

**Bulletin of TEXAS A&M UNIVERSITY**  
*The Graduate College... 1965-66*

**June 1, 1965**



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OF  
TEXAS A&M UNIVERSITY

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June 1, 1965

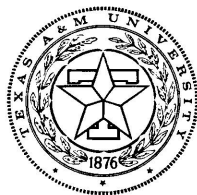
No. 3

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GRADUATE COLLEGE  
CATALOGUE

ANNOUNCEMENTS FOR THE SESSION

1965-66



COLLEGE STATION, TEXAS

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# THE ACADEMIC CALENDAR FOR 1965-66

## SUMMER SESSION, 1965

June 7	Monday. Registration for the first term, 7 a.m. to 12 noon.
June 8	Tuesday. Beginning of classes, 7 a.m.
June 10	Thursday. Last day for enrolling in the University for the first term and for making changes in registration.
July 5	Monday. A holiday.
July 15	Thursday. Beginning of first term final examinations, 7 p.m.
July 16	Friday. Last day of first term final examinations.
July 19	Monday. Registration for second term, 7 a.m. to 12 noon.
July 20	Tuesday. Beginning of classes, 7 a.m.
July 22	Thursday. Last day for enrolling in the University for the second term and for making changes in registration.
August 26	Thursday. Beginning of second term final examinations, 7 p.m.
August 27	Friday. Last day of second term final examinations.

## REGULAR SESSION, 1965-66

September 15	Wednesday. New freshmen who participated in the summer conferences report to campus.
September 15-16	Wednesday and Thursday. New Student Program and registration.
September 16	Thursday. Registration of all other students, 1 p.m. to 5 p.m.
September 17	Friday. Continuation of registration of all other students, 8 a.m. to 5 p.m.
September 18-19	Saturday and Sunday. Organization of Cadet Corps.
September 20	Monday. Beginning of Fall Semester classes, 8 a.m.
September 25	Saturday. Last day for enrolling in the University for the Fall Semester or for adding new courses.
September 29	Wednesday. Last day in the Fall Semester for dropping courses with no grade.
November 15	Monday. Mid-semester grade reports.
November 25-29	Thursday-Sunday, inclusive. Thanksgiving holidays.
December 18	Saturday, noon. Beginning of Christmas recess.
January 3, 1966	Monday. End of Christmas recess.
January 22	Saturday. Commencement.
January 24-29	Monday-Saturday, inclusive. Semester examinations.
February 2	Wednesday. New freshmen report to campus for Spring Semester.
February 4	Friday. Registration for Spring Semester, 1 p.m. to 5 p.m.
February 5	Saturday. Continuation of registration for Spring Semester, 8 a.m. to 5 p.m.
February 7	Monday. Beginning of Spring Semester classes, 8 a.m.
February 12	Saturday. Last day for enrolling in the University for the Spring Semester or for adding new courses.
February 16	Wednesday. Last day in Spring Semester for dropping courses with no grade.
April 4	Monday. Mid-semester grade reports.
April 6	Wednesday. Beginning of Spring recess, 5 p.m.
April 12	Tuesday. End of Spring recess, 8 a.m.
May 28	Saturday. Commencement and Final Review.
May 30-June 4	Monday-Saturday, inclusive. Semester examinations.

## SUMMER SESSION, 1966

June 6	Monday. Registration for the first term, 7 a.m. to 12 noon.
June 7	Tuesday. Beginning of classes, 7 a.m.
June 9	Thursday. Last day for enrolling in the University for the first term and for making changes in registration.
July 4	Monday. A holiday.
July 14	Thursday. Beginning of first term final examinations, 7 p.m.
July 15	Friday. Last day of first term final examinations.
July 18	Monday. Registration for the second term, 7 a.m. to 12 noon.
July 19	Tuesday. Beginning of classes, 7 a.m.
July 21	Thursday. Last day for enrolling in the University for the second term and for making changes in registration.
August 25	Thursday. Beginning of second term final examinations, 7 p.m.
August 26	Friday. Last day of second term final examinations.

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(Correct as of February 1, 1965)

(Figures in parentheses indicate date of first appointment on the University Staff and date of appointment to present position respectively. The symbol "†" indicates full membership on the Graduate Faculty; the symbol "‡" indicates associate membership on the Graduate Faculty.)

- †Abbott, John Paul, Distinguished Professor of English. (1926, 1956) B.A., Vanderbilt, 1925; Ph.D., Iowa, 1939.
- ‡Adkins, William G., Research Economist, Texas Transportation Institute. (1964) B.S., Texas A&M, 1951; M.S., 1953; Ph.D., 1963.
- †Adkisson, Perry Lee, Professor of Entomology. (1958, 1963) B.S., Arkansas, 1950; M.S., 1954; Ph.D., Kansas State College, 1956.
- ‡Alexander, Robert Benjamin, Associate Professor of Chemistry. (1952, 1959) B.A., Baylor, 1945; M.A., 1946; Ph.D., Texas A&M, 1957.
- †Alter, Alan Brian, Assistant Professor of Mechanical Engineering. (1949, 1952) B.S., Pittsburg, 1948; M.S., Texas A&M, 1953; Reg. Prof. Engr.
- ‡Amin, Jagdish Vaghjibhai, Assistant Professor of Plant Sciences. (1963) B.S., Bombay, 1947; M.S., 1950; M.S., Michigan State College, 1953; Ph.D., Texas A&M, 1957.
- †Anderson, John Quincy, Professor of English and Head of Department. (1953, 1962) A.B., Oklahoma Agricultural and Mechanical College, 1939; M.A., Louisiana State, 1948; Ph.D., North Carolina, 1952.
- ‡Anderson, Warren Boyd, Assistant Professor of Soil and Crop Sciences. (1964) B.S., Brigham Young, 1958; M.S., Colorado State, 1962; Ph.D., 1964.
- †Angino, Ernest Edward, Assistant Professor of Oceanography. (1962) B.S., Lehigh, 1954; M.S., Kansas, 1958; Ph.D., 1961.
- †Applegate, Howard George, Associate Professor of Plant Physiology and Pathology. (1963) B.S., Colorado State, 1950; M.S., 1952; Ph.D., Michigan State, 1956.
- ‡Ashcraft, Allan Coleman, Assistant Professor of History. (1956, 1960) B.A., Texas A&M, 1950; M.A., Columbia, 1951; Ph.D., 1960.
- †Ashworth, Lee J., Jr., Assistant Professor of Plant Physiology and Pathology. (1958) B.S., California, 1951; M.S., 1954; Ph.D., 1958.
- †Atkins, Irvin Milburn, Agronomist (Agricultural Research Service, USDA, cooperating) (1939, 1954) B.S., Kansas State College, 1928; M.S., 1936; Ph.D., Minnesota, 1945.
- †Atkinson, Robert Leon, Assistant Professor of Poultry Science. (1955) B.S., Texas A&M, 1949; M.S., 1950; Ph.D., California, 1958.
- †Baldauf, Richard John, Professor of Wildlife Science. (1952, 1964) B.S., Albright College, 1949; M.S., Texas A&M, 1951; Ph.D., 1956.
- ‡Ballinger, Richard Henry, Professor of English. (1954, 1957) B.A., Texas, 1936; M.A., 1936; Ph.D., Harvard, 1953.
- †Banks, William Carl, Professor of Veterinary Medicine and Surgery. (1941, 1955) D.V.M., Texas A&M, 1941; M.S., 1952.
- †Barker, Donald Gene, Associate Professor of Education and Psychology. (1959, 1963) B.A., Baylor, 1952; M.A., 1954; Ph.D., Texas, 1961.
- ‡Barker, Palmer Winfield, Associate Professor of Physics. (1946, 1949) B.S., Missouri, 1932; M.A., 1933.
- ‡Barnard, Herbert Marvin, Associate Professor of Electrical Engineering. (1958, 1964) B.S., Texas A&M, 1955; M.S., 1960; Ph.D., Illinois, 1964.



- ‡Barzak, Robert William, Assistant Dean of Graduate Studies and Associate Professor of English. (1955, 1962) B.A., Texas A&M, 1949; M.A., Illinois, 1951; Ph.D., 1959.
- ‡Bashaw, Elexis C., Geneticist of Agricultural Research Service, USDA. (1951, 1955) B.S., Purdue, 1947; M.S., 1948; Ph.D., Texas A&M, 1954.
- ‡Basye, Robert Eugene, Professor of Mathematics. (1940, 1952) B.A., Missouri, 1929; M.A., Princeton, 1931; Ph.D., Texas, 1933.
- ‡Baty, James Bernard, Professor of Civil Engineering. (1948, 1950) B.S., Texas A&M, 1925; M.C.E., Cornell, 1950; Reg. Prof. Engr.
- ‡Bearden, Harold D., Director of Texas Engineering Extension Service. (1947, 1957) B.S., Texas Technological College, 1931; M.A., Texas, 1936.
- ‡Beasley, Joseph Noble, Professor of Veterinary Pathology. (1959, 1964) D.V.M., Texas A&M, 1949; M.S., 1956; Ph.D., Oklahoma, 1964.
- ‡Bell, Rurel Roger, Associate Professor of Veterinary Parasitology. (1952, 1958) D.V.M., Georgia, 1952; M.S., Texas A&M, 1955.
- ‡Bennett, Alvin Lowell, Associate Professor of English. (1954, 1957) B.A., Texas, 1927; M.A., Washington, 1931; Ph.D., Texas, 1952.
- ‡Benson, Fred Jacob, Dean of Engineering, Administrator of Texas Engineering Experiment Station, and Professor of Civil Engineering. (1937, 1962) B.S., Kansas State College, 1935; M.S., Texas A&M, 1936; Reg. Prof. Engr.
- ‡Benton, Wilbourn Eugene, Professor of Government. (1957, 1962) B.A., Texas Technological College, 1939; M.A., 1941; Ph.D., Texas, 1948.
- ‡Bird, Luther Smith, Associate Professor of Plant Physiology and Pathology. (1950, 1959) B.S., Clemson College, 1948; M.S., Texas A&M, 1950; Ph.D., 1955.
- ‡Bishop, Vernon Spilman, Assistant Professor of Nuclear Engineering. (1964) B.S., Mississippi College, 1958; M.S., Kansas, 1960; Ph.D., Mississippi Medical Center, 1964.
- ‡Blackhurst, Homer T., Professor of Horticulture. (1947, 1950) A.B., Glenville State Teachers College, 1935; M.S., Texas A&M, 1940; Ph.D., 1947.
- ‡Blank, Horace R., Professor of Geology. (1949, 1953) B.S., Pennsylvania, 1919; Ph.D., 1924.
- ‡Bloodworth, Morris Elkins, Professor of Soil Physics and Head of Department of Soil and Crop Sciences. (1956, 1963) B.S., Texas A&M, 1941; M.S., 1953; Ph.D., 1958.
- ‡Bonsma, Jan C., Professor of Animal Science. (1964) B.S., Pretoria, 1931; M.S., 1935.
- ‡Boone, James Leroy, Jr., Assistant Professor of Industrial Education. (1952, 1955) B.S., Texas A&M, 1947; M.Ed., 1948.
- ‡Botner, Stanley Benton, Assistant Professor of Government. (1963) A.B., Missouri, 1947; M.A., 1960; Ph.D., 1963.
- ‡Branson, Robert Earl, Professor of Agricultural Economics and Sociology. (1955, 1958) B.S., Southern Methodist, 1941; M.P.A., Harvard, 1948; M.A., 1949; Ph.D., 1954.
- ‡Breuer, Leslie H., Assistant Professor of Animal Science. (1964) B.S., Missouri, 1960; M.S., 1962; Ph.D., Cornell, 1964.
- ‡Brewer, Burns W., Professor of Mathematics. (1938, 1957) A.B., Missouri, 1935; A.M., 1936; Ph.D., 1938.
- ‡Bridges, Charles Hubert, Professor of Veterinary Pathology and Head of Department. (1955, 1960) D.V.M., Texas A&M, 1945; M.S., 1954; Ph.D., 1957.
- ‡Brigham, Raymond D., Agronomist. (1957) B.S., Texas Technological College, 1950; M.S., Iowa State, 1952; Ph.D., 1957.

- †Brown, Murray Allison, Associate Professor of Dairy Science. (1955, 1962) B.S., Michigan State College, 1950; M.S., Texas A&M, 1953; Ph.D., 1956.
- †Brown, Meta Suche, Professor of Agronomy. (1940, 1955) B.A., Texas, 1931; M.A., 1933; Ph.D., 1935.
- †Brown, Sidney Overton, Professor of Biology. (1936, 1949) B.A., Texas, 1932; Ph.D., 1936.
- ‡Brundidge, Kenneth Cloud, Associate Professor of Meteorology. (1955, 1962) B.A., Chicago, 1952; M.S., 1953; Ph.D., Texas A&M, 1961.
- †Buchanan, Spencer Jennings, Professor of Civil Engineering. (1946) B.S., Texas A&M, 1926; M.S., Massachusetts Institute of Technology, 1931; C.E., Texas A&M, 1948; Reg. Prof. Engr.
- ‡Bull, Don Lee, Entomologist, Entomology Research Division, ARS, USDA. (1963) B.S., Texas A&M, 1953; M.S., 1960; Ph.D., 1962.
- †Burgess, Archie Rostron, Professor of Industrial Engineering and Head of Department. (1948, 1951) B.S., Washington, 1932; M.S., 1938; Reg. Prof. Engr.
- ‡Burgess, Leonard Randolph, Associate Professor of Business Administration. (1964) B.A., Brown, 1942; M.B.A., Harvard, 1947; Ph.D., Columbia, 1961.
- †Burke, Horace Reagan, Assistant Professor of Entomology. (1958) B.S., Sam Houston State Teachers College, 1953; M.S., Texas A&M, 1955; Ph.D., 1959.
- ‡Burnett, Earl, Research Soil Scientist, Department of Soil and Crop Sciences. (1964) B.S., Texas Technological College, 1948; M.S., 1949; Ph.D., Ohio State, 1952.
- †Burns, Edward Eugene, Associate Professor of Horticulture. (1956, 1959) B.S., Purdue, 1950; M.S., 1952; Ph.D. 1956.
- †Burns, Patton Wright, Professor of Veterinary Physiology and Pharmacology and Head of Department. (1926, 1935) B.S., Texas A&M, 1923; D.V.M., 1926.
- †Butler, Ogbourne Duke, Jr., Professor of Animal Science and Head of Department. (1947, 1956) B.S., Texas A&M, 1939; M.S., 1947; Ph.D., Michigan State College, 1953.
- ‡Caddess, James Harvey, Associate Professor of Mechanical Engineering. (1940, 1953) B.S., Texas A&M, 1932; M.S., 1934; Reg. Prof. Engr.
- †Calaway, Paul Kenneth, Professor of Chemistry. (1957) B.A., Arkansas College, 1931; M.S., Georgia Institute of Technology, 1933; Ph.D., Texas, 1938.
- †Calhoun, John C., Jr., Vice Chancellor for Programs and Professor of Petroleum Engineering. (1955, 1963) B.S., Pennsylvania State College, 1937; M.S., 1941; Ph.D., 1946; Reg. Prof. Engr.
- †Calliham, Melvin Ray, Professor of Veterinary Medicine and Surgery and Head of Department. (1958) B.S., Texas A&M, 1941; D.V.M., 1949.
- †Camp, Bennie Joe, Associate Professor of Biochemistry and Nutrition. (1956, 1960) B.S., East Texas State Teachers College, 1949; M.S., Texas A&M, 1953; Ph.D., 1956.
- †Carpenter, Zerle Leon, Assistant Professor of Animal Science. (1962) B.S., Oklahoma State, 1957; M.S., Wisconsin, 1960; Ph.D., 1962.
- ‡Carter, Dilford Campbell, Assistant Professor of Wildlife Science. (1961, 1964) B.S., Southern Methodist, 1956; M.S., 1956; Ph.D., Texas A&M, 1962.
- †Cartwright, Thomas Campbell, Professor of Animal Science. (1958) B.S., Clemson Agricultural College, 1948; M.S., Texas A&M, 1949; Ph.D., 1954.
- †Chalk, Alfred Franklin, Professor of Economics and Head of Department. (1936, 1956) B.A., Baylor, 1934; M.S., Texas A&M, 1936; Ph.D., Texas, 1950.
- †Clark, Robert Alfred, Assistant Professor of Meteorology. (1960, 1961) B.S., Kansas State, 1948; M.S., Texas A&M, 1959; Ph.D., 1964.
- †Clark, William Jesse, Assistant Professor of Biology. (1957) B.S., Utah State Agricultural College, 1950; M.S., 1956; Ph.D., 1958.

- †Clayton, William Howard, Associate Professor of Oceanography. (1954, 1961) B.S., Bucknell, 1949; Ph.D., Texas A&M, 1956.
- ‡Cleland, Samuel Miles, Professor of Engineering Graphics. (1941, 1958) B.A., West Texas State Teachers College, 1931; M.Ed., Texas A&M, 1940.
- †Cochran, Robert Glenn, Professor of Nuclear Engineering and Head of Department. (1959) A.B., Indiana, 1948; M.S., 1950; Ph.D., Pennsylvania State, 1957.
- ‡Cochrane, John Douglas, Associate Professor of Oceanography. (1956, 1962) B.A., California at Los Angeles, 1943; M.S., Scripps Institute of Oceanography, 1948.
- †Collier, Jesse Wilton, Associate Agronomist. (1949, 1960) B.S., Texas A&M, 1938; M.S., 1952; Ph.D., Rutgers, 1957.
- †Connor, William Stokes, Professor of Statistics. (1965) B.S., Davidson College, 1943; M.A., North Carolina, 1944; Ph.D., 1951.
- †Conway, Dwight Colbur, Associate Professor of Chemistry. (1963) B.S., California at Berkeley, 1952; Ph.D., Chicago, 1956.
- ‡Cook, Benjamin Davy, Associate Professor of Agricultural Education and Specialist in Extension Training. (1950, 1960) B.S., Texas A&M, 1934; M.Ed., 1950; Ph.D., Wisconsin, 1957.
- ‡Cook, Elton D., Agronomist of Texas Agricultural Experiment Substation, Temple. (1949, 1952) B.S., Texas Technological College, 1935; M.S., Kansas State, 1948; Ph.D., Nebraska, 1951.
- †Coon, Jesse Bryan, Professor of Physics. (1946, 1957) A.B., Indiana, 1932; M.A., 1935; Ph.D., Chicago, 1949.
- ‡Cooper, Brian Seymour, Assistant Professor of Oceanography and Meteorology. (1963) B.S., Nottingham (England), 1956; Ph.D., 1959.
- ‡Cooper, Rodney Jean, Associate Professor of Animal Science. (1963) B.S., Oklahoma State, 1954; M.S., Iowa State, 1957; Ph.D., 1958.
- †Couch, James Russell, Professor of Biochemistry and Nutrition and of Poultry Science. (1948, 1949) B.S., Texas A&M, 1931; M.S., 1934; Ph.D., Wisconsin, 1948.
- ‡CoVan, Jack Phillip, Professor of Industrial Engineering. (1946, 1956) B.M.E., Ohio State, 1935; B.I.E., 1935; M.S., Illinois, 1942; Reg. Prof. Engr.
- †Crawford, Paul B., Assistant Director of Texas Petroleum Research Committee and Professor of Petroleum Engineering. (1952, 1962) B.S., Texas Technological College, 1943; M.S., Texas, 1946; Ph.D., 1949.
- †Creger, Clarence R., Assistant Professor of Poultry Science. (1962) B.S., Kansas State, 1955; M.S., 1956; Ph.D., Texas A&M, 1961.
- †Cronk, Alfred Edward, Professor of Aerospace Engineering and Head of Department. (1956) B.S., College of St. Thomas, 1937; M.S., Minnesota, 1946; Reg. Prof. Engr.
- †Crookshank, Herman Robert, Animal Nutritionist for Department of Biochemistry and Nutrition, USDA. (1959) B.S., Northeast Missouri State College, 1938; M.S., Iowa, 1940; Ph.D., 1942.
- ‡Dahlberg, Frank Iver, Professor of Animal Science. (1936, 1947) B.S., Texas A&M, 1925; M.S., Wisconsin, 1930.
- †Danti, Alfred, Associate Professor of Chemistry. (1961) B.S., Colorado College, 1954; Ph.D., Massachusetts Institute of Technology, 1958.
- ‡Daron, Harlow H., Assistant Professor of Biochemistry and Nutrition. (1963) B.S., Oklahoma, 1956; Ph.D., Illinois, 1961.
- ‡Davis, Daniel Rowland, Associate Professor of Sociology. (1935, 1947) B.S., Texas A&M, 1932; M.S., 1935.
- †Davis, Richard Bratton, Associate Professor of Wildlife Science. (1951, 1959) B.S., Texas College of Arts and Industries, 1940; M.S., Texas A&M, 1949; Ph.D., 1952.

