experiences in local and state mental health and mental retardation centers as well as research assistantships within the department. Graduate training in psychology offers a balance between theoretical and applied psychology. Objectives of the individual student will guide the selection of his committee and the choice of courses within the department and in his minor area. Although Texas A&M University requires a minimum of 32 semester hours for the degree of Master of Science (thesis option), the Department of Psychology requires additional hours beyond this minimal requirement, depending upon the student's background and professional goals.

(Psy.)

601. Proseminar in Psychology. (5-0). Credit 5. A review of the current status of the physiological psychology, sensation-perception, and learning areas of psychology. Prerequisite: Graduate major or minor in psychology.

602. Proseminar in Psychology. (5-0). Credit 5. A review of the current status of the abnormal, personality and social areas of psychology. Prerequisite: Graduate major or minor in psychology.

603. Motivation and Cognitive Processes. (3-0). Credit 3. Selected topics in areas of motivation and higher mental processes, including symbolic processes in perceptual organization; consideration of learning and remembering, reasoning, and creativity.

604. Personality and Social Behavior. (3-0). Credit 3. An advanced seminar focusing on special topics, emphasizing the interaction of personality and situational determinants of behavior. Prerequisites: Psy. 412.

605. Clinical Psychology. (3-0). Credit 3. Survey of clinical psychology; therapeutic modalities; experimental study of disordered behavior; diagnostic constructs and the assessment process; social, political, and ethical contexts of mental health service delivery. Prerequisite: Psy. 306 and approval of instructor.

607. Experimental Psychology. (2-3). Credit 3. Course in experimental methods with emphasis on developing a general frame of reference for approaching experimental research problems.

609. Psychophysiology. (2-3). Credit 3. Advanced review of current research and methodological procedures on physiological bases of sensation-perception, memory and learning, arousal-sleep-attention, emotions and motivation. Prerequisites: Psy. 408, 409.

610. Industrial Psychology. (3-0). Credit 3. Comprehensive study of current research and literature in industrial psychology with emphasis on personnel selection, training of skilled and managerial personnel, men-machine systems, employee motivation and morale.

612. 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.

614. Practicum in Psychology. Credit 1 to 4 each semester. Practical on-the-job experience for graduate students. Activities will be guided by psychologists in the following areas: 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, as well as 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 with emphasis on the 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.

620. Theories of Social Psychology. (3-0). Credit 3. Current theories of social psychology and a review of studies to these theories. Includes theories of attitude change, prosocial behavior, aggression, equity, coalition formation, social learning, and S-R theory applied to social behavior. Prerequisites: Psy. 412; Soc. 411.

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.

634. Principles of Human Development. (3-0). Credit 3. Biological, psychological, and cultural interrelationships in human development. Emphasis upon 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, including investigation of the validity of various sterotypes of the aged. Psychological impact of various social policies. Prerequisite: Approval of instructor.

671. Experimental Design for Behavioral Scientists. (2-3). Credit 3. Intensive practical study of designs of special interest to behavioral scientists. Repeated measures designs emphasized. Prerequisites: Stat. 652 or equivalent.

672. Factor Analysis for Behavioral Scientists. (2-3). Credit 3. Principles and uses of Factor Analysis in behavioral research. Emphasis on implementation, alternate factor models and interpretation with heavy use of numerical examples. Prerequisite: Psy. 671 or approval of instructor.

681. Seminar. (1-0). Credit 1. Group study and discussion of current periodical literature not covered by formal course work. Psychology as a profession, ethical responsibilities.

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. Study of 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.

DEPARTMENT OF RANGE SCIENCE

J. R. Baur, W. H. Blackburn, R. W. Bovey, J. D. Dodd, A. J. Dye, F. W. Gould, R. H. Haas, M. R. Haferkamp, M. M. Kothmann, W. G. McCully, L. B. Merrill, R. E. Meyer, B. J. Ragsdale, L. R. Rittenhouse, J. L. Schuster (Head)*, C. J. Scifres, F. E. Smeins, R. E. Steger, J. W. Stuth, D. N. Ueckert, L. W. Varner, R. E. Whitson.

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 resources 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, ecology, mineral cycling, range animal and plant nutrition, watershed management, remote sensing, resource management and weed and woody plant control.

Graduate courses are designed to develop the skill 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 interrelate course contents and research. Individually planned graduate programs assure sound training for each candidate in a specialized area of interest.

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. All candidates for the Ph.D. will demonstrate a reading knowledge of one (1) foreign language or a suitable substitute approved by the candidate's Advisory Committee.

(R.S.)

601. Range Resource Use. (3-0). Credit 3. Basic concepts and theories of rangeland resource management. Trends in range classification, grazing management and improvement practices. Prerequisites: 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.

*Graduate Advisor

603. Range and Forest Watershed Management. (3-0). Credit 3. Management of range and forest watersheds with emphasis on the influence of range and forest practices on runoff, interception, infiltration, erosion and water quality. Current literature and research advances will be stressed. Field trips required.

604. Grazing Management and Range Nutrition. (3-0). Credit 3. Relationships between vegetation and grazing animals (domestic & 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. Special research techniques.

605. Range Research Methods. (3-0). Credit 3. Methods applicable to research on rangeland and related resources. Emphasis on development of field research projects, study design and implementation techniques for vegetation evaluation, research project management and publication. Prerequisite: Graduate majors and minors in range science.

606. Range Economics. (3-0). Credit 3. The application of economic and financial tools for improved managerial decision-making in the range-livestock industry. Prerequisite: Graduate majors and minors in range science.

607. Vegetation Influences. (3-0). Credit 3. Interrelationships between ecological factors and vegetation, influence of forest and range vegetation on watershed management and soil conservation. Prerequisite: R.S. 316 or equivalent.

609. Plant and Range Ecology. (3-0). Credit 3. Detailed study of plant communities, successions, and effect of various degrees of utilization in 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. Prerequisites: R.S. 420, 316; or approval of Department Head.

613. Analysis of Natural Resource Systems. (3-2). Credit 4. Structure and function of general systems with emphasis on ecosystems. Application of regression analysis, matrix manipulation and computer techniques in the analyses and simulation of ecosystems. Prerequisite: R.N.R. 205, Stat. 652 or equivalent.

614. Advances in Range Improvement Practices. (3-0). Credit 3. Brush and weed control, revegetation, fertilization, grazing systems, burning, and special treatments. Emphasis on principles and recent advances in improvement practices. Field trips.

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 R.S. Prerequisite: Master of Agriculture candidate in R.S.

685. Problems. Credit 1 to 4 each semester. Course designed for 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. Study of 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.

DEPARTMENT OF RECREATION AND PARKS

R. L. Bury*, N. H. Cheek, Jr., R. B. Ditton*, C. A. Gunn, J. W. Hanna, L. Hodges, B. D. Kamp, D. J. Reed, L. M. Reid (Head)*, I. W. Schmedemann, F. W. Suggitt, C. S. Van Doren*

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.

*Graduate Advisor

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 choice. The student may specialize in a variety of areas, including 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 Master of Agriculture program is designed to emphasize professional involvement. Though equally as rigorous, this program differs significantly from the traditional Master of Science 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 to serve the individual needs of persons interested in teaching, public service, research, or the administration of recreational developments. These courses stress the study of spatial relationships between humans and the natural environment in various recreational settings in which the primary concern is managerial response to urbanization, to patterns of leisure-time utilization, 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 of recreation and parks, including fundamentals of planning, development and management of resources allocated for recreation, parks and tourism purposes. Emphasizes development of the recreation movement with broad treatment of the role of recreation and parks in contemporary society.

602. Conceptual Foundations of Recreation and Resource Development. (3-0). Credit 3. Development of contrasting concepts of leisure and recreation in relation to current recreational trends and needs. Analysis of contemporary role of recreation in society with emphasis on the implications of leisure-time utilization and necessary managerial responses. Prerequisite: Approval of Department Head.