- ‡Davis, Richard Harvey, Jr., Professor of Veterinary Physiology and Pharmacology. (1951, 1964) D.V.M., Texas A&M, 1941; M.S., 1956.
- †Davis, William B., Professor of Wildlife Science and Head of Department. (1937, 1946) B.A., Chico State Teachers College, 1933; M.A., California, 1936; Ph.D., 1937.
- †Davis, William Burson, Assistant Professor of Civil Engineering. (1964) B.S., Colorado, 1952; S.M., Massachusetts Institute of Technology, 1958; S.E., 1959.
- †Davison, Richard Read, Assistant Professor of Chemical Engineering. (1958, 1961) B.S., Texas Technological College, 1949; M.S., Texas A&M, 1958; Ph.D., 1962; Reg. Prof. Engr.
- ‡Dayhoff, Eldred Eugene, Assistant Professor of Statistics. (1963) B.S., Texas A&M, 1955; M.S., 1956; Ph.D., Iowa State, 1964.
- ‡Denison, John Scott, Associate Professor of Electrical Engineering. (1949, 1954) B.S., New Mexico Agricultural and Mechanical College, 1948; M.S., Texas A&M, 1949; Reg. Prof. Engr.
- †DeWerth, Adolphe Ferdinand, Professor of Floriculture. (1946, 1949) B.S., Ohio State, 1930; M.S., 1931.
- †Dieckert, Julius Walter, Associate Professor of Biochemistry and Nutrition. (1960) B.S., Texas A&M, 1949; M.S., 1951; Ph.D., 1955.
- †Dillon, Lawrence Samuel, Professor of Biology. (1948, 1961) B.S., Pittsburgh, 1933; M.S., Texas A&M, 1950; Ph.D., 1954.
- ‡Dobson, William Jackson, Professor of Biology and Professional Counselor, Counseling and Testing Center. (1947, 1960) B.A., Austin College, 1939; Ph.D., Texas, 1946.
- ‡Dodd, Jimmie Dale, Assistant Professor of Range Science. (1963) A.B., Ft. Hays Kansas State College, 1956; M.S., 1957; Ph.D., Saskatchewan (Canada), 1960.
- †Dollahite, James Walton, Associate Professor of Veterinary Pathology and Assistant Director for Veterinary Research. (1963) D.V.M., Texas A&M, 1933; M.S., 1961.
- †Doran, Edwin Beale, Jr., Associate Professor of Geography. (1960) B.A., Louisiana State, 1938; M.S., 1947; Ph.D., California at Berkeley, 1953.
- ‡Dorough, Hendley Wyman, Assistant Professor of Entomology. (1963) B.S., Auburn, 1959; M.S., 1960; Ph.D., Wisconsin, 1964.
- ‡Dowell, William Merl,\* Professor of Health and Physical Education. (1942, 1950) B.S., Sam Houston State Teachers College, 1929; M.A., George Peabody College, 1932.
- ‡Drew, Dan D., Assistant Professor of Industrial Engineering. (1960) B.S., North Texas State College, 1950; M.S., 1951.
- ‡Drew, Donald Richard, Assistant Professor of Civil Engineering (1963) B.S., Purdue, 1952; M.S., Texas A&M, 1961; Ph.D., 1964.
- ‡Druce, Albert John, Associate Professor of Electrical Engineering. (1946, 1956) B.S., Texas A&M, 1943; M.S., 1950.
- †Duke, Frederick Robert, Distinguished Professor of Chemistry. (1963) B.A., South Dakota, 1937; Ph.D., Illinois, 1940.
- †Duller, Nelson Mark, Jr., Associate Professor of Physics. (1953, 1962) B.S., Texas A&M, 1948; M.A., Rice Institute, 1951; Ph.D., 1953.
- ‡Dunlap, Wayne Alan, Assistant Professor of Civil Engineering. (1959) B.S., Texas A&M, 1952; M.S., 1955.
- ‡Durbine, Leonel Damien, Assistant Professor of Chemical Engineering. (1961) B.S., Texas College of Arts and Industries, 1957; Ph.D., Rice, 1961.
- †Dyksterhuis, Edsko Jerry, Professor of Range Science. (1964) B.S., Iowa State, 1932; Ph.D., Nebraska, 1945.

\*Deceased January 30, 1965.

- ‡Earle, James Hubert, Associate Professor of Engineering Graphics. (1957, 1964) B.Arch., Texas A&M, 1955; M.Ed., 1962; D.Ed., 1964.
- ‡Edmondson, Vance Ward, Associate Professor of Agricultural Economics. (1956, 1959) B.S., Arkansas, 1948; M.S., Oklahoma Agricultural and Mechanical College, 1950; Ph.D., Cornell, 1956.
- ‡Eisele, John Allan, Associate Professor of Physics. (1962) Ph.D., Ohio State, 1959.
- ‡Eisner, Melvin, Professor of Physics, (1948, 1957) B.A., Brooklyn College, 1942; M.S., North Carolina, 1947; Ph.D., 1948.
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- ‡Thomas, Richard Eugene, Associate Professor of Aerospace Engineering. (1964) B.Aero.E., Ohio State, 1951; B.A., 1953; M.S., 1956; Ph.D., 1964.
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- ‡Tittle, Morris Edward, Associate Professor of Mathematics. (1943, 1959) B.A., East Texas State Teachers College, 1923; M.A., Texas, 1937.
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## 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

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

The Dean of Graduate Studies is responsible for the academic program 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 Graduate Studies, 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, for reviewing thesis and dissertation proposals, and for other matters pertaining to graduate work in their colleges.

**Degrees Offered.** Advanced instruction is offered leading to the following degrees:

- Master of Agriculture (M.Agr.)
- Master of Architecture (M.Arch.)
- Master of Arts (M.A.)
- Master of Business Administration (M.B.A.)
- Master of Computing Sciences (M.C.S.)
- Master of Education (M.Ed.)
- Master of Engineering (M.Eng.)
- Master of Science (M.S.)
- Doctor of Education (D.Ed.)
- Doctor of Philosophy (Ph.D.)

The following professional degrees in engineering are offered to graduates of this university:

- Aerospace Engineer (Aero.E.)
- Agricultural Engineer (A.E.)
- Architectural Engineer (Arch.E.)
- Chemical Engineer (Ch.E.)
- Civil Engineer (C.E.)
- Electrical Engineer (E.E.)
- Geological Engineer (Geol.E.)
- Industrial Engineer (Ind.E.)
- Mechanical Engineer (M.E.)
- Nuclear Engineer (N.E.)
- Petroleum Engineer (P.E.)

### GRADUATE DEGREES CURRENTLY OFFERED

The following graduate degrees are currently offered:

#### College of Agriculture

Master of Agriculture

Master of Education, with a major in  
Agricultural Education

Master of Science, with majors in  
Agricultural Economics  
Agricultural Education  
Agricultural Engineering  
Agronomy  
Animal Breeding  
Animal Science

Animal Nutrition  
 Animal Parasitology  
 Biochemistry and Nutrition  
 Dairy Science  
 Entomology  
 Floriculture  
 Food Technology  
 Genetics  
 Horticulture  
 Oil Seed Technology  
 Physiology of Reproduction  
 Plant Breeding  
 Plant Pathology  
 Plant Physiology  
 Plant and Soil Science  
 Poultry Science  
 Range Science  
 Sociology  
 Soil Chemistry  
 Soil Physics  
 Wildlife Science

Doctor of Philosophy, with majors in

Agricultural Economics  
 Agricultural Engineering  
 Agronomy  
 Animal Breeding  
 Animal Science  
 Animal Nutrition  
 Animal Parasitology  
 Biochemistry and Nutrition  
 Dairy Science  
 Entomology  
 Food Technology  
 Forestry Science  
 Genetics  
 Horticulture  
 Oil Seed Technology  
 Physiology of Reproduction  
 Plant Breeding  
 Plant Pathology  
 Plant Physiology  
 Plant and Soil Science  
 Poultry Science  
 Range Science  
 Soil Chemistry  
 Soil Physics  
 Wildlife Science

#### College of Arts and Sciences

Master of Arts, with majors in

English  
 Government  
 History

Master of Business Administration, with majors in approved fields

Master of Education

Master of Science, with majors in

Biology  
 Botany  
 Chemistry  
 Economics  
 Education  
 Mathematics  
 Meteorology  
 Microbiology

Oceanography  
 Physics  
 Zoology

Doctor of Philosophy, with majors in

Biology  
 Botany  
 Chemistry  
 Education  
 Mathematics  
 Meteorology  
 Microbiology  
 Oceanography  
 Physics  
 Zoology

### College of Engineering

Master of Architecture

Master of Computing Sciences

Master of Education, with a major in  
 Industrial Education

Master of Engineering, with majors in

Aerospace Engineering  
 Agricultural Engineering  
 Chemical Engineering  
 Civil Engineering  
 Electrical Engineering  
 Geological Engineering  
 Industrial Engineering  
 Mechanical Engineering  
 Nuclear Engineering  
 Petroleum Engineering

Master of Science, with majors in

Aerospace Engineering  
 Agricultural Engineering  
 Chemical Engineering  
 Civil Engineering  
 Computer Science  
 Electrical Engineering  
 Geological Engineering  
 Geology  
 Geophysics  
 Industrial Education  
 Industrial Engineering  
 Interdisciplinary Engineering  
 Landscape Architecture  
 Mechanical Engineering  
 Nuclear Engineering  
 Petroleum Engineering

Doctor of Education, with a major in  
 Industrial Education

Doctor of Philosophy, with majors in

Agricultural Engineering  
 Chemical Engineering  
 Civil Engineering  
 Electrical Engineering  
 Geological Engineering  
 Geology  
 Geophysics  
 Interdisciplinary Engineering  
 Mechanical Engineering  
 Nuclear Engineering  
 Petroleum Engineering

## College of Veterinary Medicine

Master of Science, with majors in  
 Laboratory Animal Medicine  
 Veterinary Anatomy  
 Veterinary Medicine and Surgery  
 Veterinary Microbiology  
 Veterinary Parasitology  
 Veterinary Pathology  
 Veterinary Physiology  
 Veterinary Public Health

Doctor of Philosophy, with majors in  
 Veterinary Medicine and Surgery  
 Veterinary Microbiology  
 Veterinary Pathology  
 Veterinary Public Health

## Graduate Institute of Statistics

Master of Science in Statistics  
 Doctor of Philosophy in Statistics

**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. Four 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, and (4) research by individual students under the direction of members of the Graduate Faculty.

Courses at the undergraduate level may be used as specified later.

## ADMISSION

To be admitted to the Graduate College (except under double registration) 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 scores on the Aptitude Test and on an appropriate Advanced Test of the Graduate Record Examination.

The GRE is given at various centers, including Texas A&M University, throughout the United States on regularly established dates, usually in November, January, March, April, and July. To determine exact dates and the most convenient location, prospective applicants should write to the Educational Testing Service, Princeton, New Jersey, or the Counseling and Testing Center, Texas A&M University.

Foreign students and other applicants who are otherwise qualified but who find it impossible to take the GRE on one of the regularly scheduled dates may be given provisional admission to the Graduate College on the condition that they take the GRE during their first semester.

Inquiries regarding admission to the Graduate College should be addressed to: The Director of Admissions, Texas A&M University, College Station, Texas. 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. The application forms, which are available at the office of the Director of Admissions and Registrar, should be filed not later than 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.

In addition to the records sent to this office, the student should have in his possession a copy of his record for use in conference with members of the Graduate Faculty in planning his 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.

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

A student whose academic record is not satisfactory for this purpose, whose scores on the GRE are not satisfactory, or who is changing fields of study may be required to take additional work to strengthen his background and preparation for graduate study in his field. Such work will be arranged in conference with the student's committee or the chairman of his major department.

Before accepting a student for graduate work, a department in which he expects to take work may require that he pass a comprehensive examination covering the basic undergraduate work in that field.

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

### REGISTRATION

Before his first registration the student should consult the graduate advisor representing the field of his major interest, who will assist him in planning his first registration.

The maximum load for full-time graduate students is 16 hours in a regular semester, or 6 hours in a summer term. Staff members, during full-time employment, are limited to a maximum enrollment of 4 hours of course work in a regular semester and 3 hours in a 12-week summer session. Graduate assistants on half-time employment may take up to 12 hours in a regular semester and up to 8 hours in a 12-week summer session.

Graduate students who have completed all course work on their degree programs but who are still engaged in research for their thesis or dissertation must register for a minimum of four (4) hours of 691 credit each semester or 12-week summer session until all requirements for their degree have been completed. The minimum four-hour requirement also applies to such graduate students registered in absentia, unless an approved exception is on file in the Graduate College.

At the discretion of the Department Head and Dean concerned, registration above the four-hour minimum may be required.

**Double Registration.** Qualified undergraduates at this University who at the beginning of a given semester are within 12 hours of graduation or at the beginning of a summer session are within 6 hours of graduation may be admitted to the Graduate College on a provisional basis. Such students must complete the undergraduate work and obtain the Bachelor's Degree during the first semester or summer session in the Graduate College before being eligible for full admission to the Graduate College. The maximum total credit hour load for those double registered in the Graduate College for graduate credit is 16 hours in the regular semester or 6 hours in a summer term.

A superior undergraduate student is permitted to enroll otherwise in a graduate course for graduate credit only if he files a written petition approved by the Dean of Graduate Studies stating that he is reserving the graduate course for graduate credit and is not including it for credit on his undergraduate degree program.

**Graduate Credit.** Graduate credit will not be allowed for any course unless the student has been granted admission to the Graduate College and is registered therein when the course is taken.

**Foreign Students.** A foreign student is subject to the same requirements for admission and candidacy as students from colleges and universities in the United States. In addition, admission of foreign students requires the ability on the part of each student to speak, write, and understand the English language. Before undertaking regular study in the long session, students from other countries are required to participate in a special six-week program of English, counseling, and orientation offered during the summer of each year. The specific date for taking the special program will be announced each year by the Director of Admissions, and instructions for reporting to the University will be sent to all new foreign student applicants.

**Graduate Advisors.** A graduate student entering the University for the first time is required to consult with the advisor in his 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 a committee and working out a



degree program for consideration by the student's full committee. This should be approved by the entire committee and submitted in advance of the second registration.

### FEEES

The fees of the graduate student may vary slightly from year to year. Fees for the session of 1965-66 are as follows:

	First Semester	Second Semester	First Term	Summer Session Second Term
Tuition Fee for Texas residents .....	\$ 50.00	\$ 50.00	\$ 25.00	\$ 25.00
Tuition Fee for nonresidents .....	\$200.00	\$200.00	\$100.00	\$100.00
Student Services Fee .....	\$ 18.00	\$ 18.00	\$ 9.00	\$ 9.00
Building Use Fee .....	\$ 12.00	\$ 12.00	\$ 6.00	\$ 6.00
Student Activities Fee (Optional) .....	\$ 23.80		\$ —	\$ —

In addition to expenses as outlined above, the 56th Legislature further requires the payment of laboratory fees which shall reflect the costs of materials and supplies used and which shall be not less than \$2.00 nor more than \$8.00 per laboratory course.

Each applicant for an advanced degree is required to pay a graduation fee of \$3.00. A fee of \$15.00 is required to cover the cost of binding three copies of the thesis. Each candidate for the doctorate is required to pay a dissertation abstract microfilming fee of \$20.00. A copy of the Fiscal Department receipt for payment of these fees must be presented to the office of the Dean of Graduate Studies and recorded on the student's records.

Any student withdrawing officially (a) during the first week of class work in a semester or trimester will receive a refund of four-fifths of the tuition fee; (b) during the second week of class work, three-fifths; (c) during the third week of class work, two-fifths; (d) during the fourth week of class work, one-fifth; (e) after the fourth week of class work, nothing. No refunds will be made until ten days have elapsed from the time the fees were paid.

The tuition fee for residents of Texas registering for less than 12 credit hours will be reduced by \$4.00 for each credit hour less than 12, with a minimum tuition fee of \$15.00. The tuition fee for nonresident students registering for less than 12 credit hours will be reduced by \$16.00 for each credit hour less than 12. During a six-week summer term, students registering for 4 or more credit hours pay the tuition fee of \$25.00 for Texas residents or \$100.00 for nonresidents. Nonresident students registering for less than four credit hours for a six-week summer term pay a tuition fee of \$25.00 per credit hour. Resident students registering for three hours will pay \$21.00; for two hours, \$17.00; and for one hour, \$15.00. The absentia registration fee and the fee for "thesis only" is \$15.00 for Texas residents and \$17.50 for nonresidents.

### UNIVERSITY HOUSING—DORMITORY AND APARTMENT

Although residence in the University dormitories is not required of graduate students, many of the unmarried men prefer to room in a dormitory, in sections set apart for their use. For married students a limited number of University-owned apartments, both furnished and unfurnished, are available. Rentals range from \$40.00 to \$65.00 per month, including normal utilities. Application for a graduate apartment should be made directly to the Housing Office, Texas A&M University, College Station, Texas.

### DEGREE PROGRAM

A graduate student's Degree Program includes all courses which are listed on his 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 only by petition to the Dean of Graduate Studies approved by the student's full committee.

### SCHOLARSHIP

A graduate student is expected to prove himself worthy of the privilege of advanced study. Graduate courses demand a substantially greater effort on the part of the student than do undergraduate courses.

A minimum grade point ratio of 2.00 (B average) is required on a graduate student's Degree Program. If this ratio is not maintained, the student may be denied further registration in the Graduate College. C is the lowest grade for which graduate credit will be given. All courses in Research (691) and Seminar (681) will receive grades of Satisfactory (S) or Unsatisfactory (U), with only an S grade being acceptable toward the completion of a Degree Program.

Final examinations in all formal courses are required of all graduate students.

### RESIDENCE REQUIREMENTS

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 Graduate Studies. 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 committee, program of study, etc., must be proposed by petition to the Dean of Graduate Studies with endorsements by all members of the student's committee.

### FIELDS OF SPECIALIZATION

An approved field of specialization, selected by the student, will constitute the major. The courses in the major field of specialization may be in one department, or they may be chosen from two or more departments, provided that such courses contribute directly to the major field of specialization.

For administrative purposes the department of the chairman of the student's committee will be considered the administrative department.

The presently offered fields of specialization for both the Master of Science and Doctor of Philosophy degrees which involve courses in more than one department are animal breeding, animal nutrition, animal parasitology, food technology, physiology of reproduction, plant breeding, soil chemistry, soil physics, and the interdisciplinary program in engineering.

### NEW PROGRAMS AND FACILITIES

In recent years several new graduate programs have been developed, supported by extensive new or expanded facilities. Other programs and facilities which will increase the scope and quality of graduate education at Texas A&M are in the planning stage.

The Graduate Institute of Statistics, established in 1962, has grown rapidly in both its teaching and research functions. A student has the opportunity to take either major or minor work in Statistics at the Master of Science and Doctor of Philosophy level. Students interested in this field should write to the Director of the Graduate Institute of Statistics.

The program in Statistics is facilitated by the tools and services of the soon-to-be expanded Data Processing Center, which contains an IBM 7094 and other supporting computing equipment. In addition to augmenting the research program in practically every discipline on the campus, the DPC also enables the University to offer both a Master of Science degree and a Master of Computing Sciences (non-thesis) degree in computer theory and technique.

Other new programs include a M.S. and a Ph.D. program in Interdisciplinary Engineering, which cuts across conventional departmental lines; a M.S. and Ph.D. program in nuclear engineering and in the nuclear sciences; a Ph.D. program in Education, Agricultural Engineering, Veterinary Microbiology, and Forestry Science; and a Master's program in Health Physics.

Supporting facilities in the nuclear sciences are afforded by the Nuclear Science Center, which includes a swimming-pool research reactor, designed for operation at power levels up to five megawatts, a High-Level Gamma Irradiation Facility, an Activation Analysis Laboratory, and other special facilities in nuclear technology for research and instruction in the physical and life sciences.

Other facilities, currently in use or scheduled for construction or expansion within the next year, include the "Alaminos," an ocean-going vessel for oceanographic research; an expanded Electron Microscopy Laboratory; a Space Research Center to be completed in 1966; and a Cyclotron Institute, to be in operation in 1967.

### TYPES OF COURSES

**Regular Courses** are those offered in regular class schedules on the campus.

**Extension Courses** are for part-time students. They are offered by members of the University staff, off the campus, usually in evening or week-end classes. Registration in 685 Problems courses alone by a student not resident at the University shall be considered on the same basis as Extension Courses and shall come under the limitations applying to them.

**Field Courses** are full-time courses of a minimum duration of one calendar week per hour of credit offered by regular staff members at outlying units of the Texas A&M University System or at other points affording unusual laboratory or field work facilities.

**Workshop Courses** are courses in which the class plans the problems to be studied and carries out the work of the class through student leadership under the supervision and guidance of the instructor.

Departments offering off-campus or week-end courses are responsible to the Director of Admissions and Registrar for proper procedure and records of registration. Advance approval should be obtained from the Dean of the College concerned and from the Dean of Graduate Studies as to the course, fees, minimum enrollment, instructor, and location each time the course offered. All students enrolling for graduate credit must have prior admission to the Graduate College.

### THE DEGREE OF MASTER OF SCIENCE

**Residence.** The minimum residence requirements is two semesters of at least 12 credit hours of graduate work each, five six-week summer terms, or an equivalent approved by the Dean of Graduate Studies. This regulation does not apply in the case of specific programs of off-campus work which have been approved by the Academic Council. Full-time resident staff members of the University or any of its closely affiliated organizations whose headquarters are on the campus may satisfy residence requirements while employed. Specific authorization for such joint programs must be granted in advance by the employing agency.

**Student's Committee.** A student should consult with the departmental graduate advisor or department chairman in the field of his major interest for the selection of his graduate committee. A committee for the Master's degree will be composed of not less 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 committee, in consultation with the student, will develop his Degree Program. This should be completed and filed with the Dean of Graduate Studies, whose approval is required, prior to the second registration.

This Degree Program must be submitted on the official form. Any prerequisite courses recommended should be included on the form. All courses listed on the form must be cleared to the satisfaction of the committee.

**Thesis Proposal.** The student, in consultation with members of his committee, should prepare a thesis proposal for approval by the Committee on Graduate Instruction of the College in which his major department is located. The proposal must be filed with the Dean of Graduate Studies at least 14 weeks prior to the close of the semester or summer session in which the student expects to receive his degree.

**Credit Requirement.** A minimum of two full semesters of approved courses and research (32 semester hours) is required for the Master of Science degree.

Ordinarily the student will devote the major portion of his time to work in one field or two closely related fields. Other work will be in supporting fields of interest. In general, not less than one-third of the course work, exclusive of research, should be taken in one or more fields outside the major field.

**Limitations on the Use of Certain Courses.** If otherwise acceptable, certain courses may be used toward meeting residence and credit-hour requirements for the Master's degree under the following limitations:

1. Not more than 6 hours of extension credit, including any 685 Problems courses taken by a student not then in residence at the University.
2. Not more than 6 hours of resident week-end courses.
3. Not more than 6 hours of workshop courses.
4. Not more than 8 hours each of research, thesis, special problems or research methods, nor more than 12 hours of any combination of these.
5. Not more than 2 hours of seminar.
6. Not more than 15 hours of any combination of the above.
7. Not more than 8 hours of advanced undergraduate courses (300 or 400 designation) may be used for graduate credit on any Master's degree program. Exceptions will be permitted only in unusual cases and only when approved on the official degree program or by petition to the Dean of Graduate Studies.

**Time Limit.** All work accepted in fulfillment of requirements for a Master's degree must have been completed within a period of six years before the degree is awarded. Permission to re-instate out-of-date courses by current examination may be requested by petition to the Dean of Graduate Studies.

**Transfer of Credit.** Except for unusual cases, not more than 6 hours of transfer credit may be counted toward degree requirements, except that a student having earned 12 hours of graduate resident credit at Texas A&M University may be authorized, upon the advice of his committee and with the advance approval of the Dean of Graduate Studies, to take a limited number of specified courses not available at this institution at another approved Graduate College.

**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.** 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.

**Thesis.** An acceptable thesis is required for the degrees of Master of Arts, and Master of Science and is optional for the Master of Business Administration and Master of Architecture. 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. Specific instructions on form should be obtained from the office of the Dean of Graduate Studies.

The original and the first two copies of the thesis in its final form must be filed with the Dean of Graduate Studies, after approval by the student's committee, by dates announced each semester.

A thesis binding fee must be paid to the Fiscal Department and the receipt shown to the secretary of the Dean of Graduate Studies before the degree can be conferred. Instructions for typing may be obtained from the Graduate Dean's office.

**Final Examination.** The candidate is required to take a final examination after the thesis has been completed and filed in the office of the Graduate College and after all other requirements for the degree have been completed. Students must be registered in the University in the semester in which the examination is to be given. The examination covers the thesis and all work taken on the Degree Program. It may be written or oral, or both, at the option of the candidate's committee.

Final examinations are conducted by the candidate's committee as finally constituted. The examination is open.

### THE DEGREE OF MASTER OF AGRICULTURE

The program of study leading to the degree of Master of Agriculture, for which a thesis is not required, is designed to serve those who desire additional training in agriculture and who have had one or more years of satisfactory experience in teaching, extension work, or similar fields.

Each candidate's program shall be without departmental designation and shall be approved by a committee composed of one representative from each field of study and such additional members as may be appointed by the Dean of Graduate Studies, totaling not less than five. This committee shall determine what undergraduate prerequisites, if any, will be required.

The minimum of 36 credit hours of approved courses required for this degree shall include Statistics 406, Statistical Methods, which shall be completed during the first half of the degree program. There shall be 8 to 12 credit hours in each of three fields of work, totaling not less than 29 credit hours.

Each candidate will be required to prepare two written reports in addition to papers required as a part of regular course work. The reports are expected to be of the quality of the Master of Science thesis. One shall comprise a comprehensive review of the literature on a technical problem in the candidate's field of study, together with an appropriate statistical analysis of the research data. This will be supervised by the research project leader providing the data or by another person acceptable to the committee as a whole. The other report shall be a paper involving the integration and application of the candidate's course work to a community agricultural program.

These two reports, which may carry up to four hours of credit by registration in 685, Problems courses, shall be submitted to the candidate's committee for approval, and shall be available at the time of his final examination.

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

#### THE DEGREE OF MASTER OF ARCHITECTURE

The graduate program offered by the School of Architecture leads to the degree of Master of Architecture. The requirements for this degree, with the exception of an optional thesis, are identical with those for the degree of Master of Science.

#### THE DEGREE OF MASTER OF ARTS

The degree of Master of Arts is designed for students majoring in English, Government, or History.

In addition to the general requirements of the Graduate College, the Department of English has certain requirements for the Master's degree:

1. Each candidate must complete a minimum of 30 credit hours; at least 22 hours, including up to 6 hours credit for the thesis, must be in 600-level courses.
2. In addition to the 30 hours, the candidate may be asked to make up back work, such as parts of the survey of English and American literature or a course in the English language.
3. The candidate may elect to present a minor of not more than 9 hours in a foreign language, economics, history, education, mathematics, government, or the sciences. These hours are to be taken in one department.

In addition to the general requirements of the Graduate College, the Department of History and Government has certain requirements for the Master's degree:

For the degree of Master of Arts in Government or History, the equivalent of 30 semester hours of advanced or graduate instruction is required, of which at least 22 credit hours, including thesis, shall be in courses exclusively for graduate students.

Eighteen to twenty-one semester hours, including the thesis, shall constitute the major. The remaining 9 to 12 semester hours shall constitute the minor or minors and must be related fields, such as economics, education, English, government, history, mathematics, sciences, or other social sciences. With the consent of the departmental chairman, or advisor, and with the approval of the Dean of Graduate Studies, the candidate may take a minor outside the College of Arts and Sciences. The correlation of major and minor subjects must be approved by the Dean of Graduate Studies. If the minor work is divided, it must be in no more than two departments and include at least 6 semester hours in each field of study.

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

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

### THE DEGREE OF MASTER OF BUSINESS ADMINISTRATION

The graduate program offered by the School of Business Administration leads to the degree of Master of Business Administration. Students may major in the professional fields of Accounting, Computer Science, Organization and Administration, or Statistics.

The holder of a Bachelor's Degree in Business Administration will normally be prepared to go directly into courses in a professional field in which 36 credit hours must be completed. The holder of a Bachelor's Degree not in Business Administration will be required to take pre-professional courses as explained in the section "Graduate Courses by Departments."

The writing of a thesis and the accompanying reduction of the 36 credit hours is optional with the student.

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 SCIENCES

The degree of Master of Computing Sciences is a non-thesis degree, designed to complement the Master of Science degree in Computer Science.

The requirements for this degree are the completion of 36 hours of course work and a satisfactory comprehensive final examination.

### THE DEGREE OF MASTER OF EDUCATION

Graduate students majoring in agricultural education, education, or industrial education may become candidates for the degree of Master of Education on recommendation of the heads of their major departments.

The requirements for this degree are the completion of 36 hours of course work and a satisfactory comprehensive final examination. A thesis is not required for this degree.

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 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 36 credit hours of course work will be taken in fields outside the major field.

The work in the major field will include one or two written reports (not necessarily involving results of research conducted by the candidate) for which up to four hours credit in 685, Problems courses, is permissible.

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

### PROFESSIONAL DEGREES IN ENGINEERING

The professional degrees in engineering are available to graduates of this university. These degrees are offered on the basis of acceptable professional experience, a thesis or its equivalent, and an examination. Details concerning requirements for this degree may be obtained upon application to the office of the Dean of Graduate Studies.

### 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 language. The degree is not granted solely for the completion of course work, residence, and technical requirements, although these must be met.

**Residence.** The minimum period of time required for the doctoral degree is six semesters of full-time graduate study or its equivalent, beyond the Bachelor's degree.

All of the work, except as noted below, must be done in resident graduate study at some approved educational institution, and at least two of the last four semesters must be spent at Texas A&M University.

Candidates for the doctoral degree will normally satisfy residence requirements by either (1) two semesters of 12 hours each, or (2) one semester of 12 hours and one summer session of 12 hours.

Full-time staff members engaged in graduate study and registered for less than 12 semester hours will receive proportionate residence credit.

**Credit for Work in Absentia.** Upon recommendation of his committee and approval of the Dean of Graduate Studies, a student may be permitted to carry on work in connection with his dissertation in absentia. In case credit is desired for off-campus research, the student must maintain his registration in the University.

**Time Limit.** All work for this degree must be completed within the seven-year period immediately preceding the final examination or within a five-year period if the student enters with a Master's degree.

**Student's Committee.** After admission to graduate study, the student will consult the head of his major or administrative department concerning appointment of his advisory committee. This committee will consist of not less than five members of the graduate faculty representative of the student's several fields of study and research; two of the members must be from disciplines outside the major field.

The committee will evaluate the student's previous training and degree objectives. They will then outline a degree program and research problem which, with the dissertation, will constitute the basic requirements for the degree. The degree program will be submitted on standard forms for the approval of the Dean of Graduate Studies, who will, at the time of approval, appoint a representative of the Graduate Council to the student's committee. The field of study may be chiefly in one department or may be in a combination of departments. The chairman of the committee will normally have immediate supervision of the student's research and dissertation. The degree program should be submitted before the second registration after a student enters into graduate study.

**Languages.** All students are required to possess a competent command of English. In addition, candidates for the Ph.D. at Texas A&M University must demonstrate a reading knowledge of two foreign languages, selected from German, Russian, and French or Spanish subject to the approval of the student's committee, except that another language may be substituted for one of these upon the recommendation of the student's committee and approval of the Dean of Graduate Studies, provided it is shown that there is a substantial body of knowledge in the student's field in the substitute language.

The language requirement for the Ph.D. degree may be satisfied in any one of the following ways:

1. Successfully passing the reading knowledge examinations in two languages which are scheduled by the Department of Modern Languages four times a year.
2. Successfully completing a comprehensive examination in one language when such a substitution has been approved in advance by the Dean of Graduate Studies. A description of the requirements of this test may be secured from the Department of Modern Languages.
3. Successfully passing two of the two-semester reading courses, Modern Languages 401-402 (French), 403-404 (German), or 409-410 (Russian).
4. Making acceptable scores on the Graduate School Foreign Language Tests, available in French, German, and Russian. These Tests, devised by the Educational Testing Service, Princeton, New Jersey, will be administered locally by the Counseling and Testing Center. The costs of the tests will be borne by the students. Details of this option may be obtained in the Graduate College office.

**Preliminary Examination and Admission to Candidacy.** The student must be admitted to candidacy at least seven months before the time when the degree is expected to be received, but usually not before the completion of two full years of graduate work. A student must be registered in any semester in which he asks to appear for either the preliminary or the final examination.

To be admitted to candidacy, a student must have satisfied language requirements, passed a preliminary examination, and filed with the Dean of Graduate Studies his dissertation proposal approved by his graduate committee.

The preliminary examination shall be both oral and written unless otherwise recommended by the student's committee and approved by the Dean of Graduate Studies. The written part of the examination will cover each field of study included in the student's program and both parts of the examination must be completed within a length of time approved by the Dean of Graduate Studies, usually not exceeding two weeks. Credit for the preliminary examination is not transferable.

Through the preliminary examination and the dissertation proposal, the student's committee should satisfy itself that the student has demonstrated the following qualifications:

1. He has a mastery of the subject matter of all fields in his program.
2. He has an adequate knowledge of the literature in these fields and has powers of bibliographical criticism.
3. His dissertation project is feasible and adequate.

The committee which conducts the examination will report in writing the results of the examination and make recommendations regarding admission to candidacy of the student.

By permission of his committee and the Dean of Graduate Studies, a student who has failed in his preliminary examination may be given one re-examination, but only after a period of at least six months has elapsed.

**Limitation for Staff Members.** 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.

**Dissertation.** The general field of research to be used for the dissertation should be agreed on by the student and his 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, approved at a meeting of the student's committee, and submitted to the Dean of Graduate Studies for final approval. This should be done before commencement of collection of data and not later than the third semester of resident work beyond the Master's level.

The ability to perform independent research must be demonstrated by the dissertation. While acceptance is based primarily on its scholarly merit, it must also exhibit creditable literary workmanship. The format of the dissertation shall be acceptable to the Graduate College. Suggestions on form should be obtained from the office of the Dean.

By dates announced each semester the candidate must submit to the office of the Dean of Graduate Studies the original and two copies of the dissertation. The dissertation must be completed with all suggestions and corrections of the student's committee incorporated, and bear the signatures of the chairman, the committee members, and the department head. These must be approved by the Dean of Graduate Studies before the final examination can be given.

In addition to the dissertation, the candidate must submit three copies of an abstract not exceeding 600 words.

All successful candidates for the doctorate are required to pay to the Fiscal Department a dissertation abstract microfilming fee of \$20.00. This fund is used to film abstracts of doctoral dissertations on microfilm in cooperation with University Microfilms, Inc.

**Final Examination.** The candidate for the doctoral degree must pass a final examination not less than one week before the date on which the degree is to be conferred. At least one week prior to the examination, he must file a Notice of Final Examination with the Dean of Graduate Studies. The student's 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. The final examination will be open to all members of the Faculty. The committee will submit their recommendations to



the Dean of Graduate Studies regarding acceptability of the candidate for the doctoral degree.

### THE DEGREE OF DOCTOR OF EDUCATION

The Doctor of Education program is designed to offer opportunity for advanced study and research to persons who have demonstrated superior scholarship and a promise of leadership in professional education. 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. At present this program is available only in the field of Industrial Education.

**Program of Study.** Upon acceptance as an applicant for the Doctor of Education degree, the student will take a series of tests, preferably during the first session of residence. The results of this examination will be used by the student and his Advisory Committee as a partial basis in planning and developing his doctoral program.

**Languages.** There is no specific foreign language requirement for the Doctor of Education degree.

**Statistics.** A student must demonstrate competence in statistics and educational research procedures.

**Educational Experience.** The student must have had a period of teaching experience deemed sufficient in amount and quality in the opinion of his Advisory Committee to warrant his continuing toward a doctorate.

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

### GRADUATION

Graduate degrees are conferred at the close of each regular semester or summer session. Commencement exercises, however, are held only at the close of the fall and spring semesters.

During the semester or summer session in which his degree is conferred, a student must be officially registered in the University whether or not he enrolls in course work.

Candidates for advanced degrees who expect to complete their work at the end of a given semester must give separate written notice to both the Dean of Graduate Studies and the Registrar to that effect not later than 90 days prior to the end of the semester or 30 days prior to the end of the summer term in which the student expects to have his degree conferred.

Each candidate for a degree must attend the commencement exercises in appropriate academic regalia unless his petition to be excused is approved by the Dean of Graduate Studies. The petition should be submitted at least 30 days prior to commencement.

### PUBLICATION OF THESIS MATERIAL

Graduate students pursuing work leading to an advanced degree may publish in scholarly journals material that may subsequently be used as a part of the thesis or dissertation, provided the Dean of Graduate Studies is notified of this intention 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 will be furnished the Dean of Graduate Studies. Acknowledgement should be given in the publication that the work is for partial fulfillment of graduate degree requirements.

After publication, the student will advise the Dean of Graduate Studies regarding the volume and page of the journal in which the paper was published. Students are urged to provide similar information on all scientific papers published during their graduate careers, even though the material is not intended for use as a part of the thesis or dissertation.

### FINANCIAL ASSISTANCE

Graduate Teaching Assistantships for nine months, which require one-half time service, are available to qualified students. Graduate Research Assistantships are usually twelve-month appointments, although vacancies may be filled for shorter periods.

A maximum of twelve credit hours of academic work per semester and four per six-week summer term is normally approved for graduate assistants.

The stipend for both teaching and research assistantships is competitive with that paid by most other institutions. Some adjustment in duties and the rate of pay may be made for non-resident students to aid in meeting the non-resident tuition fee; the additional stipend will be paid in monthly installments.

Many other research assistantships are available through the Agricultural and Engineering Experiment Stations, the Research Foundation, the Texas Transportation Institute, or from grants-in-aid administered by individual departments. Inquiries concerning these forms of assistance may be directed either to the Dean of Graduate Studies or the head of the department in which the student plans to do his major work.

A limited number of Graduate College Fellowships are available for students with outstanding records. These Fellowships require no service except satisfactory academic performance. Since Graduate College Fellowships permit full-time study and research, the holder of such a grant will be expected to register for sixteen credit hours per semester and six hours per six-week summer term. The stipend is variable, depending upon the nature of the grant and the qualifications of the recipient.

Post-doctoral research fellowships are available in the natural sciences and engineering.

Texas A&M also participates in and has approved fellowships or traineeships under the NDEA, Title IV Program; the National Science Foundation Regular, Cooperative, and Summer Teaching Assistant Fellowship and Traineeship (engineering, science, and mathematics) programs; the NASA Predoctoral Traineeship program in science and engineering; Health Physics and Special Fellowships in Nuclear Science and Engineering sponsored by the AEC; and the fellowship programs of the Public Health Service. Additional fellowships sponsored by individuals, industrial corporations, and private foundations are available in certain departments. In addition to the basic stipend, most of the fellowships provide dependency allowances, tuition and fees, and other expenses. Nonresident recipients of most awards may receive extra compensation equivalent to out-of-state tuition or tuition scholarships.

Applications for all assistantships and fellowships, together with transcripts, letters of recommendation, and GRE results, should be filed with the Dean of Graduate Studies 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 research assistantships and fellowships which are administered by departments may be obtained by writing directly to the head of the department concerned.

### LIBRARY FACILITIES

**Cushing Memorial Library:** The main University Library, which serves also as the research library of the Texas Agricultural Experiment Station and of the Texas Agricultural Extension Service, is in a centrally located, air-conditioned building housing a collection of over 350,000 volumes of books, periodicals, government documents, and other library materials in an open-stack arrangement. A total of 480,000 volumes are owned altogether by Texas A&M University.

The library is a federal depository for United States government documents on a selective basis. Approximately 6,000 serials are currently received, along with over 50 state, national, and foreign newspapers. Special attention has been given to obtaining important foreign language periodicals in all areas. Although the library has been developed chiefly along reference and technical lines, its collections are being expanded to meet the University's broadened needs. Generous contributions from A&M Mothers' Clubs throughout the State have been used to increase substantially the collection of fiction and non-technical popular material. The careful selection of new books in both technical and non-technical areas keeps the collection abreast of modern thought. A well-trained staff of librarians is on duty during most of the hours the library is open.

The more important reference works, including indexing and abstracting services, are shelved in the General Reference Room, second floor. State and federal documents are to be found in the Documents Division, second floor. The library receives on deposit the unclassified reports of the Atomic Energy Commission, as well as selected technical reports of the National Aeronautics and Space Administration. Microfilm, microcard, and microfiche machines are provided for reading materials available in these forms. Photocopy service is available at a nominal charge.

Individual study carrels are provided in the bookstacks for the use of graduate students and faculty members. With the exception of periodicals, government documents, and certain books temporarily reserved by departments for reference or required reading most books are loaned for home use for a period of two weeks with the privilege of renewal for the same length of time. Bound volumes of periodicals may be charged out by graduate students for over-night use only, and a one week charge is given to faculty members.

**Engineering Library:** Formerly the Texas Engineers Library, this branch library was established in 1941 by the Texas State Board of Registration for Professional Engineers in cooperation with the Agricultural and Mechanical College of Texas. It is now housed in Bagley Hall adjacent to the main university library. The collection consists of over 95,000 volumes of books, periodicals, and other library materials in all areas of engineering. The collection is well balanced but is especially strong in aeronautics, air-conditioning, highway engineering, concrete, hydrology, sanitary engineering, petroleum, and welding. Over 1500 periodicals and other serials are currently received, including many in foreign languages and some English translations of Soviet technical journals.

**Veterinary Library:** This branch library is located in the Veterinary Medicine Building and is primarily a reference library with over 12,000 volumes of books and periodicals in the fields covered by the curriculum in the College of Veterinary Medicine. The library subscribes to 441 American and foreign periodicals and receives pertinent publications from other colleges and experiment stations.

**Architecture Library:** This branch library, located in the new Architecture Building, furnishes reading room space and offers reference service. The collection, numbering approximately 7,000 volumes of selected books and periodicals, provides materials in this specialized field for both students and faculty.

**Business Administration Library:** Another branch of the University Library, this collection consists of approximately 8,000 volumes of books and periodicals in the many areas of business administration, such as accounting, insurance, marketing, business law. Over 170 periodicals are currently received and a file of annual reports of corporations is maintained. The library is located in Francis Hall.

**Chemistry Library:** This newest branch library, housed in the Chemistry Building, consists of a collection of over 4,000 volumes of books and periodicals which have been selected for their value as reference material for chemistry.

**Other Libraries:** Many departments maintain working collections of books and periodicals for use within the departments. Some of the collections are fairly large and well organized; others are small but well chosen. Use of these libraries is controlled by the departments concerned.

### WAR ORPHANS ADVISORY SERVICE

Texas A&M University provides advisory service to war orphans and assists them in securing proper benefits from the Veterans Administration. This service is provided in the office of the Department of Student Affairs, Y.M.C.A. Building.

### FOREIGN STUDENT ADVISOR

The Office of the Foreign Student Advisor is located in Room 204, Counseling and Testing Center. Information relative to immigration regulations and assistance with problems peculiar to students from other lands may be obtained from this staff member.

### REGISTRATION OF MOTOR VEHICLES

All students and employees who drive motor vehicles on the campus must have them registered in the Office of Campus Security, YMCA Building, within 48 hours of the time that they are brought on the campus.

Students are assigned parking areas according to their housing assignment. Cars must be parked in these designated areas during the regular classroom hours.

### STUDENT HEALTH SERVICES

The University Hospital provides infirmary space for over 100 patients, as well as a modern clinic for out patient care. The facilities include a complete physiotherapy department, modern laboratory, and a new x-ray department. The medical

staff includes specialists in the fields of medicine, surgery, radiology, and ear, nose, and throat.

The Clinic is open from 8 a.m. to 5 p.m. on weekdays and from 8 a.m. to 12 noon on Saturdays. The Student Services fee provides for clinic visits, diagnostic examinations, care for acute illnesses, emergency care for accidents, and 10 days of infirmary care each semester in cases requiring hospitalization. Routine medications for acute illnesses, x-rays, laboratory tests, and local ambulance service are also furnished the student without charge. A staff of registered nurses is on duty, with a staff physician on call, to care for emergency cases at any hour.

All students are encouraged to take out the Accident Insurance Policy which is available at reasonable cost.

The water of the University is supplied through a University-owned water supply system and comes from four deep wells located nine miles northwest of the campus. As a part of the sanitary work carried on throughout the entire year, the University laboratories make bacteriological checks of this water supply and of the milk supply at regular intervals.

The University is particularly concerned with the maintenance of the health and physical development of its students. It provides the finest outdoor and indoor swimming pools in the State, as well as tennis courts, a golf course, and athletic fields. An adaptive physical education program is provided for those students needing special exercises or therapy for physical defects.

### RELIGIOUS ACTIVITIES

Texas A&M University is non-sectarian, but its high objectives cannot be achieved unless its educational program is founded on a solid religious life. Divorced from the spiritual aspirations of the individual and of the group, education cannot be complete. The basic purpose of education is a normal religious life to the end that young people may be not only more efficient but better motivated by a sense of duty and obligation. Thus, in an atmosphere of tolerance and mutual respect, every student is encouraged to maintain his ties with the religious group to which such association may be made most fruitful.