603. Recreational Organization and Policy. (3-0). Credit 3. Executive leadership in park departments and recreation agencies with particular emphasis on administration of recreation resources to meet human needs, decision making and the structure of organizational goals. Prerequisite: Approval of Department Head.

605. Decision-Making in Recreation Administration. (3-0). Credit 3. Political and economic realities associated with policy and decision-making in resource allocation. Utilizing game-simulation techniques as a predictive tool, specific problems are examined and alternative decisions evaluated.

607. Recreation and Park Design. (2-3). Credit 3. Fundamentals of the recreation planning process; historical perspective and objectives of planning; review of planning models; major component analysis including public involvement, resource evaluation, demand analysis, classification systems and standards, integral implementation, and planning research needs.

609. Socio-Economic Issues in Outdoor Recreation. (3-0). Credit 3. Socio-economic characteristics impinging on provision of outdoor recreation opportunities in urban and nonurban settings. Implications of economic factors to demand estimation, valuation, costs and repayment, financing, natural resource allocation, public-private sector interactions and policy issues. Prerequisite: Approval of Department Head.

611. Recreation Systems Planning. (2-3). Credit 3. Basic concepts and methods necessary for identification and rational allocation of resources for recreation. Employs projections, attendance, and preference studies as tools of demand analysis. Includes study of demographic, mobility, and socio-economic factors as a guide to recreation planning. Prerequisite: Approval of Department Head.

615. Analytical Techniques in Recreation. (3-0). Credit 3. Analysis of current research with emphasis on instruments and adaptive techniques utilized in the selection and formulation of research problems. Prerequisite: Approval of Department Head.

622. Recreational Resource Communication. (2-3). Credit 3. Philosophies, concepts, and techniques associated with communication and dissemination of information pertaining to use of natural resources for recreation.

636. Travel and Tourism. (3-0). Credit 3. Tourism and recreational travel including its origins, present characteristics, and societal impacts, implication of non-business travel in the United States and the emerging importance of international recreation. Prerequisite: Approval of Department Head.

650. Recreation Resource Development. (3-0). Credit 3. Presentation of the theory of resource planning and development and of the role and significance of recreation and tourism in the broader environmental context, coupled with an evaluation of relevant current and previous action programs in this country and elsewhere. Field trip required. Prerequisite: R.P. 603 or approval of Department Head.

660. Environmental Impact Analysis for Parks and Recreation. (3-0). Credit 3. Analysis and critique of contemporary environmental analysis methods in current use, and study of environmental impact statements. Emphasis given to the national policies, including political, social and legal ramifications as related to recreation development.

666. Recreation Development in the Coastal Zone. (3-0). Credit 3. Specific recreational problems associated with coastal zone management. The nature, extent, location, and value of coastal recreation behavior is examined and related to the overall coastal framework. Implications for other areas of outdoor recreation resources management are analyzed.

681. Seminar. (1-0). Credit 1. Preparation and discussion by students of special reports, topics, and research data in recreation and parks. Presentation of subjects of professional significance by staff members and invited speakers.

684. Professional Internship. Credit 1 to 4. Survey and application of principles of recreation and resources development. Studies of selected aspects of park and recreation management in professional setting within an approved recreation/park agency under the supervision of a member of the graduate faculty. Required of all students in the Master of Agriculture degree program. Prerequisite: Approval of Department Head.

685. Problems. Credit 1 to 4 each semester. Designed for investigations not included in student's research for thesis or dissertation. Problems selected in administration or management, recreation, or planning.

689. Special Topics in ---. Credit 1 to 4. Study of selected topics in an identified area of recreation and resources development. May be repeated for credit. Prerequisite: Approval of Department Head.

690. Theory of Research in Recreation and Resources Development. (3-0). Credit 3. Theory and design of problems and experiments in various subfields of recreation and resources development. Communication of research proposals and results. Evaluation of current research of faculty and students and review of current literature. Prerequisite: Approval of Department Head.

691. Research. Credit 1 or more each semester. Research in recreation and resources development for thesis or dissertation.

DEPARTMENT OF SOCIOLOGY AND ANTHROPOLOGY

J. P. Alston, G. F. Bass, V. M. Bryant, Jr., J. H. Copp (Head), A. G. Cosby, B. M. Crouch, E. M. Havens, W. P. Kuvlesky, W. A. McIntosh, B. H. Nelson, K. L. Nyberg, O. J. Oyen, J. S. Picou*, D. C. Ruesink, A. Schaffer, R. Schaffer, H. J. Shafer‡, R. L. Skrabanek, N. D. Thomas, F. H. Van Doorninck, Jr., G. H. Weir

Graduates from accredited universities who meet the requirements of the Department of Sociology and Anthropology and the Graduate College may work toward the following advanced degrees: Master of Agriculture in Rural Sociology, Master of Science in Sociology, Master of Arts in Anthropology, and Doctor of Philosophy in Sociology.

Students with degrees in fields other than sociology or anthropology may be admitted provisionally at the master's degree level but will normally be required to make up deficiencies. Students at the Doctor of Philosophy level will normally be expected to have an advanced degree in sociology.

Areas of specialization in sociology currently stressed are: community and social organization; demography; sociological theory; social psychology; rural sociology, urban sociology, and research methodology. Areas of specialization in anthropology include: nautical archeology; cultural resource management; cultural anthropology and physical anthropology.

A wide variety of research programs in the department affords the student wide choice in his research for a thesis or dissertation. To aid in financing graduate education, teaching and research assistantships and fellowships are available.

*Graduate Advisor in Soc.

‡Graduate Advisor in Anth.

ANTHROPOLOGY
(Anth.)

602. Archeologic Methods and Theory. (3-0). Credit 3. Development of archeology as a discipline. Emphasis on methods and theories used in archeology for reconstructing cultural history and culture process.

603. The Family in Cross-Cultural Perspective. (3-0). Credit 3. Identical with Soc. 603. Credit cannot be given for both Anth. 603 and Soc. 603.

612. Preclassical Seafaring. (3-0). Credit 3. Seafarers and watercraft of the ancient Near East and Mediterranean until ca. 700 B.C. Emphasis on 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. Principal emphasis on types, characteristics, origins, and spread of Chinese junks and Oceanic canoes. Cross-listed with Geog. 614.

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. Cross-listed with Geog. 615. Prerequisite: Anth. 612.

616. Research and Reconstruction of Ships. (2-2). Credit 3. Techniques of recording and interpreting excavated ships; preservation of hulls; ship drafting, modelling, lofting, testing, and other methods used in the research and/or reconstruction of ships. Cross-listed with Geog. 616. Prerequisites: Anth. 612, 615.

620. Texas Prehistory. (3-0). Credit 3. Archeological 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.

631. Cultural Dynamics and Archeological Reconstruction. (3-0). Credit 3. Comprehensive overview of current archeological methods used in the reconstruction of cultural systems.

640. Mesoamerican Ethnology. (3-0). Credit 3. Topically organized examination of Indian and peasant societies in Mexico, Guatemala and adjacent regions.

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.

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

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. Study of 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.

SOCIOLOGY
(Soc.)

601. Urban Sociology. (3-0). Credit 3. Patterns of organization and the dynamics of change in the contemporary city. Both the internal and external structure of the city along with 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. Emphasis on social change and its effect on rural social structures. Prerequisite: Soc. 205 or 12 hours of social science.

603. The Family in Cross-Cultural Perspective. (3-0). Credit 3. Analysis of commonalities and differences in family patterns among variety of cultures, with emphasis on how they succeed in meeting the needs of their societies; perseverence and change in family forms; response to technological and societal change.

604. Social Gerontology. (3-0). Credit 3. Special phenomena of old age, including social roles and adjustment to problems of aging and the aged in American society.