**All Faiths Chapel:** The beautiful All Faiths Chapel, a gift of the Former Students, is made of Austin limestone and glass, and is modern in design. In addition to providing the opportunity for individual meditation and prayer and serving as a meeting place for small religious groups, the Chapel makes available a library of religious books and affords accommodations for small weddings, funerals, memorial services, baptisms, vesper services, and other religious rites. The Chapel is open at all hours for meditation and prayer.

In addition to the on-campus University religious life, there are ten churches near the campus whose primary purpose is to serve the spiritual needs of the students. The campus religious leadership is deeply conscious that the students are in perhaps the most formative period of their lives and feel keenly the responsibility for their spiritual development.

The programs of the respective churches are aimed primarily to meet the student needs. Many of the churches have distinct student departments with specialized leadership whose sole responsibility is that of ministering to the students. The pastors of the churches also give as much time as is necessary to the students for personal counseling.

The churches serving the campus have a program similar to that of the home church with an expanded young people's department and dominant emphasis upon student interests. In addition to the special student emphasis, they have the customary Sunday worship periods, church schools, and young people's organizations promoted to stimulate clear and constructive thinking in the important field of religion. The student departments are expanded to offer wholesome recreation and social life and social service.

### MEMORIAL STUDENT CENTER STUDENT PROGRAMS

Dedicated to the memory of the men of Texas A&M University who gave their lives during World Wars I and II, the Memorial Student Center was erected to foster the social, cultural, and recreational phases of student life.

General facilities of the Memorial Student Center include a dining room, cafeteria, snack bar, gift shop, telephone and telegraph center, barber shop, 66 guest rooms, travel

agency, check cashing and information center, student organizations banking center, and United States Post Office. Recreational facilities include bowling lanes, table tennis and billiards area, game room, browsing library, piano room, music practice rooms, ballroom, and record playing room. A large number of meetings, receptions, exhibits, and social affairs given by the student and staff organizations of the University are held at the Center.

Included in a special activities program of the Memorial Student Center Directorate are the following special interest committees: Music, Talent, Dance, Radio, Camera, Contemporary Arts Committee, Travel, Leadership Training Program, Great Issues, Flying Kadets, Bowling, Billiards, Table Tennis, Chess, Public Relations, Personnel, Town Hall, and the Student Conference on National Affairs.

**Town Hall:** The Town Hall series includes the best obtainable artists in the fields of music, dance, and theater. Activity fees and the sales of season and individual tickets make it possible to bring these outstanding programs to the student body at low prices.

**Singing Cadets:** This widely known singing unit consists of more than sixty students, both civilian and military. The group has appeared in many southwestern cities and in Mexico, on numerous broadcasts and telecasts, and on various other entertainment programs. For the past few years this group has served as the official glee club for the coast-to-coast television program "Miss Teen-Age America." Membership is selected from the entire student body by auditions held early in the fall semester.

## GRADUATE COURSES OF INSTRUCTION BY DEPARTMENTS

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 eighteen weeks.

Roman numerals to the right of the credit value of each course 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 registration is too small to justify the offering of the course.

### DEPARTMENT OF AEROSPACE ENGINEERING

A. E. CRONK\* (Head), R. R. GILRUTH, W. B. LEDBETTER, S. H. LOWY, C. A. RODENBERGER, C. H. SAMSON, JR., R. E. THOMAS

The Department of Aerospace Engineering offers graduate work as preparation for research careers or as more complete training in the engineering practices of the aerospace industry. Programs can be developed with emphasis on high speed aerodynamics, aerospace structures, or propulsion.

Wind tunnels provide equipment for aerodynamic research in fundamental fluid flow problems or in three-dimensional testing of complete airplane models. Investigations of structural problems are undertaken in well equipped structures laboratories.

The present trend of the aerospace industry toward more research and development rather than heavy production has stimulated interest in graduate work in aerospace engineering.

#### 601. Principles of Fluid Motion. (4-0). Credit 4. I

Mathematical methods of analysis are emphasized. Perfect fluid theory development. Treatment of viscosity and boundary layer phenomena. Prerequisite: Aero. 303.

#### 603. Aerodynamics of the Airplane. (4-0). Credit 4. II

Application of vector analysis to two- and three-dimensional airfoil theory. Viscosity and compressibility. Drag of aircraft components. Static and dynamic stability criteria. Prerequisite: Aero. 303.

#### 604. Dynamics of Compressible Fluids. (4-0). Credit 4. I

Properties of compressible fluids, dynamics of one-dimensional motion, channel flows, shock waves, methods of observation, extension to two- and three-dimensional flow, effects of viscosity. Prerequisite: Aero. 303 or approval of Department Head.

#### 606. Space Propulsion. (3-0). Credit 3. II

Propulsion systems performance, power generation, thermal and electrical power propulsion, fundamentals of magnetohydrodynamics. Prerequisites: Aero. 601; E.E. 322; or approval of instructor.

#### 608. Aircraft Flutter Analysis. (4-0). Credit 4. II

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.

#### 610. Nuclear Rocket Propulsion. (3-0). Credit 3. II

Basic rocket performance, system analysis, heat transfer and fluid flow, materials, nucleonics, system and component testing. Prerequisites: Aero. 417; N.E. 601.

#### 612. Space Technology II. (3-0). Credit 3. II

Satellite launch trajectories, oblate effects and precession, lunar trajectories, interplanetary operations and orbit transfer, satellite recovery and re-entry. Prerequisite: Aero. 423.

\*Graduate Advisor

**632. Structural Design of Missiles and Spacecraft. (3-0). Credit 3. II**

Flight loads; environment; heat transfer and thermal stresses; materials and material behavior; pressure-stabilized structures; aeroelastic effects and dynamic loads; structural fatigue; reliability. Prerequisite: Graduate classification.

**685. Problems. Credit 1 to 4 each semester. I, II, S**

Investigation of special topics not within the scope of thesis research and not covered by other formal courses. Prerequisite: Graduate classification in aerospace engineering.

**691. Research. Credit 2 to 6 each semester. I, II, S**

Technical research projects approved by Department Head.

(See S.M. 601, 602, 603, 604, 605, 606, 607, 608, 609 for description of related courses.)

**DEPARTMENT OF AGRICULTURAL ECONOMICS AND SOCIOLOGY**

R. E. BRANSON, D. R. DAVIS, V. W. EDMONDSON, D. E. FARRIS, M. L. FOWLER, C. R. HARSTON, J. A. KINCANNON, A. C. MAGEE, J. G. MCNEELY, D. S. MOORE, B. H. NELSON, C. S. SHAFER, R. L. SKRABANEK, H. B. SORENSEN, RANDALL STELLY, K. R. TEFERTILLER, T. R. TIMM (Head), J. S. WEHRLY, A. B. WOOTEN\*

The objective of the program in this field is the training of scientific and professional workers. Increasing attention of public agencies and private concerns to rural, economic, and social problems points to enlarged opportunities for qualified workers for teaching, research, public relations or administration, and private employment in these fields.

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 or social theory, its history, and its applications to contemporary agricultural problems; and the ability to employ statistical techniques and other methodology in making rural, social, and economic studies.

The teaching and research activities are grouped broadly as follows: in agricultural economics, under (1) farm management and production economics, (2) marketing, (3) land economics and agricultural policy, and (4) consumer economics; and in sociology under (1) social problems, (2) rural organizations, (3) social theory, and (4) social institutions. These fields are subdivided into several specific phases. The present and expanding program of research in the Department affords the student wide choice and interested guidance in his research for a thesis or dissertation.

**AGRICULTURAL ECONOMICS****602. Agricultural Market Organization and Structure. (3-0). Credit 3. S**

An analysis of the framework within which farm products are marketed. Implications of horizontal and vertical integration and governmental activities. Influence of producers, the food and fiber industries, and consumers on market structure. Prerequisite: Ag.Ec. 314.

**603. Land Economics. (3-0). Credit 3. II**

Study of selected problems of the allocation and utilization of natural resources with special reference to government organizations, quasi-government bodies, and other interest groups. Prerequisite: Ag.Ec. 422 or approval of Department Head.

**607. Research Methodology. (3-0). Credit 3. I**

Scientific approach, role of theory and assumptions, bias and prejudice, attributes of problems, methods and tools of agricultural economics and sociology research. Student evaluates research studies and develops thesis prospectus or equivalent. Prerequisite: Approval of Department Head.

**611. Production Economics. (3-0). Credit 3. II**

Economic principles for analyzing agricultural production and resource use; problems are treated regarding the technical unit, the firm and society with emphasis on conditions for efficiency. Prerequisite: Approval of Department Head.

\*Graduate Advisor

**613. Contemporary Thought in Agricultural Economics. (3-0). Credit 3. I**

Study of contemporary contributions to the thought and analysis of aggregate relationships and problems in the agricultural economy. Prerequisite: Approval of Department Head.

**614. Agricultural Policy. (3-0). Credit 3. S**

Analysis of public policies and programs affecting agriculture. Development of policies and programs for agriculture and their bases. Prerequisite: Ag.Ec. 429 or approval of Department Head.

**617. Economics of Consumption. (3-0). Credit 3. I**

Consumer market for agricultural products; effects of family attributes on preferences and buying habits; consumer motivations; advertising; retail price policies; and market research. Prerequisite: Approval of Department Head.

**619. Farm and Ranch Business. (2-2). Credit 3. I**

Interrelationships of factors affecting profits in farming and ranching. Organization and management of actual farm and ranch businesses. Relation of theory and practice in farming and ranching. Prerequisite: Approval of Department Head.

**620. Capital Market in Agriculture. (3-0). Credit 3. II**

Role of capital in economic growth and structure of the capital market for agriculture. Determinants of aggregate capital supply. Prerequisite: Ag.Ec. 430 or approval of Department Head.

**627. Agricultural Market and Price Analysis. (3-0). Credit 3. I**

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; B.A. 303.

**629. Public Administration in Agriculture. (3-0). Credit 3. S**

Study of 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. Prerequisite: Approval of Department Head.

**633. Economics of Underdeveloped Agricultural Areas. (3-0). Credit 3. S**

Function of agriculture in economic growth. Agricultural productivity as influenced by an economy's physical, cultural, and institutional attributes. Economic problems of underdeveloped areas. Prerequisites: Econ. 330; approval of Department Head.

**641. Statistical Methods in Agricultural Economics. (2-2). Credit 3. II**

Planning statistical research project; developing forms; selecting sample; conducting study; tabulating, analyzing and interpreting the data. Prerequisites: B.A. 303 or Stat. 406 or equivalent; 15 hours of social science; approval of Department Head.

**681. Seminar. (1-0). Credit 1 each semester. I, II**

Review of current literature, preparation of papers on selected topics, discussions with visiting agricultural economists. Prerequisite: Graduate classification.

**685. Problems. Credit 1 to 4 each semester. I, II, S**

Directed individual study of a selected problem in the field of agricultural economics. Prerequisite: Approval of Department Head.

**691. Research. Credit 1 or more each semester. I, II, S**

Initiation and completion of a research project of approved scope for an advanced degree. Prerequisite: Approval of Department Head.

**SOCIOLOGY****601. Rural-Urban Relations. (3-0). Credit 3. I, S**

City growth trends and their impact upon fringe areas. Economic, commercial, residential structures and basic urban institutions. Problems and a search for the



ideal city. For students in architecture, administration, education, and transportation. Prerequisite: Soc. 205 or 12 hours of social science\*.

**602. Contemporary Theory in Rural Sociology. (3-0). Credit 3. II**

Development of professional field of rural sociology. Theories and contributions of sociologists and social scientists to field of rural sociology. Prerequisite: Soc. 205 or 12 hours of social science\*.

**606. Youth Leadership. (4-0). Credit 4. I**

Problems of youth, training techniques, and programs. Traits, techniques, and attributes of leaders. Prerequisite: Twelve hours of social science\*.

**611. History of Social Thought. (3-0). Credit 3. I**

Social thought from ancient times to present. Evolvement of sociological theories and their contributions to modern sociology. Prerequisite: Soc. 205 or 12 hours of social science\*.

**612. The Community. (4-0). Credit 4. II**

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\*.

**618. Educational Sociology. (3-0). Credit 3. II, S**

How the school system can strengthen 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 a degree in education.

**685. Problems. Credit 1 to 4 each semester. I, II, S**

Directed individual study of selected problem in field of sociology. Prerequisite: Approval of instructor.

**691. Research. Credit 1 or more each semester. I, II, S**

Initiation and completion of research project of approved scope for an advanced degree. Prerequisite: Approval of instructor.

**DEPARTMENT OF AGRICULTURAL EDUCATION**

B. D. COOK†, J. W. HOLCOMB, JR.†, O. M. HOLT†, E. H. KNEBEL†, (Head),  
HENRY ROSS†, E. S. WEBB†

Advanced courses in agricultural education provide an opportunity for teachers of vocational agriculture to improve their efficiency as master teachers. Agricultural extension service workers and professional workers in agricultural departments of developing countries may also improve themselves professionally through selected courses in agricultural education. Selected courses in agricultural education are designed to meet the needs of professional agricultural workers 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 the 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 staff 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 service farm 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 vocational agriculture teachers, agricultural extension service workers, and professional agricultural workers encounter in their work.

**601. Advanced Methods in Agricultural Education. (3-0). Credit 3. I, II, S**

Advanced course in methods of teaching. Prerequisite: Professional experience or approval of Department Head.

\*For this purpose social science is defined to include only courses in agricultural economics, anthropology, economics, political science, psychology, and sociology.

†Graduate Advisor

**605. Supervised Farming. (3-0). Credit 3. I, II, S**

Advanced study of supervised farming and work experience programs. Prerequisite: Professional experience or approval of Department Head.

**607. Future Farmer and Young Farmer Activities. (3-0). Credit 3. I, II, S**

Methods of conducting Future Farmer and Young Farmer activities. Prerequisite: Professional experience or approval of Department Head.

**610. Methods in Adult and Young Farmer Education. (3-0). Credit 3. I, II, S**

Methods of determining and evaluating educational programs in agriculture. Prerequisite: Professional experience or approval of Department Head.

**613. Administration and Supervision of Agricultural Education. (3-0). Credit 3. I, S**

Problems of organization, administration, financing, and supervision of vocational agriculture, and extension work. Prerequisite: Professional experience or approval of Department Head.

**615. Philosophy of Agricultural Education. (3-0). Credit 3. I, II, S**

Study of philosophy and evaluation of education in agriculture. Emphasis on development and use of evaluative criteria. Prerequisite: Professional experience or approval of Department Head.

**616. Program Building in Agricultural Education. (3-0). Credit 3. I, II, S**

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. I, II, S**

Offered for one, two, 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. I, II, S**

Analysis of occupational and vocational opportunities for rural youth; techniques of individual group counseling in guidance. Practicum in personality and occupational interest testing. Prerequisite: Approval of Department Head.

**640. Methods of Technological Change. (3-0). Credit 3. I, II, S**

Dynamics of cultural change as theoretical framework for process of planned technological change, methods of planning and implementing change, its effects and how it can be predicted. Prerequisite: Approval of Department Head.

**681. Seminar. (1-0). Credit 1. I, II, S**

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.

**685. Problems. Credit 1 to 4 each semester. I, II, S**

Studies related to classroom, laboratory, supervised farming work experience, and adult educational activities in agricultural programs. Prerequisite: Approval of Department Head.

**691. Research. Credit 1 or more each semester. I, II, S**

Initiation and completion of research for advanced degree. Prerequisite: Approval of Department Head.

## DEPARTMENT OF AGRICULTURAL ENGINEERING

PRICE HOBGOOD\* (Head), O. R. KUNZE\*, E. T. SMERDON, J. W. SORENSON, L. H. WILKES

Agricultural engineering is a relatively new field. As the name implies, it involves both agriculture and engineering, but more specifically refers to the application of basic engineering principles and practices to agriculture and related industries. The growing need for an expanded and maximum agricultural production consistent with the greatest possible economy and efficiency has created numerous problems of an engineering nature. Some of these include the design of new mechanical devices for the cultivation, harvesting and storage of specific crops; the development of effective and efficient methods for the control of rainfall and water under various crop, soil, and

climatic conditions; the creation of new applications for the utilization of electricity and other development which will provide for greater efficiency.

This expansion in the field of agricultural engineering has created an increasing need for individuals having a thorough training in the basic science subjects, in certain basic and applied agricultural and engineering subjects, and in such humanistic subjects as English, history, and economics. A four-year course of study is seldom adequate to provide this broad training for the agricultural engineer, particularly if he plans to enter certain educational, research, or scientific fields of employment. For this reason, the Agricultural Engineering Department is able to offer advanced courses in various areas, including power and machinery, farm structures, land reclamation, drainage and irrigation, and rural electrification, whereby the student may obtain a more complete and thorough knowledge and training in any specific phase of agricultural engineering. A modern building and up-to-date equipment are available for graduate study in various fields.

**601. Instrumentation and Research Methods. (3-0). Credit 3. I**

Analysis of research techniques, scientific method, and design of experiments. Theory and use of instruments for research, particularly electrical-input transducers. Dimensional analysis, theory of similitude, design of research models, and development of prediction equations. Prerequisite: Approval of instructor.

**602. Irrigation and Drainage. (3-0). Credit 3. II**

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 none-steady state. Prerequisite: Ag.En. 410 or equivalent.

**603. Agricultural Machinery. (3-0). Credit 3. I**

Functional farm machinery design. Encompasses analysis of problem need, functional requirements, common materials used, design, testing, and production of efficient operational units. Prerequisites: Ag.En. 208; M.E. 313.

**605. Agricultural Structures. (3-0). Credit 3. I**

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. Prerequisites: Ag.En. 413, 418.

**606. Agricultural Process Engineering. (3-0). Credit 3. II**

Engineering principles involved in mechanical handling, cleaning and sorting, size reduction, conditioning, and storage of agricultural products. Includes use of refrigeration, electric energy, and radiation. Prerequisites: Ag.En. 418, 430; M.E. 323.

**609. Farm Power. (3-0). Credit 3. II**

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. Prerequisites: Ag.En. 324; M.E. 313, 323.

**613. Soil and Water Conservation Engineering. (2-3). Credit 3. I**

Soil and water conservation, with emphasis on hydrology of agricultural watersheds, soil erosion theory, functional design of soil and water conservation structures, methods of reducing water losses, and experimental techniques. Prerequisites: Ag.En. 428; C.E. 463.

**685. Problems. Credit 1 to 4 each semester. I, II**

Advanced laboratory or field problems not related to student's thesis. Prerequisite: Graduate classification.

**691. Research. Credit 1 or more each semester. I, II**

Research for thesis or dissertation.

## ANIMAL BREEDING

A major in animal breeding may be undertaken by selecting appropriate courses in genetics and in animal science, dairy science, or poultry science.

## ANIMAL NUTRITION

Advanced studies may be undertaken in the Departments of Animal, Dairy, and Poultry Sciences and Biochemistry and Nutrition with a major in animal nutrition. (Students entering this program should have adequate preparation in general biology or zoology, mathematics, chemistry, and physics. Deficiencies in the above areas may be corrected during the first year of graduate study.)

Candidates for degrees in animal nutrition may acquire advanced training in nutrition, biochemistry, mathematics, physiology, pathology, statistics, chemistry, physics and other pertinent areas in science and technology. At least one of the above areas, other than nutrition, should be selected as a minor subject and be emphasized in the degree program.

Various classes of animals, animal facilities, laboratories, and modern research equipment are available for use in research in most areas of ruminant and non-ruminant nutrition.

## ANIMAL PARASITOLOGY

S. O. BROWN, J. C. GAINES\*, R. L. HANNA, S. H. HOPKINS\*,  
M. A. PRICE, R. D. TURK\*

A major in animal parasitology may be undertaken by selecting appropriate courses in biology, entomology, and veterinary parasitology.

Graduate instruction is composed primarily of a detailed study of the more important parasites attacking man and domestic animals, including identification, relation to diseases, biological developments, control, and other special problems concerned with these parasites. Most of the more important ectoparasites of animals are insects and many of the endoparasites are dependent upon insects as vectors. Graduate instruction in this field is accomplished by closely correlating the graduate work offered in the respective Departments of Biology, Entomology, and Veterinary Parasitology. This arrangement makes available to the student the combined facilities of these departments. This combined course of study is intended primarily for the student working toward a Ph.D. degree.

For course descriptions of related courses, see the respective departmental listings for Biol. 627, 630; Ento. 613, 614, 615, 617, 618, 619, 691; V. Par. 601, 691.

## DEPARTMENT OF ANIMAL SCIENCE

J. C. BONSMAN, L. H. BREUER, O. D. BUTLER, JR. (Head), Z. L. CARPENTER, T. C. CARTWRIGHT, R. J. COOPER, F. I. DAHLBERG, W. C. ELLIS, FRED HALE, G. T. KING, H. O. KUNKEL, W. A. LANDMANN, J. K. RIGGS, J. M. SHELTON, A. M. SORENSEN, JR., D. F. WESELI

Advanced study in animal science prepares the graduate for a future in teaching, research, extension, livestock production, and the meats industry. Major subjects may be selected from the following:

Animal Breeding	(M.S. and Ph.D.)
Animal Nutrition	(M.S. and Ph.D.)
Livestock Production	(M.S.)
Meats	(M.S. and Ph.D.)
Physiology of Reproduction	(M.S. and Ph.D.)

The animal science subject matter fields are strongly supported by course work in the related Departments of Agricultural Economics and Sociology, Biochemistry and Nutrition, Biology, and in the departments of the College of Veterinary Medicine.

Livestock, laboratory facilities, and special equipment are available for research in the subject matter fields. The Data Processing Center with the most modern machines is used in analysis of research data.

No foreign language is required for the Master's degree. However, foreign language is recommended for those candidates who expect to go on for the Ph.D. Each thesis is to be written in a form acceptable for publication in a journal or bulletin in addition to the regularly submitted thesis manuscript.

\*Graduate Advisor

**600. Advanced Livestock Management. Credit 3. S**

Special 3-week workshop course for teachers of vocational agriculture to be offered during summer. Includes problems in all phases of animal production selected by group under supervision of instructor.