608. Social Organization. (3-0). Credit 3. Analysis of the theoretical and conceptual bases of patterned human behavior. Consideration of 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. Analysis of concepts, theories and methodological approaches to studying social change. Evolutionary, conflict, equilibrium, and modernization approaches are emphasized. Prerequisite: Approval of instructor.

610. Sociological Theory. (3-0). Credit 3. Advanced study of trends in theory-development in sociology, including 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, with special attention to Marx, Durkheim, and Weber. Their influence on current theoretical issues is emphasized. Prerequisite: Soc. 430, the equivalent, or permission of the 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. The first semester of a two-semester course on contemporary theory emphasizes structural-functionalism, system theory, and symbolic interactionism, the domain of each for sociological research, the issues raised by respective partisans and critics. Prerequisite: Soc. 611 or equivalent.

614. Seminar in Sociological Theory II. (3-0). Credit 3. The second semester of a two-semester course on contemporary theory which focuses on critical analysis of theoretical systems and models used in sociology. Major metatheoretical approaches in sociology are analyzed, as well as more limited models and schema. Prerequisite: Soc. 613.

615. Contemporary Urban Problems. (3-0). Credit 3. Problems of the contemporary city, such as poverty, decay, environmental degradation, and the role of knowledge and decision making in the adaptive process. Prerequisite: Approval of instructor.

616. Occupational Sociology. (3-0). Credit 3. Sociological analysis of changing occupational structures, labor force demography. Concepts in social structure relating to significance of work, job mobility, changing occupational ideologies, values, and choices. Prerequisites: Soc. 205; six additional hours of social science.

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. Analysis of role of education in society. Prerequisite: Soc. 205 or Ed.C.I. 215.

620. Human Ecology. (3-0). Credit 3. Interrelationships between man and his social and natural environments; emphasis upon 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. Investigation of 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. Analysis of 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. Analysis of power structures; consideration of 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. Analysis of contemporary sociological approaches to deviance. Theoretical and empirical studies of major types of deviant behavior will be examined.

631. Seminar in Sociological Research. (3-0). Credit 3. Critical analysis of research procedures utilized by sociologists. Prerequisite: Soc. 623.

632. Migration. (3-0). Credit 3. Causes and effects of international and internal migration; migration models and theories; data sources and methods of measurement; and policy implications of migration. Prerequisite: Sociology 622.

633. Demographic Methods. (3-0). Credit 3. Procedures and techniques for the collection, evaluation, and analysis of demographic data, including measures of population growth, composition, fertility, mortality, and migration. Prerequisite: Sociology 622.

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. E. Adams, W. B. Anderson, E. C. Bashaw, J. B. Beard, M. E. Bloodworth (Head), A. J. Bockholt, R. D. Brigham, K. W. Brown, E. Burnett, L. E. Clark, J. W. Collier, B. E. Conrad, J. P. Craigmiles, J. B. Dixon, R. L. Duble, E. F. Eastin, G. W. Evers, P. A. Fryxell, C. J. Gerard, E. C. Gilmore, Jr., E. C. Holt, W. L. Hoover, L. R. Hossner, D. E. Kissel, R. J. Kohel, G. W. Kunze, J. E. Larsen, W. N. Lipe, G. G. McBee, K. J. McCree, M. E. McDaniel, J. E. Matocha, J. R. Melton, M. G. Merkle, N. L. Meyers, M. H. Milford*, F. R. Miller, J. F. Mills, G. A. Niles, A. B. Onken, R. D. Palmer, F. C. Petr, K. B. Porter, J. D. Price, J. C. Read, K. C. Rhee, J. T. Ritchie, L. W. Rooney, D. T. Rosenow, F. M. Rouquette, Jr., J. R. Runkles, K. F. Schertz, D. T. Smith, O. D. Smith, J. W. Stansel, R. D. Staten, A. R. Swoboda, N. A. Tuleen, C. H. M. van Bavel, D. Weaver, R. W. Weaver, C. D. Welch, C. W. Wendt, E. L. Whiteley, A. F. Wiese, L. P. Wilding

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. The department is housed in a well equipped new building. Agronomy, food science and technology, plant breeding and soil science are the principal majors available to students.

Programs of professional study in soil and crop management, agricultural chemistry, agricultural development, food technology, and turf management 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, and soil science lead to a M.S. or Ph.D. degree in these fields. Areas of specialization within the majors include cereal chemistry, crop breeding, crop physiology, environmental agronomy, cytogenetics, food science and technology, 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.

*Graduate Advisor

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 Institute of Statistics.

(Agro.)

601. Grain and Cereal Crops. (3-0). Credit 3. Advanced study of grain and cereal ecology, utilization, physiology, and morphology, including critical review of world literature reporting recent investigations in this field.

602. Forage Crops. (3-0). Credit 3. Advanced study of pasture production, management and utilization. Factors affecting forage quality and animal performance with emphasis on 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; Biol. 422 or approval of instructor.

605. Pedology. (3-0). Credit 3. Advanced study of development, morphology, constitution, and classification of soils. Prerequisites: Agro. 301, 411, or approval of instructor.

610. Host Plant Resistance. (3-0). Credit 3. Host plant resistance programs from standpoint of plant breeder, plant pathologist and entomologist. Team taught with each discipline represented. Roundtable discussion of assigned readings and lectures included. Prerequisite: Approval of instructors.

612. Forage Crops Management. (3-0). Credit 3. Advanced study of 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 with emphasis on current literature and concepts. Prerequisites: Agro. 308 or approval of instructor.

617. Advanced Soil Physics. (3-3). Credit 4. Physical properties of soil including the 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 1978-79 and in alternate years thereafter.)

618. Advanced Soil Analysis. (2-3). Credit 3. Designed to familiarize student with more difficult problems of soil analysis and interpretation of data. Prerequisite: Agro. 422.

620. Saline and Sodic Soils. (2-3). Credit 3. Intensive and advanced study concerning 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, is also studied. Prerequisites: Agro. 445, 618; or approval of instructor.

621. Principles of Crop Ecology. (2-2). Credit 3. Basic principles of crop ecology. Techniques for measuring rates of crop production. The effects of light, temperature and water supply on production rates. Laboratory and field training in the use of instruments suitable for experiments in field ecology. Prerequisites: P. Phy. 314, Met. 305. (Offered in 1977-78 and alternate years thereafter.)

622. Environmental Aspects of Crop-Water Relations. (3-0). Credit 3. Review and synthesis of physical processes that affect crop-water balance and water use by plant communities with special reference to productivity, water use efficiency and water management in crop production. Prerequisites: Agro. 440, 445; Ag.En. 410; Met. 465; P.Phy. 314 or equivalent. (Offered in 1977-78 and in alternate years thereafter.)

623. Experimental Crop Ecology. (2-3). Credit 3. Principles of interactions between crop plants and their environments. Theoretical and experimental methods for studying rates of exchange of light, radiation, heat, water vapor and carbon dioxide by stands of crop plants, and their effects on crop productivity. Laboratory and field training in handling modern instruments used in field crop ecology experiments. Prerequisites: Agro. 440, R.S. 419, Met. 465 or equivalent. (Offered in 1978-79 and alternate years thereafter.)

624. Physical Chemistry of Soils. (3-3). Credit 4. Physical chemistry of clay minerals and inorganic and organic soil colloids. Prerequisites: Agro. 617, 618, 626; Chem. 324. (Offered in 1977-78 and in alternate years thereafter.)

626. Soil Mineralogy. (3-3). Credit 4. Study of crystal structures and properties of more important mineral in soils and sediments, especially clay minerals combined with identification techniques involving X-ray diffraction, electron microscopy, infrared and chemical methods.

627. Soil Fertility Relationships. (3-0). Credit 3. Advanced study of behavior of nutrient elements in soils and plants. Emphasis placed on nitrogen, phosphorus and potassium. Principles of experimental design, plot technique and interpretation of fertility response data. Prerequisites: Agro. 422; P.Phy. 314.