**604. Ruminant Nutrition. (3-0). Credit 3. I, S**

Survey of current knowledge and concepts in ruminant physiology and biochemistry, their literature and experimental basis and relation to current and future nutrition practice and investigation. Basis, applications, and limitations of methods and techniques in ruminant nutrition research. Prerequisites: An.Sc. 444; B.N. 410 or 611 and/or approval of Department Head.

**605, 606. Advancements in Beef Cattle Production. (3-0). Credit 3 each semester. I 1965, 1967; S 1966; II 1965, 1967; S 1966**

Review of research relating to various phases of cattle production. Evaluation of research application of basic principles to nutrition, animal breeding, disease control, and management of beef cattle. Prerequisites: An.Sc. 306, 406, or approval of Department Head.

**607. Meat Science and Research Techniques. (2-2). Credit 3. II 1966, 1968**

Emphasizes biochemical, histological, anatomical, and physical factors associated with transformation of muscle cell into meat. Prerequisite: An.Sc. 407 or approval of Department Head.

**616. Animal Genetics. (3-3). Credit 4. II 1966, 1968; S 1967**

Population and quantitative genetics as related to improvement of individuals or groups within species. Consideration of courses of change in gene frequency, selection methods, mating systems, and estimation of genetic parameters. Prerequisites: Gen. 603; Stat. 406.

**619, 620. Advancements in Sheep and Angora Goat Production. (3-0). Credit 3 each semester. I 1967; S 1965, II 1967**

Review of research relating to various phases of sheep and Angora goat enterprise. Evaluation of research; fitting sheep and Angora goats to whole farm and ranch system. Special attention to over-all economic operation. Prerequisites: An.Sc. 306, 414; or approval of Department Head.

**621, 622. Advancements in Swine Production. (3-0). Credit 3 each semester. I 1965; S 1966; II 1965; S 1966**

Review of research relating to various phases of swine enterprise. Evaluation of research; fitting swine to whole farm system. Special attention to over-all economic operation. Prerequisites: An.Sc. 306, 412; or approval of Department Head.

**628. Animal Breeding. (2-0). Credit 2. I 1967, 1969.**

Survey of current status of knowledge in field through critical review of literature emphasizing recent developments. Attention focused on methods and techniques for animal breeding and quantitative genetic research. Prerequisite: An.Sc. 616.

**631. Physiology of Reproduction. (2-2). Credit 3. II 1966, 1967; S 1965**

Critique of scientific literature on reproduction. Students compile, evaluate, and summarize literature. Research project proposals are formulated and evaluated. Current topics are discussed and experimental surgery is conducted in area of reproduction. Prerequisite: An.Sc. 433.

**681. Seminar. (1-0). Credit 1 each semester. I 1965, 1967; II 1965, 1966, 1967; S 1966.**

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.

**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. Prerequisite: Graduate classification.

**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. Prerequisite: Graduate classification.

## SCHOOL OF ARCHITECTURE

T. R. HOLLEMAN, J. H. MARSH, P. E. PATE, J. R. PATTERSON, E. J. ROMIENIEC (Chairman),  
M. M. ROTSCHE, WILLARD STRODE, R. F. WHITE

Graduate study in architecture is essentially a matter of individual effort. For this reason, the graduate program of the School is sufficiently broad in scope to encourage individual research in design, structures, history, environment (technology), landscape, and research. No sharp distinction is made between the six, the one being as important as the other in any comprehensive program. The work is so arranged as to enable the student to devote extensive units of his time to research and design and to the problems and construction and professional practice.

### 627. Contemporary and Creative Structures. (2-2). Credit 3. I

Studies and analyses of contemporary and creative structures as related to architectural design, with emphasis on esthetic considerations, structural limitations and design, functional use, construction procedures and estimates of cost. Prerequisite: Arch. 528 or equivalent.

### 628. Contemporary and Creative Structures. (2-2). Credit 3. II

Continuation of Arch. 627. Studies and analyses of contemporary and creative structures as related to architectural design with emphasis on esthetic considerations, structural limitations and design, functional use, construction procedures, and estimates of cost. Prerequisite: Arch. 627.

### 629, 630. History and Archaeology. (2-0). Credit 2 each semester. I, II

Individual problems of study and research in field of American architecture and archaeology.

### 681. Seminar. (1-0). Credit 1 each semester. I, II, S

Review of current work in architecture; original presentation on selected topics.

### 685. Problems. Credit 1 to 4. I, II, S

Individual problems involving application of theory and practice in design and construction of buildings and groups of buildings.

### 691. Research. Credit 2 to 4 each semester. I, II, S

Research for thesis.

## DEPARTMENT OF BIOCHEMISTRY AND NUTRITION

See also ANIMAL NUTRITION

B. J. CAMP, J. R. COUCH, C. R. CREGER, H. R. CROOKSHANK, H. H. DARON, J. W. DIECKERT, H. O. KUNKEL, W. A. LANDMANN, C. M. LYMAN\* (Head), P. F. PARKS, J. M. PRESCOTT, J. D. PRICE, RAYMOND REISER, L. R. RICHARDSON, E. S. VANDERZANT, U. G. WHITEHOUSE

Facilities and equipment are available for advanced instruction in various phases of biochemistry and nutrition. There is an adequate stock of the usual equipment necessary for metabolic, nutritional, and chemical work. The Department has adequate facilities for the use of radioactive isotopes as tracers for following specific chemical reactions in plant and animal tissues. Other special equipment includes an ultracentrifuge, automatic amino acid analyzers, gas chromatographic equipment, electron microscopes, Tiselius electrophoresis apparatus, Barcroft-Warburg tissue respiration apparatus, ultraviolet and infra-red spectrophotometers, high speed refrigerated centrifuges, and paper electrophoresis apparatus.

Research is in progress in the fields of vitamins, antibiotics, proteins, viruses, minerals, lipids, enzymatic systems, and microbiology. The Department cooperates with Animal Science, Dairy Science, Poultry Science, and other departments in studying the nutritional requirements of various farm animals. Research in plant biochemistry includes studies on the chemical structure of the poisonous constituents of range plants, and the biochemistry and cytology underlying the storage and mobilization of metals and proteins in seeds and seedlings.

Students planning to take work in biochemistry and nutrition should have adequate preparation in chemistry, the biological sciences, physics, and mathematics.

\*Graduate Advisor

A program in animal and poultry nutrition may be developed from the offerings of various departments and schools. Students desiring such a program should consult the Dean of Graduate Studies and the representatives of the appropriate departments.

**611. General Biochemistry. (3-0). Credit 3. I**

Chemistry of the principal constituents of living cells, with introduction to intermediary metabolism. Prerequisites: Chem. 228, 316, 318.

**612. Laboratory Procedures in Biochemistry. (0-6). Credit 2. I**

Laboratory course designed to familiarize student with application of chemical and biological methods to solution of fundamental biochemical problems. Prerequisite: B.N. 611 or registration therein.

**613. Vitamins. (3-0). Credit 3. II**

Role of vitamins in animal nutrition and metabolism. Occurrence in plant and animal tissues. Specific functions of vitamins in enzyme systems. Prerequisite: Chem. 228.

**614. The Determination of Vitamins and Minerals. (0-3). Credit 1. II**

Laboratory course designed to familiarize student with methods for determination of vitamins and minerals in biological materials. Prerequisite: B.N. 613 or registration therein.

**615. Experimental Animal Procedures. (0-3). Credit 1. II**

Laboratory course involving management, preparation of purified rations, and production and cure of nutritional diseases. Prerequisite: B.N. 614 or registration therein.

**618. Chemistry and Metabolism of Lipids. (2-0). Credit 2. II**

Advanced course in lipid chemistry and metabolism. Prerequisite: B.N. 611.

**619. Proteins. (2-0). Credit 2. I**

Advanced studies on chemical, physical, and biological properties of proteins. Particular emphasis placed on biological synthesis and metabolism of proteins. Prerequisite: B.N. 611.

**620. Advanced Biochemical Techniques. (0-6). Credit 2. S**

Laboratory course using special techniques and instruments in isolation, identification, and analysis of biological compounds. Prerequisites: B.N. 612, 624.

**624. Enzymes. (2-0). Credit 2. II**

General principles of enzyme chemistry. Physical chemistry of enzyme action. Types of enzymes and coenzymes. Enzymes in patterns of metabolism. Prerequisites: B.N. 611; Chem. 324 or 342; or approval of instructor.

**626. Radioisotopes Techniques. (2-3). Credit 3. I**

General course on the nature and utilization of isotopes in chemical and biochemical studies. History, general properties of nuclei, nuclear reactions, radiations; health physics and instrumentation. Prerequisites: Chem. 316, 317; Phys. 201, 202.

**627. Mineral Nutrition and Metabolism. (2-0). Credit 2. II**

Study of the role of minerals in animal nutrition with emphasis on physiological functions, biochemical interrelationships with other minerals and other nutrients, deficiency symptoms and nutritional significance. Prerequisite: B.N. 410 or 611.

**630. Metabolism. (3-0). Credit 3. II**

Descriptive consideration of various chemical pathways of metabolism. Prerequisites: B.N. 611, 613.

**632. Radioactive Tracer Techniques in Metabolism. (1-3). Credit 2. II**

Use of isotopes in measuring metabolic pool, precursor-product relationships, isotopic competition, cycles and intermediates, permeability, adsorption and absorption, and assay of common elements. Prerequisites: B.N. 612, 626, or approval of instructor.

**634. Techniques in Lipid Chemistry. (0-6). Credit 2. II**

Designed to acquaint student with recently developed techniques in chemical and biochemical investigations on lipids. Prerequisites: B.N. 612, 618 or registration therein.

**640. Clinical Chemistry. (2-6). Credit 4. II**

Study of the quantitative distribution of body constituents and their physiological interpretations. Prerequisites: B.N. 312 or 410 or 611, or Biol. 433, or V.P.P. 427.

**681. Seminar. (1-0). Credit 1 each semester. I, II**

Study and discussion of original articles in biochemistry and nutrition and related fields designed to broaden understanding of problems in the field and to stimulate research.

**685. Problems. Credit 1 or more each semester. I, II, S**

Advanced course in biochemical laboratory procedures including preparations and instrumentation. Problems assigned according to experience, interests, and needs of individual student.

**691. Research. Credit 1 or more each semester. I, II, S**

Research for thesis or dissertation. Laboratory facilities available for original investigations in various phases of biochemistry and nutrition. Prerequisite: Approval of major advisor.

(See Gen. 631 for full description of related course.)

## DEPARTMENT OF BIOLOGY

See also ANIMAL PARASITOLOGY and  
PHYSIOLOGY OF REPRODUCTION

S. O. BROWN, W. J. CLARK, L. S. DILLON, W. J. DOBSON, H. L. GRAVETT, S. H. HOPKINS\*,  
E. W. HUPP, G. M. KRISE, D. D. MCLAIN, JR., J. G. MACKIN (Head), A. B. MEDLEN, C. P. READ,  
J. J. SPERRY\*, M. H. SWEET, W. A. TABER

The graduate courses and research in biology include the three major fields of bacteriology, botany, and zoology, and the minor fields of aquatic biology, microtechnique, cytology, and physiology. Biology has its main applications in medicine, veterinary medicine, and the various agricultural fields including fisheries and wildlife management. The objective of graduate courses in biology is to train for research and teaching.

Courses in the biological sciences administered by the Department of Biology include sequential programs in botany, microbiology, and zoology. All courses, irrespective of subject matter area, bears the departmental designation (Biology), and a course number from a single numerical sequence. The nature of the offerings is more clearly indicated, however, by the subject matter groupings shown on the following pages.

### GENERAL BIOLOGY

**600. Teaching of High School Biology. (2-3). Credit 3. S**

Study of techniques of teaching biology in secondary school. Laboratory emphasizes exercises useful in high school biology laboratory. Prerequisite: Approval of Heads of Biology and Education and Psychology Departments.

**654. Radiation Biology. (3-0). Credit 3. I**

Review of physical theory of ionizing radiations important to living organisms; X-ray, gamma, alpha, beta and neutron. Survey of effects of ionizing radiations on biological systems. Prerequisite: Graduate classification in biological or agricultural science.

**655. Mammalian Radiation Biology. (3-0). Credit 3. II**

Lecture and demonstration on effects of X-ray, gamma, alpha, beta, and neutron radiation on mammalian organisms. Both early and delayed effects emphasized. Use of radioactive materials in mammalian biology will be introduced. Prerequisites: Biol. 433, 434, 654.

**660. Aquatic Ecology. (2-3). Credit 3. II**

Study of fresh water as an environment; its physical and chemical characteristics and plant and animal communities which inhabit it. Prerequisites: Biol. 327, 435 or equivalent; graduate classification or approval of instructor.

\*Graduate Advisor



**661. Cellular Physiology. (2-3). Credit 3. II**

Consideration of physiochemical nature of cell and its relationship to environment with emphasis on conversion of energy and matter as required by cell as living unit. Prerequisites: Graduate classification in biology or animal or plant science; approval of instructor.

**681. Seminar. (1-0). Credit 1. I, II**

Detailed reports on specific topics in field chosen. Prerequisite: Graduate classification in appropriate field.

**685. Problems. Credit 1 to 4 each semester. I, II**

Limited investigations in fields other than those chosen for thesis or dissertation.

**691. Research. Credit 1 or more each semester. I, II**

Research for thesis or dissertation. Prerequisite: Approval of ranking professor in field chosen.

**BOTANY****608. Ecology and Taxonomy of the Algae. (2-6). Credit 4. I**

Study of form, structure, reproduction, and ecology of the algae. Prerequisite: Biol. 327 or 353 or approval of instructor. (Offered in 1964-65 and in alternate years thereafter.)

**615. Cytology. (2-6). Credit 4. I**

Intensive study of organization and activities of cell, with emphasis on topics related to cytogenetics and cytotaxonomy. Prerequisites: Gen. 301; approval of instructor.

**619. Systematic Botany. (2-6). Credit 4. I**

Phylogenetic considerations and criteria. History of classification. Nomenclature and identification. Field and herbarium techniques. Prerequisites: Biol. 102, 327, or approval of instructor.

**620. Systematic Botany. (2-6). Credit 4. II**

Survey of Angiosperms. Biosystematics and modern taxonomy. Procedures in monograph preparation. Monographers. Field and herbarium techniques. Prerequisite: Biol. 619.

**623. Plant Morphology. (2-6). Credit 4. II**

Study of anatomical, reproductive, and ontogenetic and phylogenetic features of representative vascular plants. Prerequisite: Biol. 327 or equivalent.

**651. Mycology. (2-6). Credit 4. II**

Detailed studies of fungi, with emphasis on life cycles of representative forms; genetics and cytology; taxonomy; ecology. Prerequisite: Biol. 353 or approval of instructor. (Offered in 1965-66 and in alternate years thereafter.)

**MICROBIOLOGY****635. Physiology of Microorganisms. (2-6). Credit 4. I**

Advanced consideration of physiological activities of bacteria with special emphasis on metabolism. Prerequisite: B.N. 312 or 410. (Offered in 1964-65 and in alternate years thereafter.)

**647. Industrial Microbiology. (2-6). Credit 4. II**

Microorganism as basis of industrial processes. Practice includes antibiotic assay; analysis of products of metabolism, and fermentation balances. Prerequisites: B.N. 312 or 410. (Offered in 1965-66 and in alternate years thereafter.)

(See Biol. 608, 630, 651; P.P.P. 607, 618, 620 for descriptions of related courses.)

**ZOOLOGY****603. Advanced Vertebrate Zoology. (1-5). Credit 3. II**

Phylogeny of vertebrates based on comparative anatomy, histology, embryology, and distribution. Prerequisites: Biol. 218, 343, 344, or equivalent.

**604. Advanced Embryology. (1-5). Credit 3. I**

Comparative and experimental studies of mechanics of embryonic development. Prerequisites: Biol. 218, 343, 344, or equivalent. (Offered in 1964-65 and in alternate years thereafter.)

**627. Helminthology. (3-3). Credit 4. I**

Study of parasitic worms, especially Trematoda, Cestoda, Nematoda, and Acanthocephala. Prerequisite: Biol. 436. (Offered in 1964-65 and in alternate years thereafter.)

**630. Protozoology. (3-3). Credit 4. I**

Morphology, taxonomy, physiology, reproduction, phylogeny, ecology, and life history of both free living and parasitic protozoa. Prerequisite: Biol. 108. (Offered in 1965-66 and in alternate years thereafter.)

**632. Methods in General Physiology. (2-6). Credit 4. II**

Methods for quantitative study of metabolism, respiration, circulation, excretion, movement, and other basic physiological phenomena. Recent advances in physiological methods presented on seminar basis. Prerequisite: Biol. 433 or equivalent.

**649. Biology of the Endocrine Glands. (3-3). Credit 4. I**

Study of structure, development, comparative anatomy, and physiology of endocrine glands of different animal groups. Prerequisites: Three hours of either anatomy or anatomy and physiology.

**653. Zoogeography. (3-0). Credit 3. II**

Study of distribution of animals during geologic and present times; emphasis on role of ecology and effects of geography upon terrestrial and marine distribution. Prerequisite: Twelve hours of biological sciences, including at least 3 hours of advanced courses.

**656. Analytical Histology. (2-6). Credit 4. II**

Designed to acquaint student with certain quantitative histochemical techniques in plant and animal science as applied to nucleoproteins, carbohydrates, lipids, and enzymes. Prerequisites: Biol. 343 or 453 or equivalent; Chem. 227.

**662. Biology of the Mollusca. (3-3). Credit 4. I, II, S**

Conferences and laboratory work on classification, life history, morphology, physiology, ecology, diseases, parasites, predators, and competitors of molluscs, with special reference to oysters. Prerequisite: B.S. degree in biology or related fields, or approval of instructor.

## SCHOOL OF BUSINESS ADMINISTRATION

L. P. BURGESS, R. L. ELKINS, P. B. GOODE, S. C. HOYLE, JR., T. D. LETBETTER,  
W. S. MANNING, E. S. PACKENHAM, J. E. PEARSON (Head), G. H. RICE, JR.,  
R. M. STEVENSON\*, H. G. THOMPSON, JR.

The graduate work in business administration is designed to train students for research or for careers in business and government where the student desires a more advanced program than is offered at the undergraduate level.

Graduate students may specialize in Accounting, Computer Science, Organization and Administration, or Statistics.

The holder of a Bachelor's Degree in Business Administration will normally be prepared to go directly into courses in a professional field. The holder of a Bachelor's degree not in Business Administration will take the following pre-professional business and economics courses, excluding, however, courses covering areas in which he has shown proficiency: B.A. 640, 643, 646, 649, 652, 655.

**601. Statement Analysis. (3-0). Credit 3. II, S**

An analytical study of different kinds of statements for guidance of executives, investors, and creditors; balance sheet and profit and loss ratios. Prerequisite: B.A. 330.

**602. Consolidated Statements. (3-0). Credit 3. II**

Consolidated balance sheets, consolidated income and surplus statements, holding companies, mergers. Prerequisite: B.A. 330.

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**605. Accounting Problems. (3-0). Credit 3. I**

Advanced accounting theory and problems dealing primarily with corporation accounting, assets and liabilities, analysis of statements, and cost accounting. Prerequisite: Approval of instructor.

**606. Accounting Problems. (3-0). Credit 3. II**

Continuation of B.A. 605. Topics will deal primarily with partnerships, fiduciaries, home office and branch, insurance, and auditing. Prerequisite: Approval of instructor.

**609. Management Seminar. (3-0). Credit 3. I, S**

Study of organization theory and its application to business systems. Prerequisite: Approval of instructor.

**612. Advanced Taxes. (2-0). Credit 2. II**

Study of special income tax problems of taxpayers; Federal estate and gift taxes; Texas inheritance tax; Texas franchise tax on corporations; claims for refund of taxes. Prerequisite: B.A. 403.

**616. Governmental and Institutional Accounting. (3-0). Credit 3. I, S**

Study of accounting principles and procedures peculiar to governmental units and institutions. Prerequisite: B.A. 328. Econ. 412 recommended.

**622. Trade Regulations. (3-0). Credit 3. II, S**

Governmental control including Federal anti-trust acts; Federal Trade Commission and unauthorized business practices; price discrimination and retail price maintenance. Prerequisite: B.A. 211.

**630. Problems of Corporation Finance. (3-0). Credit 3. I**

Financial problems of corporation are analyzed, including current financing, re-funding operations, dividend policies, and corporate reorganization. Prerequisite: B.A. 341.

**640. Accounting Concepts and Procedures. (3-0). Credit 3.**

Accounting concepts and relationships essential to administrative decisions; use of accounting statements and reports as policy-making and policy-execution tools. Prerequisites: Graduate classification; approval of graduate advisor.

**643. Legal Relationships. (3-0). Credit 3. II, S**

Various relationships based on law encountered by business executive; agreements; circumstantial relationships; and governmental responsibilities. Prerequisites: Graduate classification; approval of graduate advisor.

**646. Business Trends, Fluctuation, and Measurements. (3-0). Credit 3. I, S**

Study of business trends and economic fluctuations; theory; causes and control of cyclical behavior; analytical forecasting; economic and statistical services. Prerequisites: Graduate classification; approval of graduate advisor.

**649. Survey of Marketing. (3-0). Credit 3. I, II, S**

Analysis of marketing functions and institutions; marketing mix related to consumers, trade, and industrial products. Emphasis on terminology and essential concepts. Prerequisites: Graduate classification; approval of graduate advisor.

**652. Financial Management. (3-0). Credit 3. I, II, S**

Financial policies and practices in business firm; finance function, financial control and organization; financial analysis and planning. Prerequisites: Graduate classification; approval of graduate advisor.

**655. Survey of Management. (3-0). Credit 3. I, II, S**

Personnel and production management practices and theories; organization, plant layout, efficiency studies, control administration, personnel methods and techniques, and human relations. Prerequisites: Graduate classification; approval of graduate advisor.

**663. Legal Environment of Business. (3-0). Credit 3. I, S**

Constitutional and legislative enactments; stare decisis and judicial process; regulation of commerce; taxation and regulation of competition, business and labor. Prerequisites: Graduate classification in business administration; approval of graduate advisor.

**666. Quantitative Analysis for Business Decisions. (3-0). Credit 3. II, S**

Quantitative techniques including statistics, inventory control, game theory, capital budgeting, simulation, linear programming, pricing. Prerequisites: Graduate classification in business administration; approval of graduate advisor.

**669. Accounting Theory. (3-0). Credit 3. II, S**

Appraisal of concepts and standards underlying accounting procedures. Includes developments and trends in theory. Prerequisites: Graduate classification in business administration; approval of graduate advisor.

**672. Management Information Systems. (3-0). Credit 3. I, S**

Integrative approach to data processing and management information systems with emphasis on data flow, systems analysis and design, and information economics. Prerequisites: Graduate classification in business administration; approval of graduate advisor.

**675. Marketing Management. (3-0). Credit 3. II, S**

Analysis of 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; approval of graduate advisor.

**678. Management Accounting. (3-0). Credit 3. I, S**

Problems, cases, and readings; use of accounting data in planning business operations and policies. Prerequisites: Graduate classification in business administration; approval of graduate advisor.

**680. Business Policy. (3-0). Credit 3. I, II, S**

Case study governing functions of production, distribution, and finance; analysis and decision making; a comprehensive business game. Prerequisites: Graduate classification in business administration; approval of graduate advisor.

**681. Seminar. (1-0). Credit 1 each semester. I, II**

Critical examination of subject matter presented in current periodicals, recent monographs and bulletins. Separate seminars may be offered in accounting, finance, marketing, management, and statistics.

**685. Problems. Credit 1 to 3 each semester. I, II, S**

Directed study on selected problems using recent developments in business research methods. Prerequisites: Graduate classification; approval of instructor.

**691. Research. Credit 1 or more each semester. I, II, S**

Research for thesis.

## DEPARTMENT OF CHEMICAL ENGINEERING

R. R. DAVISON, L. D. DURBIN, P. T. EUBANK\*, W. B. HARRIS, W. D. HARRIS,  
C. D. HOLLAND\* (Head), J. D. LINDSAY, W. W. MEINKE

The graduate program in chemical engineering is designed to give the student a well-rounded training in the fundamentals of chemical engineering and in research methods. The courses given cover various unit operations and chemical engineering thermodynamics, economics, transport phenomena, and process control. The applications courses utilize mainly petroleum and other hydrocarbon process data to develop examples of methods which are of general applicability. Courses devoted to specialized industrial technology are given, but the major emphasis is on fundamentals.

Research is an integral part of the work leading to an advanced degree. The department specializes particularly in research on heat transfer, solar heating, non-Newtonian flow, thermodynamics, distillation, extraction, process control, water purification, microbiological transformations, electrochemistry, chemical reactor design and optimization, and chemical engineering kinetics and catalysis.

The research facilities include, in addition to standard laboratory equipment, several precision analytical distillation columns, vapor-phase chromatograph, ultra-violet and infra-red spectrometers, high speed movie and other photographic equipment, high speed recorders, digital data logging equipment, and a medium size electronic

\*Graduate Advisor

analog computer. Many other specialized pieces of equipment are contained in the laboratories where the work in the areas of specialization is performed. In addition, the facilities of the Data Processing Center are available for use in the correlation of experimental results and for the analysis of mathematical models of chemical processes.

**605. Chemical Engineering Economics. (3-0). Credit 3. I**

Advanced calculations involving process design and process control as limited by least cost or maximum profit. Problems based on various unit operations and unit processes. Prerequisite: Ch.E. 423.

**606. Unit Operations. (3-0). Credit 3. II**

Applications of chemical engineering fundamentals in manufacture of chemicals, refining petroleum, and other allied industries. Prerequisite: Ch.E. 423.

**608. Heat Transmission. (3-0). Credit 3. I**

Process and process design calculations on equipment involving transfer of heat by conduction, convection, and radiation. Prerequisite: Ch.E. 423.

**612. Distillation. (3-0). Credit 3. I**

Process and process design calculations involving distillation of multi-component and complex systems. Extractive and azeotropic distillation are covered. Prerequisite: Ch.E. 423.

**619. Corrosion and Materials of Construction. (3-0). Credit 3. I**

Uses of materials of construction to preclude high corrosion rates in process equipment. Prerequisite: Ch.E. 423.

**623. Applications of Thermodynamics to Chemical Engineering. (3-0). Credit 3. II**

Study of applications of thermodynamics to chemical engineering operations and processes. Prerequisite: Ch.E. 454.

**624. Chemical Engineering Kinetics I. (3-0). Credit 3. I**

Study of rates and mechanisms of chemical reactions. Thermal and catalytic reactions both homogeneous and heterogeneous are considered. Prerequisite: Ch.E. 423.

**625. Chemical Engineering Kinetics II. (3-0). Credit 3. II**

Study of physical factors affecting chemical reaction rates and of methods for design of reaction equipment. Prerequisite: Ch.E. 624.

**626. Oil and Fat Technology. (3-0). Credit 3. I**

Study of composition and properties of oils and fats, methods of extraction and purification, and their industrial utilization. Prerequisites: Ch.E. 423; Chem. 228.

**627. Oil Mill Operation. (2-6). Credit 4. I**

Study of theoretical and practical operating characteristics of various units used in vegetable oil production. Economic factors of each unit and their over-all effect on plant operation. Prerequisite: Ch.E. 626 or registration therein.

**629. Transport Phenomena. (3-0). Credit 3. I**

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. 454.

**631. Process Dynamics I. (3-0). Credit 3. I**

Study of 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.

**632. Process Dynamics II. (3-0). Credit 3. II**

Continuation of Ch.E. 631. Theory and application of discrete, non-linear, and stochastic dynamic analysis and optimal design policies to processes in chemical and allied fields. Prerequisite: Ch.E. 631.

**681. Seminar. (1-0). No credit. I, II**

Graduate students will be required to attend one hour per week to discuss problems of current importance in connection with their research.

**685. Problems. Credit 1 to 6. I, II, S**

The work covers one or more of numerous problems in chemical engineering processes and operations. Prerequisite: Approval of Department Head.

**691. Research. Credit 1 or more each semester. I, II, S**

Problems of unit operations and unit processes. For maximum credit comprehensive thesis must be prepared of sufficiently high calibre to permit publication in scientific and technical journals. Prerequisite: Approval of Department Head.

**DEPARTMENT OF CHEMISTRY**

R. B. ALEXANDER, P. K. CALAWAY, D. C. CONWAY, ALFRED DANTI, F. R. DUKE,  
J. K. GLADDEN, C. K. HANCOCK, R. M. HEDGES, D. W. HOOD, A. F. ISBELL,  
J. L. JONES, R. N. KUST, M. P. MENON, E. A. MEYERS, J. O. PAGE,  
HENRY RAKOFF, N. C. ROSE, FRED SICILIO, A. D. SUTTLE, JR.,  
R. N. TRAXLER, R. D. WHEALY, R. A. ZINGARO,  
B. J. ZWOLINSKI\* (Head)

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 more of his time in research. The dissertation which results from this research must satisfactorily demonstrate that the student is capable of (1) independent and creative research in a specialized area of chemistry and (2) that the student has a superior knowledge and understanding of this 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.

Opportunities for research are available to the graduate student in a variety of specialized areas. Those areas in which research activities currently are available include organic phosphorus compounds, halogenated dienes, natural products, compounds of pharmacological activity, relationship of physical and chemical properties of organic compounds to their structure, and studies of organic reagents for use in inorganic analysis. Other opportunities are found in the areas of kinetics, passivity of aluminum, molecular ultra violet spectroscopy and molecular quantum mechanics, and X-ray diffraction studies of crystal and molecular structure. There are also research opportunities in the areas of gas chromatography, oxidation-reduction potentials, solubility studies in non-aqueous solvents, phase studies, and inorganic compounds. Too, research is being done in the chemical deposition of semi-conducting surface films, positive halogen ions, chemical reactions in liquid hydrogen telluride, and inorganic charge-transfer complexes. Other areas of study are found in excess thermodynamic properties of binary liquid solutions; and the entropy, enthalpy, and free energy of transfer of simple salts from non-aqueous to aqueous solutions. In addition one might work with the analytical determination of ferrous metals in ores and the chemistry of metal complexes and development of analytical methods via complexation.

**600. Survey of Chemistry. (2-3). Credit 3. I**

Survey course designed for teachers of high school chemistry. Prerequisites: Graduate classification; approval of Heads of Departments of Chemistry and of Education and Psychology.

**607. Organic Techniques and Preparations. (1-6). Credit 3. II**

Study of laboratory operations theory and description and comparison of equipment used in advanced work. Application of techniques of organic chemistry in laboratory. Prerequisite: Chem. 646 or registration therein.

**608. Qualitative Organic Analysis. (1-6). Credit 3. I**

Analysis of organic compounds. Prerequisite: Chem. 228.

**609. Theory of Organic Chemistry. (3-0). Credit 3. II**

Development and application of chemical theories to organic compounds. Prerequisite: Chem. 646.

\*Graduate Advisor

**610. Organic Reactions. (3-0). Credit 3. II**

Relatively detailed study of organic reactions, not only those commonly described in undergraduate course but also the less well known but equally useful reactions. Advantages and limitations of these reactions in organic syntheses. Prerequisites: Chem. 609, 646 or their equivalent.

**611. Principles of Physical Chemistry. (3-0). Credit 3. I**

Study of general principles of chemistry from quantitative standpoint. Discussion of gases, liquids, and solutions. Prerequisite: Graduate classification.

**620. Principles of Chemical Analysis. (3-0). Credit 3. II**

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. I**

Study of some of present theories about chemical reaction rates and mechanisms. Prerequisite: Chem. 324.

**624. Physico-Organic Chemistry. (3-0). Credit 3. II**

Mathematical and quantitative investigation of organic chemical phenomena. Prerequisite: Chem. 609 or approval of instructor.

**625. Petroleum Chemistry. (3-0). Credit 3. II**

Practical and theoretical consideration of chemical reactions of petroleum hydrocarbons. Prerequisites: Chem. 228, 324. (Offered in 1965-66 and in alternate years thereafter.)

**626. Thermodynamics. (3-0). Credit 3. I**

Theory and applications of classical thermodynamic functions. Prerequisite: Chem. 324.

**627. Diffraction Methods. (3-0). Credit 3. II**

Introduction to use of 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.

**628. The Non-Metallic Elements. (3-0). Credit 3. I**

Study of non-metals and their compounds. Recent developments. Knowledge of German or French desirable. Prerequisite: Chem. 324.

**630. The Metallic Elements. (3-0). Credit 3. I**

Study of metals and their compounds. Recent developments. Knowledge of German or French desirable. Prerequisite: Chem. 324.

**631. Statistical Thermodynamics. (3-0). Credit 3. II**

Introduction to methods of statistical mechanics based primarily on Boltzmann statistics. Approach to thermodynamics through partition function. Statistical concept of entropy. Prerequisite: Chem. 626.

**635. Heterocyclic Compounds. (3-0). Credit 3. I**

Structure, preparation, and properties of heterocyclic compounds with special emphasis on those with biological activity. Prerequisite: Chem. 228. (Offered in 1964-65 and in alternate years thereafter.)

**636. Electrochemistry. (3-0). Credit 3. I**

Advanced treatment of conductivity, electrochemical thermodynamics, galvanic cells, electrodeposition, and corrosion. Prerequisite: Chem. 324.

**639. Instrumental Methods of Analysis. (2-3). Credit 3. I**

Study of theory and practice of modern techniques of chemical analysis. Laboratory work illustrates use of these instruments for routine analytical work and as research tools. Prerequisite: Chem. 317.

**641. Structural Inorganic Chemistry. (3-0). Credit 3. I**

Study of nuclear and extranuclear structure, isotopes, valency of elements, and stereochemistry of inorganic compounds. Prerequisite: Chem. 462.

**642. Methods of Structural Chemistry. (3-0). Credit 3. II**

Study of theory, methods, and application of structural determination (arrangement and bonding) of chemical species. Prerequisite: Chem. 641 or approval of instructor. (Offered in 1964-65 and in alternate years thereafter.)

**643. Inorganic Complex Compounds. (3-0). Credit 3. II**

History, theories, and methods of investigations of inorganic complex compounds. Prerequisite: Chem. 462. (Offered in 1965-66 and in alternate years thereafter.)

**644. Quantitative Organic Analysis. (1-6). Credit 3. I**

Determinations: Macro Dumas, sulfur, Carius halogen, Micro residue, fractionation, Micro Dumas, catalytic hydrogenation, carbon and hydrogen, Micro Kjeldahl, Rast molecular weight, molar refraction, active hydrogen, alkoxyl, semi-micro saponification number. Prerequisites: Chem. 228; reading knowledge of German.

**646. Organic Chemistry. (3-0). Credit 3. I**

Systematic and thorough presentation of organic chemistry on advanced level. Prerequisite: Chem. 228.

**648. Principles of Quantum Mechanics. (3-0). Credit 3. I**

Brief review of 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. II**

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. II**

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.

**661. Radiochemistry. (2-3). Credit 3. II**

General course dealing with radioactive materials; their radiations; their preparation, purification, detection, identification, and their practical applications. Material on nuclear structures, nuclear transmutations, and radioactivity. Prerequisite: Chem. 324.

**685. Problems. Credit 1 to 6. I, II, S**

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.

**691. Research. Credit 1 or more each semester. I, II, S**

Research for thesis or dissertation.

## DEPARTMENT OF CIVIL ENGINEERING

J. B. BATY, F. J. BENSON, S. J. BUCHANAN, W. B. DAVIS, D. R. DREW, W. A. DUNLAP,  
C. R. FOSTER, H. L. FURR, B. M. GALLAWAY, ROY W. HANN, JR., E. L. HARRINGTON,  
T. J. HIRSCH, R. M. HOLCOMB, D. L. IVEY, R. A. JIMENEZ, C. J. KEESE,  
W. B. LEDBETTER, W. R. MCCASLAND, J. A. ORR, CHARLES PINNELL,  
C. H. SAMSON, JR.\* (Head), R. E. SCHILLER, JR., F. H. SCRIVNER,  
E. T. SMERDON, J. H. SORRELS, R. N. TRAXLER,  
JOSEPH WATTLEWORTH, S. R. WRIGHT

Sufficient graduate courses are offered in civil engineering to permit a student to specialize in a particular branch of civil engineering. These courses are designed to acquaint the student with the new developments in a particular field and to permit the student to study some of the more advanced problems not covered in the undergraduate curriculum. The Department is especially well equipped to teach courses in construction engineering, environmental engineering, foundation engineering and soil mechanics, hydraulic engineering and fluid mechanics, materials engineering, public works engineering, structural engineering and structural mechanics, surveying and photogrammetry, transportation engineering, urban management, and urban planning.

\*Graduate Advisor



**601, 602. City Management. (4-0). Credit 4 each semester. I, II**

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. Sewage Treatment and Stream Sanitation. (4-0). Credit 4. I**

Processes of sewage treatment and requirements regarding quality of sewage treatment plant effluents in relation to sanitary protection of receiving waters. Prerequisite: C.E. 402.

**604. Water Quality and Treatment. (4-0). Credit 4. II**

Characteristics of available sources of water, standards of quality of public water supplies, and theories of treatment and purification processes, with special attention given to details of methods and units employed to effect these processes. Prerequisite: C.E. 402.

**607, 608. Environmental Sanitation. (4-0). Credit 4 each semester. I, II**

Environment and its relation to disease; rodent control; sanitation of milk, shellfish, and other foods; collection and disposal of municipal refuse; sanitary aspects of air conditioning; housing sanitation; rural water supply and excreta disposal; sanitary inspection procedure.

**610. Industrial Wastes. (4-0). Credit 4. II**

Amount and characteristics of common industrial wastes; their effects upon sewage treatment; methods of treatment. Prerequisite: C.E. 301 or equivalent.

**612. Transportation in City Planning. (2-0). Credit 2. I, S**

Importance of transportation in urban development and planning. Role of engineer in planning. Relationship of transportation to planning studies, land use, zoning, planning legislation, and administration. Prerequisite: Graduate classification in College of Engineering.

**615. Structural Design of Flexible Pavements. (2-0). Credit 2. I**

Characteristics of pavement loads, stress analysis in flexible pavements, design practices, construction and maintenance. Prerequisite: C.E. 307.

**617. Traffic Engineering: Characteristics. (2-3). Credit 3. I**

Advanced theory and practice of engineering studies of traffic characteristics. Methods of traffic administration. Prerequisite: C.E. 457.

**618. Traffic Engineering: Operations. (2-3). Credit 3. II**

Advanced theory and application of traffic control and design of traffic facilities. Traffic regulations. Prerequisite: C.E. 617.

**619. Highway Problems Analysis. (2-3). Credit 3. II**

Advanced techniques in statistics, aerial photogrammetry, and data processing in solution of problems in highway and traffic design and research. Students should have knowledge of computer programming and basic statistics. Prerequisites: C.E. 617; I.En. 414.

**620. Structural Design of Rigid Pavements. (2-0). Credit 2. II**

Theory of rigid pavement design, design practices, maintenance, and construction. Prerequisite: C.E. 307.

**621. Advanced Reinforced Concrete Design. (3-3). Credit 4. I**

Flat slabs, continuous building frames, torsion, deep beams, bulk storage structures, creep and temperature change effects. Prerequisite: C.E. 444.

**622. Hydraulics of Drainage Structures. (2-3). Credit 3. II**

Hydraulics of open channels, bridge openings, culverts, head walls, surface street drainage, storm sewers, gutters, drop inlets and spillways. Theory of model studies as applied to drainage of highways, streets, and freeways. Prerequisite: C.E. 338 or equivalent.

**625. Geometric Design of Highways. (2-3). Credit 3. I**

Advanced theory and practice in highway design. Design controls and criteria, elements of design, design of alignment, cross-section, intersections and interchanges, multilane expressways, and drainage structures. Prerequisites: C.E. 307, 365.

**627. Hydrology. (3-3). Credit 4. I.**

Precipitation, stream gaging methods, evaporation and transpiration, groundwater, hydrograph analysis, flood hydrographs from rainfall and snow, snow melt. Stream flow routing, frequency and duration. Studies, sedimentation, storage reservoir design, graphical correlation, airfield drainage.

**628. Hydraulic Engineering. (3-3). Credit 4. II**

Boundary layer theory, fluid flow in pipes, complex pipe networks, dimensional analysis, similitude and models, gradually and rapidly varied flow in open channels, backwater curves in natural streams, stilling basin design problems.

**629. Hydraulics of Open Channels. (3-3). Credit 4. I**

Advanced problems in uniform and non-uniform flow in open channels; hydraulic jump; control section; backwater profiles.

**632. Advanced Design in Metals. (2-3). Credit 3. II**

Properties of high-strength and other special materials. Stress concentrations and fatigue. Design of complex members and connections such as: curved columns, fixed bases, and rigid-frame knees. Prerequisites: C.E. 483; S.M. 468.

**633. Advanced Mechanics of Materials. (4-0). Credit 4. II, S**

Stresses and strains at a point, torsion of non-circular 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. Airfield Planning and Design. (2-0). Credit 2. II**

Regional planning, air traffic routing, landing requirements, methods for development of master plans for site selection, airfield design requirements involving layouts, pavement selection, and design. Review and application of criteria of design of drainage for all types of fields.

**636. City Street Design. (2-0). Credit 2. S**

Street classification and function. Design of city streets, intersections, access drives, and pavements. Street drainage. Financing city street improvements. Prerequisite: C.E. 307.

**640. Freeway Design and Operation. (2-0). Credit 2. S**

Characteristics of traffic flow on controlled access facilities. Advanced theory and practice in operation on freeways and related street systems. Freeway traffic control. Material based on advanced research of Texas Transportation Institute. Prerequisite: C.E. 618.

**643. Plastic Analysis and Design in Steel. (2-3). Credit 3. I, S**

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.

**649. Soil Mechanics. (3-3). Credit 4. I**

Study of foundation materials as they exist and of various types of soils, their physical properties, testing procedure, and principles of classification. Prerequisites: C.E. 365; Geol. 320.

**650. Soil Mechanics. (3-3). Credit 4. II**

Foundation exploration, laboratory investigations of undisturbed foundation samples, stress distribution through soils; foundation design, correlation of settlement data from actual observations, stability of embankments, backfill pressures. Prerequisite: C.E. 649.

**651. Advanced Theory and Application of Soil Mechanics. (3-3). Credit 4. I**

Special lectures, discussions and applications of theory to solution of major problems encountered in practice of soil engineering, embracing the fields of seepage, earth work design, foundation design, port structures, and special problems. Prerequisite: C.E. 650.

**653. Flexible Materials of Construction. (2-3). Credit 3. I**

Theory supplemented with laboratory tests of bitumen, tars, and plastics. Stabilization of base and subgrade materials. Advanced mix design and evaluation of test methods; rheology and chemistry of asphalt. Prerequisite: C.E. 417.

**654. Rigid Materials of Construction. (2-3). Credit 3. II**

Physical and chemical properties of rigid materials of construction; laboratory tests of different kinds of concrete, tests of metals and laminates; theory of corrosion of ferrous metal; corrosion mitigation; shrinkage and plastic flow of stressed concrete; design of concrete mixtures. Prerequisite: C.E. 443.

**656. Concrete Structures Testing Laboratory. (1-3). Credit 2. II**

Methods and equipment used in testing reinforced concrete structures and elements of structures. Observations of behavior in compression, flexure, shear, torsion, and combinations thereof. Correlations with theory, both elastic and plastic. Prerequisite: C.E. 621.

**657. Dynamic Loads and Structural Behavior. (3-3). Credit 4. I**

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: C.E. 483; M.E. 459; S.M. 468.

**659. Structural Design. (3-3). Credit 4. II**

General theory and design procedures for thin-shell and folded-plate structures. Characteristics, use, construction, problems, and economic factors. Membrane theory for shells. Edge effects and effects of unsymmetrical loading. Prerequisite: S.M. 469 or equivalent.

**664. Water Resources Development. (3-0). Credit 3. II**

Conservation and utilization of water resources with emphasis on legal, social, and economic phases of watershed planning and multi-purpose projects. Prerequisites: Graduate classification; approval of Department Head.

**666. Foundation Structures. (2-3). Credit 3. II**

Spread footings, combined footings, and raft foundations. Retaining walls, piles, and pile foundations. Sheet-pile structures, cofferdams, wharves, and piers. Bridge piers and abutments. Prerequisites: C.E. 365 or equivalent; graduate classification in civil engineering.