630. Cereal Grains for Human Food. (3-3). Credit 4. Includes discussion of 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. Laboratory includes use of instruments and techniques to evaluate cereal quality. Prerequisite: Approval of instructor.

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. Discussion of dough structure and rheology and enrichment of cereal products. Prerequisite: Bi.Ch. 410. (Offered in 1978-79 and in alternate years thereafter.)

634. Oilseed Proteins for Foods. (3-0). Credit 3. World production, composition, processing technologies, uses of products (oil, meal and protein concentrates) in feeds and foods emphasizing present and potential food applications of oilseed proteins. Prerequisites: Chem. 228, 317. (Offered in 1977-78 and in 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 1978-79 and in alternate years thereafter.)

641. Plant Breeding I. (3-0). Credit 3. Study of theoretical and practical aspects of plant breeding, including genetic basis. Application of breeding methods and interdisciplinary considerations in breeding problems. Prerequisites: Gen. 603; Stat. 602.

642. Plant Breeding II. (3-0). Credit 3. Expectations of genetic improvement for different plant breeding methods with emphasis on relative efficiency for crops of different reproductive mechanisms. Genetic variances, covariances, and genotype-environment interaction components of variance utilized in planning selection procedures. Prerequisites: Agro. 641, Gen. 613, Stat. 619.

650. Chemical Weed Control. (2-3). Credit 3. Detailed study of families of herbicides. Emphasis given to relationship of molecular structure to herbicidal activity, mode of action, pathways of degradation, and herbicidal interactions. Prerequisite: Agro. 450 or approval of instructor.

660. Growth and Development of Turfgrass. (3-0). Credit 3. The growth and development of turfgrasses are studied as a function of physiological and morphological responses to environmental influences. Management schemes are developed based on predicted responses to environmental influences. Prerequisites: Agro. 428, P.Phy. 613 or approval of instructor.

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, seed technology 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. Study of 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.

INSTITUTE OF STATISTICS

R. J. Freund, C. E. Gates, H. O. Hartley, O. C. Jenkins, J. H. Matis, E. Parzen, L. J. Ringer*, R. L. Sielken Jr., W. B. Smith (Director), T. E. Wehrly

The Institute of Statistics offers a graduate program, leading to the degrees of Master of Science or Doctor of Philosophy. The Institute 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 Institute of Statistics offers two options in its master's degree programs: (1) the Master of Science degree (thesis option) which requires the preparation of a thesis and, (2) the Master of Science (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 Institute of Statistics requires its Ph.D. candidates to have reading knowledge in one foreign language or to take an equivalent approved "enrichment" program of coursework outside of the department.

The following courses are offered on an irregular basis: 603, 604, 615, 617, 618, 621, 622, 625, 626, 629, 632, 634, 635, 636, 641. 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 210.

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 with emphasis on 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. (2-2). 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. Use of order statistics and other distribution-free statistics for estimation and testing hypotheses, exact non-parametric tests and measures of rank-correlation. Prerequisite: Stat. 601 or 652.

610. Theory of Statistics I. (3-0). Credit 3. Distributions of random variables and functions of random variables. Moment-generating functions and limit theorems. Prerequisite: Math. 307 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. 610 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. Probability measures and distribution functions, random variables, characteristic functions, asymptotic distributions. Prerequisites: Math. 606, 607 or approval of instructor.

615. Stochastic Processes and Time Series. (3-0). Credit 3. Stationary and nonstationary stochastic processes, autoregressive processes and correlogram analysis, harmonic-periodogram and spectral analysis. Markoff and diffusion 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 in multiphase sampling, analytic studies and multiframe problems. Prerequisites: Stat. 607, and 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. Statistical theory and methods for modern stochastic control systems including time series modeling, estimation, and forecasting. Forecasting and control using interrelationships among multiple time series. Prerequisite: Stat. 601 or approval of instructor.

628. Mathematical Programming I. (3-0). Credit 3. Simplex methods and variants. Parametric and sensitivity analysis. Network flow theory. Special algorithms. Prerequisites: Math. 304 or equivalent or approval of instructor.

629. Mathematical Programming II. (3-0). Credit 3. Mathematical theory and methodology of nonlinear programming including convexity, Kuhn-Tucker theory, general duality, optimum control, development of computational algorithms. Mixed integer programming. 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. 610 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.

641. Usage of Statistical Methodology I. (2-0). Credit 2. Study of uses and abuses of some advanced statistical methodologies emphasizing appropriate and inappropriate usage and interpretation with minimal exposition of theory and computational techniques. Topics include: discrimination and classification, analysis of covariance structure, regression. Not primarily intended for statistics majors. Prerequisite: Stat. 608.

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. Specific procedures covered include t-tests, analysis of variance, and linear regression. Prerequisite: Math. 102 or equivalent.

652. Statistics in Research II. (3-0). Credit 3. Continuation of Statistics 651. Specific procedures covered include 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.

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 Institute of Statistics by researchers in other disciplines. Prerequisite: Masters 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. Study of 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 Institute of Statistics.

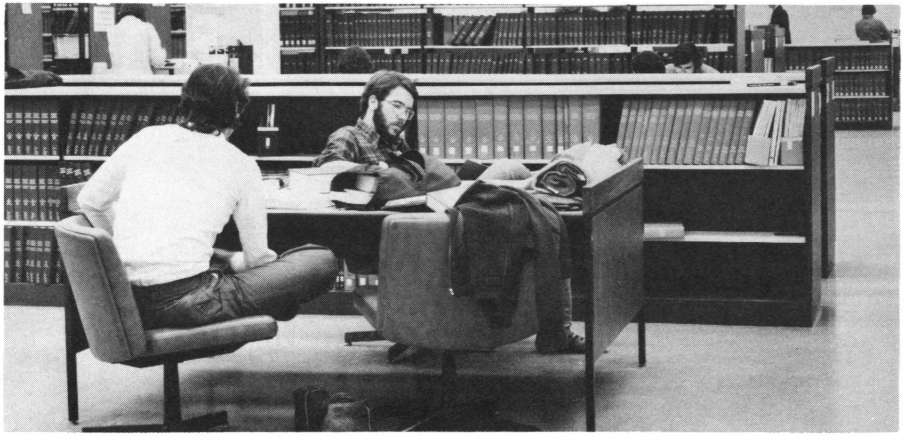
691. Research. Credit 1 or more. Research for thesis or dissertation. Prerequisite: Graduate classification.

See Econometrics for descriptions of related courses.

TEXAS A&M UNIVERSITY — BAYLOR COLLEGE OF MEDICINE

(TAMU)

699. Courses at Baylor College of Medicine. Credit 1 or more each semester. Designed to serve registration needs of graduate students who will engage in graduate work through interinstitutional cooperative agreements with Baylor College of Medicine. Specific arrangements for registration in this course must be made through the Office of 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 student's advisory committee, the Dean of the Graduate College of Texas A&M University, and the Dean of the Graduate School of Baylor College of Medicine.



DEPARTMENT OF URBAN AND REGIONAL PLANNING

R. S. Cornish, R. G. Echols, J. R. Gardner, J. H. Hinojosa, D. L. Pugh*, W. G. Roeseler* (Head), S. Rothmel, V. G. Stover, D. A. Sweeney

The objective of the graduate program in the Department of Urban and Regional Planning is to provide the profession of planning and the State of Texas with competent professionals in the fields of urban and regional planning. In the process of making available to the student the appropriate facilities, programs and qualified faculty the Department becomes a center for the advancement and dissemination of knowledge in the art and science of planning.

Candidates for the degree of Master of Urban Planning are accepted, and encouraged to apply, from a broad range of disciplines and undergraduate programs. The work and attitude of the professional planner is interdisciplinary in nature; a close, effective relationship thus exists between student and faculty in planning with supporting programs in the social sciences, humanities, the arts, engineering sciences and architecture.

*Graduate Advisor

(Plan.)

601. Introduction to Urban Planning. (3-9). Credit 6. General course addressing 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 will work in cooperation with metropolitan or municipal planning staffs, conduct general research; analysis and synthesis; develop particularized plans; and draft implementing tools. Each participant will be 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 will 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 will be 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; relationship between land use and transportation; conceptual layout of street systems. Trends in urban development; site development with emphasis on onsite circulation and relationship to the street system. Guidelines for the redevelopment of existing streets and adjacent lands are discussed. Cross-listed with C.E. 612.

613. Planning Methods and Techniques. (3-0). Credit 3. Existing and potential methods of research, data collection and analysis. Methods coordinating planning process with public policy and plan implementation are emphasized.

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 United States to Latin America; applicability of planning concepts and programs in developing countries to United States.

622. Development Planning in Latin America. (2-3). Credit 3. Research and projects in the "Third World". Interdependence of advanced and developing countries. Development planning and application of methods, techniques and programs as a continuation of Plan. 621.

630. Survey of Health Planning Process. (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, including 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 will work in cooperation with state or regional health and 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. Emphasis is on 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; discussion of major judicial decisions. Prerequisite: Approval of Department Head.

654. Planning Administration and Management. (1-0). Credit 1. Discussions by the faculty and others concerned with the activities of professional practice.

656. Housing and Community Facilities. (3-0). Credit 3. Discussions of housing, its development, planning, marketing, designing, financing and production. Student program 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 emphasized. Illustrative case studies will be used. Prerequisite: Approval of Department Head.

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.

659. Survey Research in Urban and Regional Planning. (2-3). Credit 3. Survey research methods, from the design of the research project to the presentation of findings. Students complete an actual project to illustrate theories. Topics include questionnaire and survey design, data processing and handling. Computer data analysis.

660. Models of Analysis in Urban and Regional Planning. (3-0). Credit 3. Review selected quantitative methods used in URPL. Matrix Methods (population models, economic models, transportation planning) Probabilistic Models (migration studies, demand for services) and Statistical Models (urban indicators, factorial studies). Theoretical presentations supplemented by practical problems.

665. Comprehensive Planning. (3-0). Credit 3. Comprehensive urban and regional planning process, and relationship to plan documents and to management decisions, including 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; *planned irregularity;* planning with the physical environment; parkways and freeways; Segoe, McHarg; planning stereotypes: *701;* present-day concepts and accomplishments.

667. Development Feasibility and Design. (3-4). Credit 5. Selected residential and non-residential development projects of varying size are analyzed by student teams with respect to the following: (a) economic feasibility and cash flow; (b) site analysis; and (c) design concept. Interdisciplinary faculty team. Prerequisite: Approval of Department Head. Cross-listed with Arch. 667 and Land. 667.

670. Urban Public Transportation Planning. (2-3). Credit 3. Lectures and laboratory introducing planning, operations, fiscal, management and legal aspects of urban/rural public transit systems. Preparation of community transit development program. 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.

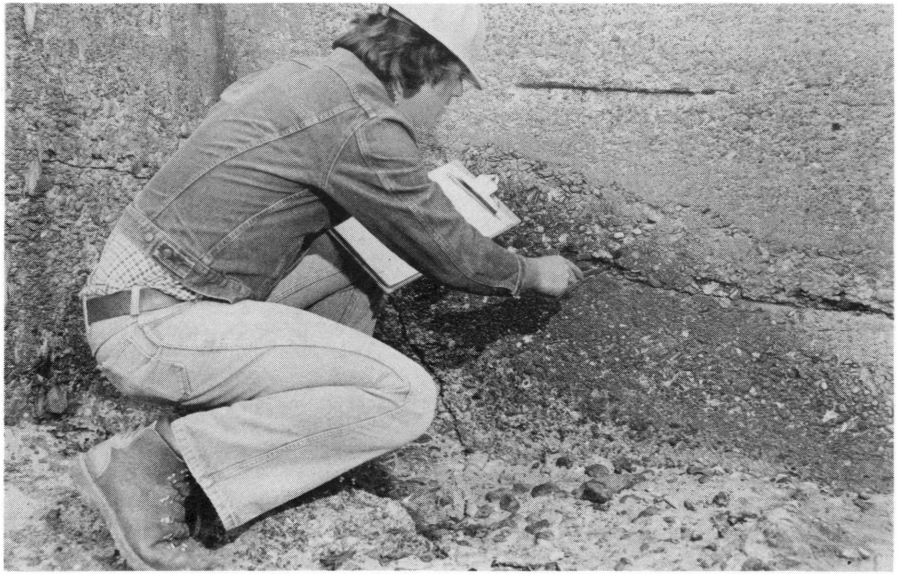
673. Comprehensive Transportation Planning and Urban Development. (3-4). Credit 5. Comprehensive plan for multiple urban transport modes are prepared for selected metropolitan area. Following data collection and problem identification plans and programs for 10-15-25 year goals are prepared. Interrelationship 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. Prerequisite: 12 hours graduate work.

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 & youth programs; juvenile delinquency & 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. Prerequisites: Plan. 665 and 659 or 660.

681. Seminar. (1-0). Credit 1. Presentation, review and discussion of current practice and innovative programs in urban planning.

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 8 hours of credit in any semester. For doctoral students working on options B and C of the D.E.D. on campus the limit will be the same as for Plan. 691-Research.



685. Problems. Credit 1 to 6 each semester. Individual and group problems dealing with application of planning theory and practice. Opportunities will be presented the student to select foreign and domestic planning programs of special interest. Prerequisite: Plan. 603, or approval of Department Head.

689. Special Topics in ---. Credit 1 to 4. Study of selected topics in an identified field of urban and regional planning. May be repeated for credit. Prerequisite: Approval of instructor.

691. Research. Credit 1 or more each semester. Research and dissertation. Prerequisite: Approval of Department Head.

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 the rationale, procedure, and results of the completed project. Prerequisite: Approval of committee chairman.

DEPARTMENT OF VETERINARY ANATOMY

B. V. Beaver, W. E. Haensly,* M. A. Herron, A. G. Kemler, N. H. McArthur, M. J. Shively, R. F. Sis (Head)*, G. G. Stott

(V.A.)

601. Anatomy. (2-6). Credit 4 each semester. Topographical dissection of one of the following domestic animals — horse, cow, sheep, pig, dog or cat. Prerequisite: V.A. 202 or 302 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. Study of gross, developmental, and microscopic anatomy of nervous systems of domestic animals. Prerequisite: Approval of instructor.

604. Neuroendocrine Anatomy. (2-6). Credit 4. Comparative morphology of the neuroendocrine system of laboratory and domestic animals: the light and electron microscopy of the hypothalamus, pituitary, thyroid, parathyroid, adrenal, testes, ovary and pineal glands. Prerequisite: Approval of instructor.

606. Anatomy of Laboratory Animals. (2-6). Credit 4. Gross and microscopic anatomy of laboratory animals. Prerequisite: V.A. 202 or 301 or 305 or equivalent.

609. Anatomy of Reproductive Systems. (2-6). Credit 4. Gross and microscopic anatomy of the reproductive systems of domestic animals. Prerequisite: V.A. 202 or V.A. 301 or V.A. 601 or V.A. 602 or equivalent.

610. Microscopic Histochemistry. (2-6). Credit 4. Theoretical and practical application of histochemistry in the microscopic study of animal cells, tissues, and organs. Prerequisite: Approval of instructor.

611. Histology. (2-6). Credit 4. Detailed study of microscopic anatomy of organ systems of domestic animals; especially pertaining to ultrastructure, histochemistry, growth and age changes observed in cells, tissues and organs. Prerequisite: V.A. 303 or 602 or Biol. 343 or equivalent.