**667. Highway Structures. (3-3). Credit 4. I**

Structural analysis and design of bridges, grade separation structures, retaining walls, and culverts. Loads, materials, comparisons of different types, and economic proportions. Current standards, new developments, and current cost information. Prerequisites: C.E. 483, 625.

**669. Bituminous Technology. (2-0). Credit 2. I, II**

Methods and techniques used in evaluating chemical, physical, colloidal and rheological properties of asphaltic materials. Available data will be discussed and a study made of methods for evaluating durability of asphalt. Prerequisite: C.E. 417.

**670. Bituminous Technology. (2-0). Credit 2. I, II**

Procedures used in selecting and processing crude oil for manufacture of asphalt; fundamental properties of asphaltic cutbacks, asphalt emulsions and mineral filled bitumens. Requirements of asphalts for use in roads, roofing and special applications. Prerequisite: C.E. 669.

**671. Urban Transportation Planning. (2-0). Credit 2. S**

Urban transportation problem. Techniques of estimating demand for traffic facilities. Special studies required in transportation planning. Prerequisite: C.E. 617.

**672. Urban Transportation Planning. (2-0). Credit 2. S**

Problems of mass transportation. Study of central business district, suburban shopping centers and terminal planning. Street and subdivision transportation system planning. Urban transportation economics, financing, and administration. Prerequisite: C.E. 671.

**681. Seminar. (0-2). Credit 1. I, II, S**

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. Prerequisite: Graduate classification.

**685. Problems. Credit 1 to 6 each semester. I, II, S**

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.

**691. Research. Credit 1 or more each semester. I, II, S**

Research for thesis or dissertation.

(See S.M. 601, 602, 603, 604, 605, 606, 607, 608, 609 for descriptions of related courses.)

**DEPARTMENT OF DAIRY SCIENCE**

See also **ANIMAL BREEDING** and **ANIMAL NUTRITION**

M. A. BROWN, R. E. LEIGHTON (Acting Head), A. V. MOORE, I. I. PETERS,  
I. W. RUPEL (Head), CARL VANDERZANT

Graduate work leading to the M.S. and Ph.D. degrees is offered in dairy production and dairy manufacturing. The dairy herds, numbering some 400 head, afford opportunities to study various problems in nutrition, breeding, artificial insemination, and management.

The various processing operations and the procedures in bacteriological and technical control provide opportunities for graduate research study. Experiment Station projects are under way in both production and manufacturing. Such projects offer an opportunity for the graduate student to study these and allied problems.

Minors or joint majors, or both, in such areas as Biochemistry and Nutrition, Genetics, and others, according to the field of interest of the candidate, readily may be arranged.

**601, 602. Dairy Production. (2-6). Credit 4 each semester. I, II**

Advanced study of dairy production, feeding, breeding, and management. Prerequisite: D.S. 418.

**603, 604. Dairy Manufacturers. (2-6). Credit 4 each semester. I, II**

Advanced study of dairy manufactures. Prerequisites: Graduate classification; approval of instructor.

**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 manufacturers and not pertaining to thesis or dissertation. Prerequisite: Graduate classification.

**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 manufacturers. Prerequisite: Graduate classification.

**DEPARTMENT OF ECONOMICS**

A. F. CHALK\* (Head), I. O. LINGER

Graduate study in economics is offered leading to the degree of Master of Science. Curricular offerings are designed to equip the student with a specialized knowledge for careers in teaching, government, and business, and to give a sound preparation for continuing graduate study toward the doctorate elsewhere.

**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. To minor in economics, the student should submit a minimum of 12 semester hours of undergraduate credit in economics. Up to 6 semester hours of prerequisites in economics for majors and minors may be granted for undergraduate courses in statistics, corporation, finance, business cycles, and other closely related work in business administration or agricultural economics.

Those students who major in economics are expected to enroll in Courses 601, 602 and to have a good knowledge of economic theory. The thesis may be written in any of several fields, including economic theory, labor, international economics, public finance, and fiscal policy.

**601. History of Economic Thought. (4-0). Credit 4. I**

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. (4-0). Credit 4. II**

Primary emphasis given to emergence of marginal utility theory and analytical system of Alfred Marshall. Prerequisite: Approval of Department Head.

**606. Economics of Labor. (4-0). Credit 4. II**

Survey of theories of labor movement followed by analysis of wage and employment theories, effect of union policies and practices upon wages and employment, and role of unionism in economic stability. Prerequisite: Econ. 318.

**607. Contemporary Economic Theory. (4-0). Credit 4. I**

Survey of more important contributions to economic thought made during last generation. Current writings of important contemporary economists are read and evaluated. Prerequisite: Econ. 323.

**611. National Income Analysis. (4-0). Credit 4. I**

Development of modern static national income analysis from general equilibrium system. Roles of fiscal and monetary policy in promoting economic stability are examined. Prerequisite: Econ. 410.

**613. International Economic Policies. (3-0). Credit 3. II**

Critical examination of governmental policies toward international trade. Export and import controls, exchange controls, tariff and rehabilitation policies in relation to foreign trade. Prerequisite: Econ. 321.

**615. The American Economy, I. (3-0). Credit 3. I**

Brief historical survey of growth of capitalist institutions. Analysis of market system with particular reference to behavior of both individual and firm. Study of fluctuations in level of economics activity and macro analytical tools required for understanding causes of such fluctuations. Prerequisites: Graduate classification; approval of Department Head.

**616. The American Economy, II. (3-0). Credit 3. II**

Policy course which entails application of micro and/or macro analytical tools to following problem areas: public finance, international trade and finance, capital markets, labor markets, and social control of business. Prerequisite: Econ. 615.

**685. Problems. Credit 1 to 3 each semester. I, II, S**

Individual problems not related to thesis or dissertation. Prerequisites: Graduate classification with major or minor in economics; approval of Department Head.

**691. Research. Credit 1 or more each semester. I, II, S**

Thesis research.

## DEPARTMENT OF EDUCATION AND PSYCHOLOGY

D. G. BARKER, W. H. GRAVES, P. R. HENSARLING (Head), L. H. HOPE, L. V. MCNAMEE,  
G. P. PARKER, D. G. PARRY, W. W. STOKES, W. A. VARVEL

Graduate courses in education and psychology are designed to advance knowledge and competency related to the teaching profession. Planned programs lead to the Master of Education, Master of Science, or Doctor of Philosophy degrees, and professional certificates for the superintendent, principal, supervisor, counselor, and specialized teacher of mathematics, biology, physics, chemistry, general science, English, and history. Professional programs for these certificates are subject to the requirements of the Texas Education Agency (state accrediting agency). Course work is designed to assist practicing school personnel to improve their professional efficiency and to serve students majoring in other departments as they minor in education or work toward additional certificates. Members of the faculty have had successful teaching, supervisory

\*Graduate Advisor

ory, counseling, and administrative experiences in the fields related to the courses they are assigned to teach. Emphasis is given to counseling the graduate student and to supervising his program of study.

### EDUCATION

**601. College Teaching. (3-0). Credit 3. I, S**

Conceptions of higher education underlying typical programs including general education, learning process, and effective use of techniques and instrumentalities of classroom instruction.

**606. Secondary School Administration and Supervision. (3-0). Credit 3. I, S**

Functional study of secondary school. Administration and supervision of personnel. Pupil accounting. Observations and field studies. Designed to meet needs of secondary school principals, supervisors, and superintendents. Prerequisite: Twelve hours of education.

**607. Programs and Procedures in Supervision. (3-0). Credit 3. II, S**

Designed for teachers, supervisors, and administrators. Philosophy, organization, and administration of supervision of both elementary and secondary schools. It is suggested that Educ. 639 precede this course.

**608. School Finance and Business Management. (3-0). Credit 3. S**

Study of school funds on local, state, and federal level; budgeting, systems of accounting, and reporting. Supply management as related to school efficiency. Administration of special services, maintenance of buildings, grounds, and equipment.

**609. Public School Laws. (3-0). Credit 3. S**

Review of constitutional provisions, statute laws, court decisions, and regulations governing public schools, with special reference to Texas.

**613. The School Plant. (3-0). Credit 3. S**

Study of plans for determining extent and character of present and future building and equipment needs of school unit; efficiency of present plant; operation and maintenance; planning building program.

**615. Structural Organization and Administration. (3-0). Credit 3. II, S**

Organization and administration of systems of schools and their relationships on federal, state, intermediate, and local levels. Also private, parochial, and adult education.

**616. Administration of Staff Personnel. (3-0). Credit 3. I, S**

Analysis of personnel organization and administration in school systems. Relationship of positions. Ethics, welfare, security, and professional improvement.

**623. Standardized Tests and Measurements. (3-0). Credit 3. I, S**

Principles of psychological testing. Uses and critical evaluation of tests of achievement, intelligence, aptitude, and personality.

**624. Individual Testing. (2-3). Credit 3. II, S**

Practicum in administration and interpretation of Stanford-Binet and Wechsler-Bellevue intelligence tests. Introduction to individual tests of personality. Prerequisite: Educ. 623 or registration therein.

**629. Practicum in Counseling and Guidance. (2-3). Credit 3. II**

Supervised practice in individual counseling and group guidance. Cases assigned in Counseling and Testing Center and local public schools. Prerequisites: Educ. 624, 631 or registration therein.

**631. Techniques of Counseling. (3-0). Credit 3. I, S**

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: Educ. 427 or 635, 623; Psy. 634 or registration therein.

**632. Educational and Occupational Information. (3-0). Credit 3. II, S**

Sources, classification, and analysis of educational and occupational information. Occupational trends, local occupational surveys. Use of occupational information by classroom teacher and guidance specialist.

**633. Methods of Group Guidance. (3-0). Credit 3. II, S**

Methods and practices in group guidance. Homeroom, classroom, and school clubs as opportunities for guidance. Prerequisite: Educ. 427 or 635.

**635. Organization and Administration of Pupil Personnel Services. (3-0). Credit 3. I, S**

Designed to help administrators, counselors, supervisors, and teachers develop an understanding of role of pupil personnel services; responsibility for techniques of evaluating programs of pupil personnel services.

**637. Advanced Elementary School Methods. (3-0). Credit 3. II, S**

Study of teaching methods, devices, and techniques of learning-teaching situations on elementary school level. Prerequisite: Twelve hours in elementary education or an elementary school certificate.

**638. Trends in Curriculum and Instruction. (3-0). Credit 3. I, II, S**

Recent research and development in theories and practices of curriculum and instruction. Special attention given to programmed subject content and new instructional media. Prerequisite: Approval of Department Head.

**639. Processes in Educational Leadership. (3-0). Credit 3. I, S**

Analysis of skills and techniques of administrator in modern school, with emphasis on democratic leadership, teacher-administrator relationships, group processes, and evaluation of administrative programs.

**640. School-Community Relationships. (3-0). Credit 3. S**

Systems of interpretation of schools to community publics. Promotion of effective school-community relations through media of communication.

**646. Internship for the School Principal. (0-9). Credit 3. I, II**

Designed to give prospective school principal on-the-job training under guidance of successful, experienced, practicing public school administrator and supervision of member of University staff. Certification requirement for principalship unless waived by Department Head.

**647. Internship for the School Superintendent. (0-9). Credit 3. I, II**

Designed to give prospective school superintendent on-the-job training under guidance of successful, experienced, practicing public school superintendent and supervision of member of University staff. Certification requirement for superintendency unless waived by Department Head.

**648. Internship for the School Business Administrator. (0-9). Credit 3. I, II**

Internship designed to give prospective school business administrator on-the-job training under guidance of successful, experienced, practicing public school administrator and supervision of members of University staff. Prerequisite: Approval of Department Head.

**651. Orientation in Business Principles and Procedures. (3-0). Credit 3. I, S**

Interdisciplinary survey course utilizing various fields in business to broaden knowledge of school superintendent and school business official. Case studies. Field studies. Prerequisite: Master's degree or approval of Department Head.

**652. Educational-Governmental Relationships. (3-0). Credit 3. II, S**

Interdisciplinary survey course utilizing various fields in political science, comparative government, American and state history. Interrelationships of educational administration to political organizations. Prerequisites: Master's degree; approval of Department Head.

**653. The Nature and Problems of Administrative Behavior. (3-0). Credit 3. I, S**

Interdisciplinary survey course utilizing case study method. Designed to enhance understanding and improve techniques in decision making, communication, and personnel relations. Field studies, problems, and experiences. Prerequisites: Master's degree; approval of Department Head.

**681. Seminar. (1-0). Credit 1. I, S**

Problems pertinent to superintendent, principal, counselor, supervisor, and visiting teacher. Recent developments and research in different areas. Prerequisites: Eighteen hours of advanced education; approval of Department Head.

**685. Problems. Credit 1 to 4 each semester. I, II, S**

Directed individual study of selected problem in field of education. Prerequisite: Graduate classification in education.

**691. Research. Credit 1 or more each semester. I, II, S**

Research for thesis.

**PSYCHOLOGY****634. Principles of Human Development. (3-0). Credit 3. I, S**

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.

**DEPARTMENT OF ELECTRICAL ENGINEERING**

H. M. BARNARD, J. S. DENISON, A. J. DRUCE, J. P. GERMAN†, G. D. HALLMARK (Head),  
L. M. HAUPT, JR.†, M. G. REKOFF, JR.†, E. N. ROOTS, JR.†

The graduate program in electrical engineering provides suitable course offerings for students whose major interest is in either the electronics or the power field. Opportunity is afforded for independent laboratory investigations in either field. The facilities include a large modern AC network calculator provided with two control desks which make it possible to have two separate studies in progress at the same time. An electronic analog computer has been built in the department and is available for investigations in all fields. The machinery laboratories are amply provided with all the standard and many special machines. The department is well equipped as regards instrumentation in all of the various laboratories.

**601.\* Linear Network Analysis. (3-4). Credit 4. I, S**

Fourier and Laplace transform methods of analysis applied to linear networks having periodic, transient, or random excitation.

**602.\* Nonlinear Network Analysis. (3-4). Credit 4. II**

Analysis and application of nonlinear electrical and electronic systems. Introduction to stability and phase plane analysis.

**605.\* Linear Servomechanisms. (3-3). Credit 4. I**

Continuation of E.E. 420 to include advanced topics which will extend study of analytic methods as applied to linear systems and introduce concepts related to linear systems synthesis. Prerequisite: E.E. 420.

**606. Nonlinear Servomechanisms. (3-0). Credit 3. II**

Study of techniques available to analyze nonlinear systems and discontinuous systems, and a study of associated synthesis procedures. Prerequisites: E.E. 605; Math. 617.

**607. Alternating Current Circuits and Machines. (3-4). Credit 4. I**

Study of transient conditions in electrical machines.

**611. Symmetrical Components Applied to Electrical Engineering. (3-4). Credit 4. I**

Solution of unbalanced electrical circuits by means of symmetrical components; study and measurements of machine constants by means of oscillograph.

**624. Electronic Circuits for Instrumentation and Computation. (3-3). Credit 4. II**

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, 457.

**628.\* Design of Active Networks. (4-0). Credit 4. II**

Study of regeneration and feedback theory with emphasis on circuit design methods suitable for treatment of these topics. Prerequisites: E.E. 601; Math. 601 or equivalent.

†Graduate Advisor

\*In the summer session these courses may be divided into two parts, a and b, each with two hours of credit.



**629. System Engineering. (3-0). Credit 3. I**

Study of processes of systems engineering, a discipline concerned with planning, organization, and management of programs for developing large, highly complex systems. Establishing of need, selection of objectives, environmental research, decision making, selecting optimum system, analysis, synthesis, and communication interface problems. Prerequisite: E.E. 605 or approval of instructor.

**636. Network Synthesis. (4-0). Credit 4. I**

Synthesis of electrical networks having arbitrarily specified terminal characteristics. Realizability conditions, realization of general two-terminal and four-terminal networks, and approximation of network specifications. Prerequisites: E.E. 601; Math. 601.

**637. Wave Guides and Cavities. (3-0). Credit 3. I**

Application of Maxwell's equations to solution of guided electromagnetic fields. Studies in skin effect, parallel plane wave guides, rectangular wave guides, circular wave guides, cavities, and microwave networks. Prerequisite: E.E. 451.

**638. Antennas and Propagation. (3-0). Credit 3. II**

Application of Maxwell's equations to determine electromagnetic fields of antennas. Studies in radiation, directional arrays, impedance characteristics, aperture antennas, propagation in free space, and propagation through ionosphere. Prerequisite: E.E. 451.

**642. Transistors. (3-3). Credit 4. I, S**

Theory of junction triodes; voltage, current, power and frequency limitations. Small signal parameters and equivalent circuits for transistors; analysis of design of circuits at both small and large signal levels. Prerequisite: E.E. 326.

**644. Sampled Data Servomechanisms. (3-0). Credit 3. II**

Study of techniques for analysis of sampled data and discrete data servo systems and associated synthesis procedures. Prerequisites: E.E. 605; Math. 617.

**646. Statistical Communication Theory. (3-0). Credit 3. II**

Generalized harmonic analysis of deterministic and random signals; elements of probability and statistics; detection of signals in noise; sampling theory; optimum linear systems. Prerequisites: E.E. 601; Math. 601.

**648. Electromagnetic Wave Propagation. (3-0). Credit 3. II**

Study of electromagnetic surface waves; direct and ground-reflected space waves; tropospheric refraction, reflection, and scattering; ionospheric refraction, reflection, and scattering; propagation via meteor trails and whistlers; space communication. Prerequisite: E.E. 451.

**653. Electronic Computer Design. (3-3). Credit 4. I, S**

Function generation and system simulation for analog solution of differential equations, simulation techniques applied to control systems; advanced study of digital adders, subtractors, accumulators, multipliers, and dividers; digital error-detection; digital control. Prerequisite: E.E. 457.

**685. Problems. Credit 1 to 4 each semester. I, II**

Research problems of limited scope designed primarily to develop research technique.

**691. Research. Credit 1 or more each semester. I, II**

Research for thesis or dissertation.

## DEPARTMENT OF ENGINEERING GRAPHICS

S. M. CLELAND, J. H. EARLE, J. P. OLIVER, W. E. STREET\* (Head)

The graduate courses in engineering graphics have as their main objectives the preparation of men in the profession of teaching, both high school and college; for the preparation of men specializing in industrial graphic methods; and for scientific investigation and research in science.

The Engineering Graphics Department is well equipped with drafting machines, lettering devices, models, reproduction equipment, projectors and other visual aids, and a complete library of the field of graphics.

\*Graduate Advisor

**601. Advanced Industrial Drawing. (2-3). Credit 3. I, S**

For high school and college teachers. Problems pertinent to all industrial fields. Research and visual aids development. Study of current industrial graphical practices. Prerequisites: E.G. 106, 127 or equivalent.

**603. Advanced Machine Drawing. (1-6). Credit 3. II, S**

For high school and college teachers. Conventional practices, pictorial sketches, dimensioning. Visual aids development, creative design, analysis and synthesis, machine components. Prerequisite: E.G. 106 or equivalent.

**605. Spherical Projections.\* (2-0). Credit 2. I, S**

Graphical cartography, spherical projections and industrial applications, great circles, rhumb lines, other global projections, and geodesic domes. Designed for advancement of teacher and industrial designer. Prerequisite: E.G. 106 or equivalent.

**606. Stereographic and Clinographic Projections.\* (2-0). Credit 2. II, S**

Research and experimentation with stereographic (3 dimensional) photography and drawing as applied to industry and teaching. Development of audio-visual presentations and teaching aids. Graphical investigation of crystal projections, perspectives, and related systems. Prerequisite: E.G. 106 or equivalent.

**607. Descriptive Geometry for Teachers.\* (4-0). Credit 4. II, S**

Research of early and current applications of descriptive geometry to scientific problems. Research and study of new scientific principles for advancement and improvement of teachers of current graphics curricula. Prerequisites: E.G. 106; I.Ed. 323 or equivalent.

**611. Technical Illustration.\* (3-3). Credit 4. I, S**

Axonometric projection—isometric, dimetric, trimetric, and pseudo representations, oblique, pseudo-obliques, and perspectives. Commercial and technical illustrating—airbrush, pencil rendering, ink delineations, and other methods. Prerequisite: E.G. 601 or equivalent.

**685. Problems. Credit 1 to 4 each semester. I, II, S**

Special research problems to fit needs of individual student. Prerequisites: E.G. 106; I.Ed. 323; graduate classification; approval of instructor.

## DEPARTMENT OF ENGLISH

J. P. ABBOTT, J. Q. ANDERSON\* (Head), R. H. BALLINGER, R. W. BARZAK, A. L. BENNETT, F. E. EKFFELT, K. W. ELMQUIST, H. P. KROITOR, L. F. HAUER, J. Q. HAYS, H. E. HIERTH, P. C. HUNTER, JR., C. D. LAVERTY, L. J. MARTIN, S. S. MORGAN, E. E. STOKES, JR.

The general aim of the graduate program in English is to broaden and enrich the student's cultural background. Specific aims of the program are to prepare students (1) for further graduate study leading to the Doctor of Philosophy degree; (2) for the profession of teaching English in high schools, junior colleges, colleges, and universities; and (3) for those positions in business, industry, and government that require a broad knowledge of humanities.

A minimum of thirty credit hours is required for the M.A. degree in English, six of these hours being allowed for work on the thesis. The master's thesis may be written on topics in either English or American literature. Candidates for the degree may present a minor of not more than nine credit hours in history, education, economics, mathematics, modern languages, or other liberal arts fields.

To be admitted to this program, students should have an undergraduate major in English. Those students with a B.A. degree in other fields in the humanities may be admitted provisionally and allowed to make up deficiencies.

**613. Studies in the Renaissance. (3-0). Credit 3. I**

Poetry, prose, and drama of English Renaissance exclusive of Shakespeare. Research papers. Prerequisite: Graduate classification or approval of Department Head.

**614. Studies in the Renaissance: Non-Dramatic Literature. (3-0). Credit 3. II, S**

Major writers of non-dramatic prose and poetry of English Renaissance: Wyatt, Surrey, Sidney, Spenser, Marlowe, Raleigh, Shakespeare, Drayton, Jonson, and Donne. Research papers. Prerequisite: Graduate classification or approval of Department Head.