681. Seminar. (1-0). Credit 1. Review and discussion of current scientific work in anatomy and related subjects. Prerequisite: Graduate major or minor in veterinary anatomy.

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. Study of selected topics in an identified area of Veterinary Anatomy. May be repeated for credit. Prerequisite: Approval of instructor.

690. Theory of Research. (3-0). Credit 3. Design of research in various subfields of Veterinary Anatomy and the evolution of research results with the aid of examples taken from the current scientific literature. Prerequisite: Graduate standing in V.A.

691. Research. Credit 1 or more each semester. Original research on selected thesis problem in anatomy. Prerequisite: Graduate major in veterinary anatomy.

*Graduate Advisor

DEPARTMENT OF VETERINARY LARGE ANIMAL MEDICINE

C. L. Boyd (Head), M. R. Calliham, D. V. Hanselka, J. R. Joyce, W. C. McMullan, J. C. Ramge, W. J. Roenigk, 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. Cross-listed with V.S.A.M. 603.

612. Diagnostic Radiology. Credit 2 or 3 each semester. Radiographic interpretation of domestic animals with special emphasis on film reading. Use of special techniques including contrast media and diagnostic aids discussed and demonstrated. Prerequisite: D.V.M. degree. Cross-listed with V.S.A.M. 612.

621. Reproductive Diseases of Female Domestic Animals. Credit 1 to 4. Advanced study of diagnosis, treatment, and control of diseases primarily affecting reproduction in female domestic animal. Prerequisite: D.V.M. degree. May be repeated for credit.

622. Andrology. Credit 1 to 4. Advanced study of diagnosis, treatment, and control of diseases primarily affecting reproduction in male domestic animal, including study of 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 utilized 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. Cross-listed with V.S.A.M. 630.

632. Veterinary Dermatology. (4-0). Credit 4. Pathogenesis, diagnosis and therapy of integumentary diseases of domestic animals with stress on diseases of infectious, nutritional, neoplastic, endocrinologic and immunologic influence. Prerequisite: D.V.M. degree or approval of the Department Head. Cross-listed with V.S.A.M. 632.

636. Veterinary Ophthalmology. (3-0). Credit 3. Large and small animal ophthalmic diseases with emphasis on diagnosis, instrumentation, therapy, surgical approaches and complications. Prerequisite: D.V.M. degree or approval of the Department Head. Cross-listed with V.S.A.M. 636.

669. Veterinary Clinical Cardiology. (2-0). Credit 2. Diagnosis and treatment of clinical cardiac disease in domestic animals with emphasis on 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 equivalent. Cross-listed with V.S.A.M. 669.

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. Prerequisite: D.V.M. degree and approval of instructor.

689. Special Topics In . . . . Credit 1 to 4. Study of 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

A. K. Eugster, R. R. Bell, T. J. Galvin, J. E. Grimes, L. C. Grumbles, C. F. Hall (Head)*, F. C. Heck*, K. L. Kuttler, D. H. Lewis, C. W. Livingston, Jr., S. McConnell, R. W. Moore, S. A. Naqi, N. C. Ronald*, G. C. Shelton, R. B. Simpson

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.

*Graduate Advisor

VETERINARY MICROBIOLOGY

(V.Mi.)

643. Pathogenic Bacteriology. (3-4). Credit 4. Study of 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. A general course with emphasis on the organisms in the orders Rickettsiales and Chlamydiales which are of importance in the medical sciences.

646. Avian Virus Diseases. (3-3). Credit 4. Study of viral diseases of poultry including 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. Detailed study of virus infections in animals, including types of infections, mode of transmission, intracellular pathology, epidemiology, isolation and identification of inciting agents. Practice includes tissue cultivation, animal inoculations, and diagnostic tests. Prerequisite: V.Mi. 438 or equivalent.

648. Medical Mycology. (3-3). Credit 4. Study of actinomycetes, yeasts, and molds that are pathogenic to man 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. (3-3). Credit 4. Comprehensive study of the humoral and cell mediated arms of immunologic responses including relative relationships and immunochemical applications. Antigen-antibody reactions pertinent to diagnostic serology and in vitro cell mediated methods are considered.

650. Experimental Microbiology. (3-3). Credit 4. Familiarization, development and integration of techniques into experimental design of microbiologic investigation. Included are virus and protein purification, immunofluorescence, agar diffusion, immunoelectrophoresis, germ free animal techniques, microflora analysis 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 emphasized. Prerequisites: V.Mi. 647 or the equivalent and approval of instructor.

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: 12 hours of biological science, including at least 3 hours of histology or microtechniques and approval of instructor.

661. Diseases of Fish. (3-4). Credit 4. The etiology, epidemiology, pathology, symptoms, diagnosis, treatment and prevention of infectious diseases of propagated and wild fish. Prerequisite: Approval of instructor.

662. Viral Oncogenesis and Tumor Immunology. (3-0). Credit 3. Viral etiology and related immunologic considerations of natural occurring and inducible cancer in animals. Morphology, classification and transmission of oncogenic viruses and candidate viruses. Cell mediated and humoral immunologic responses to virus induced cancer. Prerequisites: V.Mi. 438, 649 or equivalent and approval of instructor.

681. Seminar. (1-0). Credit 1. Review of 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. Study of 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. Credit 1 to 4 each semester. Detailed study of more important helminth parasites of domestic and laboratory animals, including 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 man. 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, W. W. Bay, C. H. Bridges,* J. P. McGrath, K. R. Pierce (Head)*, W. K. Read, R. W. Storts

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.

*Graduate Advisor

(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. (2-4). Credit 4. Study of 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. Study of 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: Bi.Ch. 604 and V.A. 303 or Biol. 343.

643. Applied Pathology. Credit 1 or more. Student studies gross pathological changes at necropsies performed daily. Follows selected tissues through suitable histopathological techniques and corrects gross diagnosis in light of microscopic findings. Confirmatory bacteriologic methods utilized 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. Particular emphasis on interpretation of gross and microscopic lesions of the nervous system associated with disease processes. Prerequisite: D.V.M. degree or equivalent.

653. Diseases of Laboratory Animals. (2-2). Credit 3. Study of pathology and pathogenesis of spontaneous infectious, parasitic, metabolic, and neoplastic diseases of laboratory animals. Prerequisites: V.Mi. 438; V.Par. 484; V.Pat. 444; V.P.P. 427; or equivalents.

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. Advanced special problems concerned with pathogenesis and pathology of disease. Prerequisites: V.Pat. 444 or equivalent; approval of Department Head.

689. Special Topics in ---. Credit 1 to 4. Study of selected topics in an identified area of veterinary pathology. May be repeated for credit.

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.

*Graduate Advisor

DEPARTMENT OF VETERINARY PHYSIOLOGY AND PHARMACOLOGY

M. S. Amoss, Jr., J. G. Anderson, E. M. Bailey, B. J. Camp, L. D. Claborn, D. R. Clark, N. P. Clarke, R. H. Davis,* D. R. Gross, D. Hightower, H. L. Kim, D. C. Kraemer, J. D. McCrady (Head),* A. A. Price, S. W. J. Seager, D. O. Wiersig

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 physiol-

*Graduate Advisor

ogy, 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 his previous training. Prerequisite: Basic courses in morphology, organic chemistry and physiology.

603. Endocrinology. (3-3). Credit 4. Study of 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.

605. Toxicology I. (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: Bi.Ch. 411 and V.P.P. 601 or equivalent.

606. Toxicology II. (3-3). Credit 4. Effects of organic intoxicants including herbicides, insecticides, rodenticides and fungicides on mammalian species. Additional topics concern effects of plants and other biotoxins on animal species. Prerequisite: V.P.P. 605 or 607.

607. Pharmacology. (3-3). Credit 4. Modern methods of research in pharmacology and pharmaceutical processes. Original research in studying actions and uses of drugs. Prerequisites: V.P.P. 601 and approval of instructor.

613. Cardiovascular Physiology. (3-3). Credit 4. Detailed study of 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. (2-0). Credit 2. Detailed study of kidney and body fluids. Prerequisite: V.P.P. 601 or equivalent.

616. Neurophysiology. (3-0). Credit 3. Detailed study of physiology of nervous system. Prerequisite: V.P.P. 602 or equivalent.

617. Respiratory Physiology. (2-3). Credit 3. An indepth consideration of gas exchange, regulation of respiration, response to various gases, reflexes associated with respiration and the mechanical factors of breathing in health and disease. In addition the pulmonary circulation and non-respiratory functions of the lungs. Prerequisites: Veterinary Physiology and Pharmacology 601 and 602 or equivalent.

618. Physiologic and Biochemical Disorders of Endocrine Function. (3-0). Credit 3. Endocrine influences on organ and tissue function, including modification of specific cellular mechanisms. Physiologic changes and clinical signs arising from dysfunction of each endocrine gland. Specific emphasis on metabolic and biochemical alterations. Prerequisites: VPP 329, VPP 603, Biol. 649, or approval of instructor.

619. Molecular Endocrinology. (3-0). Credit 3. Structure-function relationships of hormones, their receptors and biologic activities. Prerequisites: VPP 603 or Biol. 649, Bi.Ch. 410 or equivalent and approval of instructor.

624. Surgery for Physiologists. (2-6). Credit 4. The physiological applications of experimental mammalian surgery. Emphasizes a number of surgical procedures used in the preparation of classical experiments in physiology. Prerequisites: Approval of instructor.

625. Physiological Measurements. (3-3). Credit 4. Study of 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.

626. Bionucleonics II. (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.

631. Instrumentation in Toxicological Analysis. (2-6). Credit 4. Introduction to analytical methods in toxicology with particular reference to procedures using modern laboratory instruments. Prerequisites: Chem. 316, 319; V.P.P. 601 or equivalent.

632. Metabolic and Detoxication Mechanisms. (3-0). Credit 3. Study of fate of foreign compounds with particular reference to their inhibitory and antagonistic action toward normal metabolic processes of the animal body. Prerequisites: Bi.Ch. 603; approval of instructor and Department Head.

634. Industrial and Environmental Toxicology. (3-0). Credit 3. Study of hazards encountered from poisons contaminating environment. Prerequisite: Approval of instructor and Department Head.

645. Physiological Instrumentation. (2-3). Credit 3. Evaluation, selection, and operation of modern physiological instruments in mammalian research. Emphasis on physiologic principles associated with data collected. Prerequisite: V.P.P. 602, 625 or 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. Study of selected topics in an identified area of veterinary physiology and pharmacology. May be repeated for credit. Prerequisite: Approval of instructor.

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*, A. I. Flowers (Head)*, N. D. Heidelbaugh*, G. N. Joiner, W. F. McCulloch, L. H. Russell, Jr.*, J. D. Williams*

Veterinary Public Health is that part of public health which utilizes 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	(Ph.D.)

The Department's principal teaching and research activities involve the study of: 1) epidemiology of diseases transmitted between animals and man; 2) methods to protect and improve human health through development of new knowledge, particularly through comparative medical research; 3) means to develop and implement technological and/or regulatory practices designed to protect and/or improve aspects of human food which affect the public health; 4) public health programs involving control of stray animals; 5) programs to protect and improve the health of people by professional administration in human health and environmental agencies.

Veterinary Public Health is a broad discipline. Faculty specialty areas include epidemiology, food hygiene, food science and technology, zoonotic diseases, preventive and regulatory medicine, laboratory animal medicine, and biostatistics. The research program is broad, encompassing all the areas listed above.

*Graduate Advisor

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 program in epidemiology, laboratory animal medicine and food science and technology are interdepartmental in nature. A minimum of 32 semester hours and a thesis are required for the M.S. degree. 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. Foreign language requirements for candidates for the Doctor of Philosophy degree will be determined by the individual student's Advisory Committee.

(V.P.H.)

601. Food Hygiene. (3-4). Credit 4. Study of causes of spoilage, detection of adulterants and regulations governing the inspection of foods of animal origin. Prerequisites: Approval of instructor and Department Head.

607. Applied Epidemiology. (3-3). Credit 4. Application of epidemiologic concepts to the study of disease occurrence. Emphasis on descriptive and analytical epidemiologic methods in the investigation of diseases of contemporary interest. Prerequisites: Approval of instructor and Department Head.

618. Food Toxicology. (3-0). Credit 3. Study of the potential toxicity and other public health implications of various foods and food components, particularly food additives, chemical and microbial contaminants, and naturally occurring toxic factors associated with foods. Prerequisites: Approval of instructor and Department Head.

632. Public Health Concepts. (3-0). Credit 3. The 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. Prerequisites: Approval of instructor and Department Head.

633. Animal Diseases in Comparative Medicine. (3-0). Credit 3. Consideration of selected diseases transmitted between animals and man with primary emphasis upon transmission, prevention, control, and use of animal models of human diseases. Prerequisites: Approval of instructor and Head of Department.

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: Approval of Department Head.

685. Problems. Credit 1 to 4 each semester. Problems course in veterinary public health. Prerequisite: Approval of Department Head.

689. Special Topics in ---. Credit 1 to 4. Study of 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

M. R. Calliham, D. K. Chester, E. W. Ellett, G. M. Gowing, M. R. Herron, L. I. Hurov, K. W. Knauer, R. F. Playter (Head)*, W. J. Roenigk, W. L. Sippel

(V.S.A.M.)

603. Surgery. Credit 1 to 8 each semester. Special surgery of domestic animals. Prerequisite: D.V.M. degree. Cross-listed with V.L.A.M. 603.

612. Diagnostic Radiology. Credit 2 or 3 each semester. Radiographic interpretation of domestic animals with special emphasis on film reading. Use of special techniques including contrast media and diagnostic aids discussed and demonstrated. Prerequisite: D.V.M. degree. Cross-listed with V.L.A.M. 612.

630. Veterinary Diagnostics. Credit 1 to 3. Advanced training in arts and science of diagnosis. Clinical and theoretical diagnostic models utilized 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. Cross-listed with V.L.A.M. 630.

632. Veterinary Dermatology. (4-0). Credit 4. Pathogenesis, diagnosis and therapy of integumentary diseases of domestic animals with stress on diseases of infectious, nutritional, neoplastic, endocrinologic and immunologic influence. Prerequisite: D.V.M. degree or approval of the Department Head. Cross-listed with V.L.A.M. 632.

636. Veterinary Ophthalmology. (3-0). Credit 3. Large and small animal ophthalmic diseases with emphasis on diagnosis, instrumentation, therapy, surgical approaches and complications. Prerequisite: D.V.M. degree or approval of the Department Head. Cross-listed with V.L.A.M. 636.

669. Veterinary Clinical Cardiology. (2-0). Credit 2. Diagnosis and treatment of clinical cardiac disease in domestic animals with emphasis on 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 equivalent. Cross-listed with V.L.A.M. 669.

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. Study of 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

D. V. Aldrich, K. A. Arnold*, S. L. Beasom, J. W. Bickham, L. H. Blakenship, R. W. Brick, M. E. Chittenden Jr., W. J. Clark*, W. B. Davis, J. R. Dixon*, W. E. Grant, F. S. Hendricks, J. M. Inglis*, W. H. Kiel, Jr., J. D. McEachran, W. H. Neill*, R. L. Noble*, R. E. Quinn, S. M. Ray, D. J. Schmidly, N. J. Silvy, R. D. Slack, R. R. Stickney, R. K. Strawn*, W. G. Swank*, J. G. Teer (Head)*, L. W. Varner, F. R. Walther*, W. B. Wilson

*Graduate Advisor

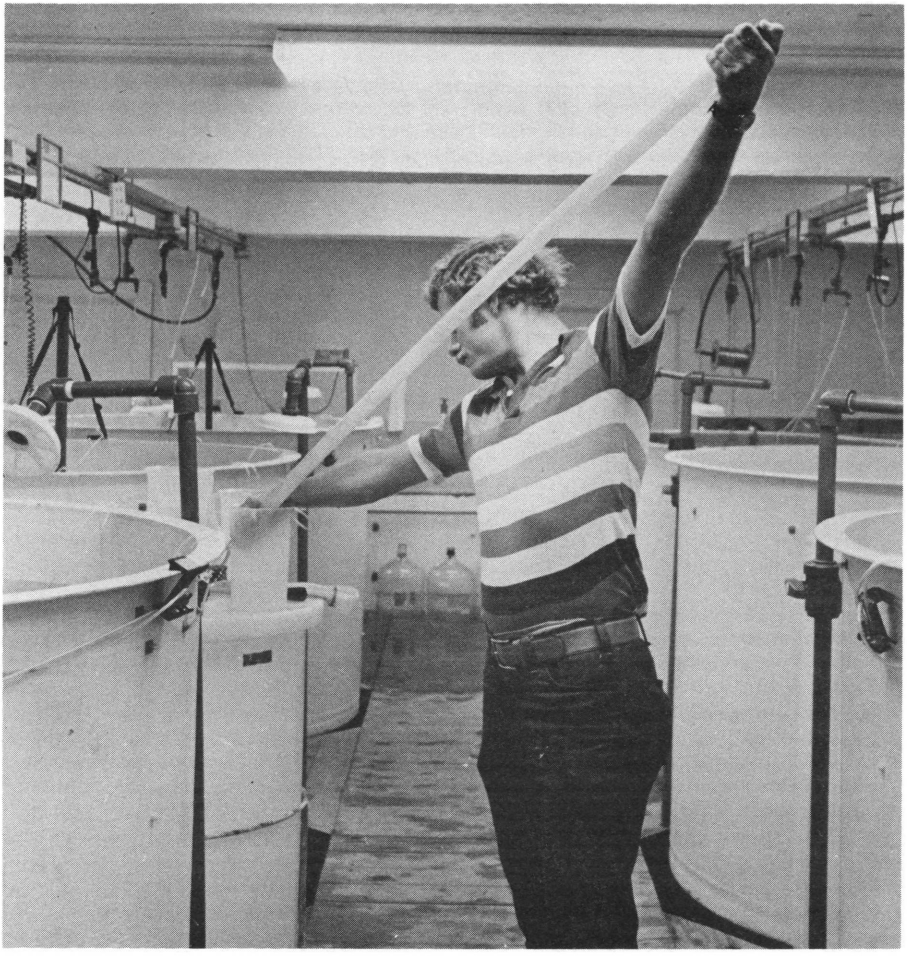
Graduate programs leading to Master of Agriculture, Master of Science, and Doctor of Philosophy degrees are designed to prepare a graduate for college or university teaching, research, fisheries and wildlife management, vertebrate biology and systematics and conservation of renewable resources.

Lines in which this department is especially qualified to direct graduate research are: (1) ecology, systematics and behavior of vertebrates; (2) wildlife and fisheries management; (3) aquaculture; and (4) limnology. Facilities are available at the Texas A&M Moody College, 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 100,000 fish, 50,000 amphibians and reptiles, 10,000 birds, 30,000 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 in Texas and in many countries of the world. Freshwater and marine environments for fisheries teaching and research programs are available near the campus and at the University's Moody College in 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.

*Graduate Advisor



(W.F.S.)

600. Field and Laboratory Methods. (1-6). Credit 3. Designed to give experience in field studies, organizing field notes, collecting and preserving vertebrate animals for teaching and museum purposes. Emphasis on 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, including historical development of discipline, mechanisms of speciation, the origin of higher categories, and a consideration of major taxonomic philosophies (numerical taxonomy, phylogenetic systematics, and evolutionary systematics). Emphasis given to theory involved in the study of vertebrates.

603. Vertebrate Ecology. (2-3). Credit 3. Ecology of the individual, population, and ecosystem, with consideration given to the epistemology of major ecological concepts. Emphasis given to theory evolved in the study of vertebrates.

605. Systematic Ichthyology. (2-3). Credit 3. Functional morphology, phylogeny, ecology and zoogeography of fishes of the world. Emphasis is placed on relating adaptive morphology and ecology to phylogeny of fishes.

606. Systematic Herpetology. (2-3). Credit 3. Study of distribution, evolution, speciation, and new systematics of amphibians and reptiles, including extensive field studies of local problem groups and philosophy and role of herpetology as a science. Prerequisite: W.F.S. 315.

607. Systematic Ornithology. (2-3). Credit 3.A study of the living birds of the world, including diversity, radiation, adaptation, distribution and past history. Considers contrasts both between the taxa and between the continental avifaunas. Field trips. Prerequisites: W.F.S. 402 or equivalent experience in ornithology.

609. Wildlife Research Methods. (3-0). Credit 3. Study of research methods applied to wildlife management and related subjects. Review of the scientific method with emphasis on research proposals and data analysis. Prerequisite: W.F.S. 408 or approval of instructor.

610. Systematic Mammalogy. (2-3). Credit 3. Study of distribution, speciation, and systematics of recent mammals of world, with special emphasis on research methods and techniques used in systematic investigations of mammals. Prerequisite: Approval of instructor.

611. Estuarine Ecology. (3-3). Credit 4. Principles governing the relationships of estuarine organisms to their environment. Special attention devoted to such areas as productivity, adaptations to environment, community structure, and factors affecting the distribution and abundance of biota. Prerequisites: Invertebrate zoology and ichthyology or approval of instructor.

613. Shore and Estuarine Fishes. (0-9). Credit 3. Field survey of fishes found in shallow-water habitats along the Gulf of Mexico. Extensive collecting trips made; ecological data taken; and collected specimens identified, counted and evaluated in laboratory. Prerequisite: W.F.S. 312 or approval of instructor.

614. Biological Limnology. (2-3). Credit 3. Qualitative and quantitative methods of evaluating the productivity of inland waters and of sampling the biological populations involved. Natural and man caused influences on eutrophication are considered as are problems in obtaining reliable quantitative measurements of aquatic populations.

615. Mariculture. (3-3). Credit 4. Environmental, physiological, behavioral, legal, and economic factors which determine the success of efforts to cultivate saltwater species having economic importance. Practices employed in various parts of the world to produce fishes, molluscs, and crustaceans considered. Prerequisites: Ichthyology and invertebrate zoology or approval of instructor.

616. Physiological Ecology of Vertebrates. (3-4). Credit 4. Effects and limitations of temperature, photoperiod and other environmental factors on the distribution and abundance of animals. Comparative behavioral and physiological adjustments to environment as an evolutionary response. Students will be expected to develop and execute a laboratory investigation in an appropriate subject area. Emphasis on terrestrial vertebrates in 616T; emphasis on aquatic vertebrates, particularly fishes, in 616A.

620. 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.

681. Seminar. (1-0). Credit 1 each semester. Important current developments in wildlife field with special reference to literature.

684. Professional Internship. Credit 1 to 4 each semester. This course will give students opportunity for on-the-job training in fields of wildlife and fisheries sciences. The program will emphasize two main areas: commercial production of fresh-water and marine organisms for food, and environmental education. Prerequisite: Graduate classification in the Department of Wildlife and Fisheries Sciences.

685. Problems. Credit 2 to 6 each semester. Credit adjusted in accordance with requirements of each individual case.

689. Special Topics in ---. Credit 1 to 4. Special topics in wildlife ecology, fisheries ecology, vertebrate systematics and conservation education. May be repeated for credit.

691. Research. Credit 1 or more each semester. Original research on selected wildlife problem to be used in thesis or dissertation.

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