\*Graduate Advisor

**615. Seventeenth Century English Literature. (3-0). Credit 3. I, II, S**

Poetry and prose of chief writers of seventeenth century: Bacon, Donne, Jonson, Herrick, Milton, and Dryden. Research papers. Prerequisite: Graduate classification or approval of Department Head.

**616. Studies in the Eighteenth Century. (3-0). Credit 3. I**

Poetry and prose to 1750, concentrating on Defoe, Addison, Swift, Pope, Thomson, and Young, with emphasis on aesthetic, scientific, and religious ideas. Research papers. Prerequisite: Graduate classification or approval of Department Head.

**617. Studies in the Eighteenth Century: The Age of Johnson. (3-0).**

**Credit 3. II, S**

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. Prerequisite: Graduate classification or approval of Department Head.

**633. Studies in the Nineteenth Century: The Romantic Age. (3-0). Credit 3. I**

Romantic writers, along with literary, religious, and scientific issues of century. Research papers. Prerequisite: Graduate classification or approval of Department Head.

**634. Studies in the Nineteenth Century: The Victorian Age. (3-0). Credit 3. II, S**

Prose and poetry from Carlyle to Shaw. Research papers. Prerequisite: Graduate classification or approval of Department Head.

**649. Studies in the Twentieth Century: British Literature. (3-0). Credit 3. I**

Selected authors since 1900: Yeats, Joyce, Huxley, and others. Emphasis upon development of particular literary movement or literary form. Research papers. Prerequisite: Graduate classification or approval of Department Head.

**650. Studies in the Twentieth Century: American Literature. (3-0). Credit 3. II**

Selected authors since 1900: Robinson, Frost, Eliot, Lewis, Faulkner, Hemingway, and others. Emphasis on particular literary movement or literary form. Research papers. Prerequisite: Graduate classification or approval of Department Head.

**674. Studies in American Literature: The Age of Transcendentalism. (3-0).**

**Credit 3. I, S**

Backgrounds of Transcendentalism in Europe; the movement in the U. S.; works of Emerson, Hawthorne, Poe, Whitman, Melville, Thoreau, and others. Research papers. Prerequisite: Graduate classification or approval of Department Head.

**675. Studies in American Literature. (3-0). Credit 3. II**

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. Prerequisite: Graduate classification or approval of Department Head.

**685. Problems. Credit 1 to 4 each semester. I, II, S**

Special readings designed to supplement student's knowledge of English and American literature in subjects which he has not studied in other courses. Research papers. Prerequisites: Graduate classification; approval of Department Head.

**691. Research. Credit 1 to 4. I, II, S**

Research for thesis. Prerequisite: Graduate classification.

## DEPARTMENT OF ENTOMOLOGY

See also ANIMAL PARASITOLOGY

P. L. ADKISSON, D. L. BULL, H. R. BURKE, H. W. DOROUGH, J. C. GAINES\* (Head),  
R. L. HANNA, D. A. LINDQUIST, M. A. PRICE, N. M. RANDOLPH,  
R. L. RIDGWAY, J. C. SCHAFFNER, J. N. WEAVER

Work is offered for advanced degrees in the various phases of entomological science including taxonomy, morphology, parasitology, physiology, toxicology, economic entomology, and apiculture. 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

\*Graduate Advisor

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.

**601, 602. Systematic Entomology. (3-3). Credit 4 each semester. I, II**

Taxonomic study of orders and families, including genera and species of class Hexapoda; study of International Rules of Nomenclature. Special study of some particular group of insects required in practice. Prerequisite: Ento. 302.

**607. Economic Entomology. (3-3). Credit 4. I, S**

Designed primarily for workers in Vocational Agriculture and Extension Service. Biologies, economic importance and control of agricultural pests are stressed. Insecticides and methods of application. Prerequisite: Approval of Department Head.

**608. Economic Entomology. (3-3). Credit 4. II**

Detailed study of insect pests, including identification, distribution, principles, and methods of natural, cultural, and chemical controls. Literature and research methods stressed. Prerequisite: Ento. 401 or 402.

**613, 614. Morphology. (3-3). Credit 4 each semester. I, II**

Detailed study of anatomical structures of insects. Prerequisite: Ento. 305.

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

Study of physiology of respiration, circulation, digestion, and excretion; mechanical and chemical senses of insects are considered. Prerequisite: Ento. 306 or equivalent.

**617, 618. Medical Entomology. (3-3). Credit 4 each semester. I, II**

Taxonomy and biology of parasitic insects, ticks, mites and their role in causation and transmission of diseases affecting man and domestic animals. Prerequisite: Ento. 208 or equivalent.

**619. Insect Toxicology. (3-3). Credit 4. II**

Chemical compounds which possess toxic properties; actions of poisons on insects; evaluation of insecticides in laboratory and field; mathematical analysis of data. Prerequisite: Ento. 615.

**685. Problems. Credit 1 to 4 each semester. I, II, S**

Entomological problems not pertaining to thesis or dissertation. Prerequisites: Graduate classification with major or minor in entomology; approval of Department Head.

**691. Research. Credit 1 or more each semester. I, II, S**

Research problems on taxonomy, life histories, biological control, ecology, and physiology of insects, and toxicology of insecticides. Prerequisite: Graduate classification.

## FOOD TECHNOLOGY

Programs may be developed from the offerings of various departments and colleges which serve the needs of a food technologist. Students desiring such a program should consult the Dean of Graduate Studies and the appropriate departmental representative.

## DEPARTMENT OF GEOGRAPHY

E. B. DORAN, JR., G. W. SCHLESSELMAN (Head)

**601. Economic Geography. (4-0). Credit 4. I**

Regional survey of world distribution of major agricultural and industrial commodities with particular attention to causal action of natural, social, and economic factors. (Offered in 1965-66 and in alternate years thereafter.)

## DEPARTMENT OF GEOLOGY AND GEOPHYSICS

H. R. BLANK, D. A. FAHLQUIST, K. J. KOENIG, T. J. PARKER\* (Acting Head)  
M. C. SCHROEDER\*, C. L. SEWARD, JR., F. E. SMITH

In addition to advanced academic training, special emphasis is placed on macro-paleontology, micropaleontology, subsurface structural geology, sedimentation, ground water, and geophysics.

Detailed surface and subsurface courses in the microscopic study of recent and fossil organisms and their relation to ancient sediments are available, with abundant material for individual stratigraphic problems, especially in the Tertiary formations of the Gulf Coast. Subsurface structural geology courses are based upon information obtained from well cuttings, cores, electric logs, and other well-logging devices. Field problems involving both Cenozoic structure and stratigraphy are aided by the numerous exposures of formations in the vicinity of the campus. Field problems in rocks of pre-Cambrian and Paleozoic ages are available in the Llano area. In geophysics emphasis is on principles. Research is in surface ship gravity measurements, observatory electromagnetic measurements, seismic model studies, long-period seismic recordings, marine crustal refraction work, and analyses with digital computers.

## GEOLOGY

**600. Earth Science for Secondary School Teachers. (2-3). Credit 3. II, S**

Survey of fundamental principles of physical geology, geologic processes, 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.

**601. Advanced Research Techniques. (1-0). Credit 1. I**

Introduction to modern instrumentation techniques and methods used in geology. Prerequisite: Graduate classification.

**609. Field Geology. Credit 2 to 6. I, II, S**

Systematic geologic surveying of selected areas. Prerequisite: Geol. 300.

**612. Structural Geology. (3-0). Credit 3. I**

Detailed study of geologic structures and consideration of theories regarding earth movements, with selected readings. Prerequisite: Geol. 312.

**616. Micropaleontology. (1-6). Credit 3. I**

Study of microscopic fossils and their uses in correlation. Laboratory work in examination of well samples. Prerequisite: Geol. 423.

**618. Sedimentation. (3-0). Credit 3. II**

Investigation of processes of sedimentation with analytical laboratory work on sedimentary rocks. Seminar. Prerequisite: Geol. 315.

**619. Petroleum Geology. (3-0). Credit 3. II**

Theoretical study of some problems in petroleum geology. Prerequisite: Geol. 404.

**620. Geology of Ground Water. (3-0). Credit 3. I**

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.

**622. Stratigraphy. (3-0). Credit 3. I**

Sources and depositional environment of sediments, character and relation of sedimentary strata, and principles involved in delimiting, correlating and naming stratigraphic units.

**625. Advanced Ground Water Geology. (3-0). Credit 3. II**

Seminar course in application of principles of advanced geology to development and use of ground water supplies. Prerequisites: Geol. 620 or equivalent; approval of Department Head.

**627. Structural Geology of Foreign Areas. (2-0). Credit 2. II**

Reading and conference course on available literature dealing with basic geology of areas outside of North America.

\*Graduate Advisor

**629. Structural Geology of North America. (3-0). Credit 3. II**

Description of important geologic structures of North America and of development of regional structural features in geological times. Prerequisite: Graduate classification.

**631. Geology in Engineering Construction. (3-0). Credit 3. II**

Geologic principles applied to construction of highways, foundations, bridge abutments, and piers, tunnels, dams, reservoirs, etc. Construction materials. Test borings and their interpretation. Prerequisites: Graduate classification; approval of instructor.

**639. Paleozoic and Mesozoic Paleontology. (3-0). Credit 3. I**

Study of important faunas of these eras. Prerequisites: Graduate classification; approval of Department Head.

**640. Cenozoic Paleontology. (3-0). Credit 3. II**

Study of important faunas of this era with emphasis on megafossils of Gulf Coast. Prerequisites: Graduate classification; approval of Department Head.

**643. Paleozoic Stratigraphy. (3-0). Credit 3. II**

Stratigraphy of Paleozoic System with particular emphasis on Paleozoic of West Texas and Oklahoma. Prerequisites: Graduate classification; approval of Department Head.

**644. Mesozoic Stratigraphy. (3-0). Credit 3. II**

Study of stratigraphy of Mesozoic System. Prerequisites: Graduate classification; approval of Department Head.

**645. Cenozoic Stratigraphy. (3-0). Credit 3. II**

Study of Cenozoic System. Prerequisites: Graduate classification; approval of Department Head.

**646. Gulf Coast Stratigraphy. (3-0). Credit 3. II**

Detailed study of Mesozoic and Cenozoic Systems of Gulf Embayment. Prerequisites: Graduate classification; approval of Department Head.

**685. Problems. Credit 1 to 4 each semester. I, II, S**

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.

**691. Research. Credit 1 or more each semester. I, II, S**

Original research on problems in various phases of geology. Research for thesis or dissertation.

**GEOPHYSICS****651. Theoretical Seismology. (3-0). Credit 3. I**

Mathematical development of elasticity theory and stress waves in bounded and unbounded solid media. Prerequisites: Geop. 435 or registration therein; Math. 308; approval of Department Head for majors in other departments.

**653. Gravity and Magnetic Methods. (3-0). Credit 3. II**

Study of earth's gravity and magnetic fields; role of gravity in geodesy; methods, instruments, and interpretation of data in gravity and magnetic methods of exploration. Prerequisites: Geop. 435; Math. 308.

**655. Electrical and Radioactivity Methods. (2-0). Credit 2. II**

Study of procedures, instruments, and interpretation of data obtained from electrical, electromagnetic, and radioactivity methods of exploration. Minor emphasis on geothermal and geochemical methods. Prerequisites: Geop. 435; Math. 308 or registration therein.

**657. Earthquake Seismology. (2-0). Credit 2. I**

Study of earthquakes, their causes, effects, method of location, determination of wave paths, interpretation of deep structures; and instruments used for recording. Prerequisite: Geop. 651 or registration therein.

**685. Problems. Credit 1 to 4 each semester. I, II, S**

A course to enable graduate students with 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.

**691. Research. Credit 1 or more each semester. I, II, S**

Original research on problems in various phases of geophysics. Research for thesis or dissertation.

**DEPARTMENT OF HEALTH AND PHYSICAL EDUCATION**

W. M. DOWELL\*\*, C. W. LANDISS\*, EMIL MAMALIGA, N. A. PONTHEUX, C. E. TISHLER\* (Head)

Graduate study in health and physical education is offered leading to the Master of Education degree.

Graduate courses in health and physical education have been designed to serve the needs of those actively engaged in public school and recreational work. It is the purpose of the Department of Health and Physical Education to assist in the advanced preparation of master teachers, school administrators, and recreational leaders. A Professional Teaching Certificate for the state of Texas may be earned in this department.

**HEALTH EDUCATION****631. Community and Public Health. (3-0). Credit 3. S**

Community health problems; public health laws; national, state, and local health agencies. Prerequisite: H.E. 415 or 421.

**PHYSICAL EDUCATION****601. Survey of Research. (3-0). Credit 3. S**

Study of published reports and research in field of health and physical education. Prerequisite: Educ. 426 or P.E. 425.

**603. Coaching and Officiating. (3-0). Credit 3. S**

Advanced coaching and officiating techniques in football, basketball, track, and baseball. Prerequisites: Teaching and coaching experience.

**610. Administration of Interschool Athletics. (2-0). Credit 2. S**

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. S**

Divergent origins, leaders, conditions, and forces affecting development of health and physical education.

**622. Supervision of Health and Physical Education. (3-0). Credit 3. S**

Principles and processes of supervision; in-service training of personnel. Prerequisite: P.E. 423.

**636. Advanced Tests and Measurements. (3-0). Credit 3. S**

Critical study of tests and measurements; methods of constructing and evaluating tests. Prerequisite: P.E. 425.

**681. Seminar. (1-0). Credit 1. I, II, S**

Discussions of laws, certification, professional ethics, and other current problems relating to health, physical education, and recreation.

**685. Problems. Credit 1 to 3 each semester. I, II, S**

Directed study of selected problems of health, physical education, and recreation not related to thesis.

\*Graduate Advisor

\*\*Deceased January 30, 1965

## DEPARTMENT OF HISTORY AND GOVERNMENT

A. C. ASHCRAFT, W. E. BENTON, S. B. BOTNER, P. A. FORD, C. H. HALL, H. H. LANG,  
T. L. MILLER, H. M. MONROE, JR., J. M. NANCE\* (Head), A. B. NELSON, L. C. TAYLOR, JR.

Graduate study in government and history is offered leading to the degree of Master of Arts. The graduate programs in history and government are designed to give added preparation to students for teaching, government service, and for continuing graduate study in either history or government leading to a doctorate. In history the student may specialize in Texas history, United States history (colonial, early national, Old South, the West, Civil War period, recent), European history, Latin American history, agricultural history, and industrial history. In government the student will find opportunities for specialization in American national, state and local government; comparative government; international relations; and public administration.

Students will find acceptable minors in education, English, mathematics, science, or other social sciences, including either history or government depending upon their major field. The minor must be some field outside of the major field of study.

Prerequisites: For a major in government or history, 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 12 semester hours (including at least 6 advanced hours) in the minor field of study. See page 35 of this catalogue.

### GOVERNMENT

**611. Government of the Soviet Union and Eastern Europe. (3-0). Credit 3. II, S**

Nature and structure of Soviet political institutions; communist ideology; Russian imperialism and international Communism; the "cold war." Prerequisites: Twelve semester hours of advanced government or equivalent.

**632. International Law. (3-0). Credit 3. I, S**

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: Twelve semester hours of advanced government.

**685. Problems. Credit 1 to 3. I, II, S**

Individual instruction in selected fields of government. Will stress reports and wide reading in field selected. Prerequisites: Eighteen hours of government and history; graduate classification.

**691. Research. Credit 1 or more each semester. I, II, S**

Thesis research. Credit will be given only upon acceptance of completed thesis. Prerequisites: Twelve hours of advanced government.

### HISTORY

**607. The United States, 1763-1800. (3-0). Credit 3. I, S**

Study of causes of American Revolution, the Revolution, Articles of Confederation, and final union under Constitution. Careful attention given economic and social developments as well as political developments. Prerequisite: Eighteen hours of history and government.

**609. American Historical Writing. (3-0). Credit 3. I, S**

Survey of American historical writing and historiography from 1607 to present, with some attention to bibliographical guides to sources and literature of United States. Prerequisites: Twelve hours of advanced history or equivalent.

**610. The Trans-Mississippi West. (3-0). Credit 3. II**

Study of the West in American history. Emphasizes political, economics, social, and cultural influences of frontier. Extensive reading required. Prerequisites: Eighteen hours of history and government.

**611. American Leaders. (3-0). Credit 3. II, S**

Personalities and contributions of thirty-six American leaders from Samuel Adams to Dwight Eisenhower. Prerequisite: Twelve hours of advanced history or equivalent.

\*Graduate Advisor



**612. The French Revolution and Napoleon. (3-0). Credit 3. II**

Detailed consideration of decline of ancient regime, influence of Encyclopedists, causes and course of events during revolution and after; evaluation of source material. Prerequisite: Eighteen hours of history and government. (Offered in 1965-66 and in alternate years thereafter.)

**615. Growth of Spanish Institutions in America, 1492-1857. (3-0). Credit 3. I**

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: Eighteen hours of history and government. (Offered in 1966-67 and in alternate years thereafter.)

**685. Problems. Credit 1 to 3 each semester. I, II, S**

Individual instruction in selected fields of history. Stresses reports and wide reading in field selected. Prerequisite: Eighteen hours of history and government.

**691. Research. Credit 1 or more each semester. I, II, S**

Thesis research. Credit given only upon acceptance of completed thesis. Prerequisite: Twelve hours of advanced history.

**DEPARTMENT OF INDUSTRIAL EDUCATION**

H. D. BEARDEN, J. L. BOONE, E. R. GLAZENER, C. H. GRONEMAN\* (Head),  
L. B. HARDEMAN, L. V. HAWKINS, F. J. KONECNY

It is the responsibility of the Industrial Education Department to develop master teachers and effective leaders in such human relationship vocations as teaching of industrial arts and vocational industrial education, vocational guidance, industrial school administration and supervision. It is a major function of the department to promote the interest of industrial education programs and to afford opportunities for professional education, both theoretical and practical. Graduate degree programs in this department are: Master of Education, Master of Science, and Doctor of Education. A professional teaching certificate for the state of Texas may be earned in this department to become a master teacher of industrial arts.

The classrooms, laboratories, shops and libraries of Texas A&M University are made available to students for studying industrial education. The high schools in the vicinity of the University afford ample opportunity for students to observe the most modern techniques of teaching industrial subjects.

Specialists in other departments and divisions of the University give instruction in special material which is closely related to industrial education. The shops and laboratories embody the newest type of equipment, shop plans, and instructional aids.

**601. History of Industrial Education. (2-0). Credit 2. I, II, S**

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. (2-0). Credit 2. I, II, S**

Problems of local director or supervisor of industrial arts.

**603. Administration and Supervision of Vocational Industrial Education. (2-0). Credit 2. I, II, S**

Problems of local director or supervisor of vocational industrial education.

**604. Industrial Programs for Junior Colleges and Technical Schools. (2-0). Credit 2. I, II, S**

Study of kinds, purpose, size, accreditation, growth, and teaching problems in junior colleges, technical institutes, and adult schools, with particular emphasis on organization and presentation of industrial subject material in these schools.

**605. Problems in Industrial Safety. (2-0). Credit 2. I, II, S**

Basic reasons for accidents; prevention of industrial accidents; qualifications and duties of safety consultants; methods of making investigations; making investigations and how to prepare safety reports.

\*Graduate Advisor

- 606. Organization of Industrial Arts Department. (2-0). Credit 2. I, II, S**  
Problems in determining type and size of industrial arts programs for various types and sizes of schools with plans for organization of each.
- 609. Methods of Teaching High School Drawing. (2-3). Credit 3. I, II, S**  
Survey of field of drawing. Designing and organizing of problems and teaching devices.
- 614. Guidance Seminar. (2-0). Credit 2. I, II, S**  
Organization of occupational information; educational and vocational guidance; counseling case problems. Prerequisite: I.Ed. 406 or equivalent.
- 616. Methods of Teaching Industrial Arts in Secondary Schools. (2-0). Credit 2. I, II, S**  
Selecting and organizing instructional material for problems in a particular industrial activity.
- 618. Tests and Measurements in Industrial Education. (2-0). Credit 2. I, II, S**  
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. I, II, S**  
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. I, II, S**  
Basic principles involved in development and operation of industrial education programs under State and Federal vocational laws.
- 622. Philosophy of Industrial Arts Education. (2-0). Credit 2. I, II, S**  
Principles involved in development and operation of industrial arts courses and their purpose and function in the field of general education.
- 623. Vocational Guidance Procedures. (3-0). Credit 3. I, II, S**  
Workshop approach to study of vocational guidance, programs, relationships, group techniques, and methodology of clinical approach.
- 626. Classroom Management and Shop Organization. (2-0). Credit 2. I, II, S**  
Organization of procedures to facilitate teaching; setting up roll-checking devices, issuing procedures for tools and materials, keeping material inventory, using assignment and progress charts, using student leadership in routine non-teaching class and laboratory routine, and keeping records.
- 627. Teacher Training for Local Supervisors of Trade and Industrial Classes. (2-0). Credit 2. S**  
Discussion of problems related to administration of industrial education programs, in-service training, and upgrading of programs on local level. Methods of organizing and conducting teacher improvement programs, including methods of conducting organized research.
- 628. Organization of Vocational Industrial Schools and Classes. (2-0). Credit 2. S**  
Methods of making surveys, determining needs for various industrial education programs, and organization of curriculum and classes according to State certification requirements.
- 630. Auto Mechanics. (1-4). Credit 2. I, II, S**  
Development and preparation of instructional materials and testing of laboratory problems pertaining to economic selection, operation, and maintenance of internal combustion engines, power transmission systems, and automated control systems.
- 631. Electricity. (1-4). Credit 2. I, II, S**  
Development and preparation of instructional materials for use by electricity and electronics teachers in industrial arts, vocational and technical education programs.
- 632. Cabinet Making. (1-4). Credit 2. I, II, S**  
Development and preparation of instructional materials and testing of laboratory problems pertaining to modern methods of kiln drying, veneer construction, upholstery, and fabrication within the furniture industry.

**633. Machine Shop. (1-4). Credit 2. I, II, S**

Development and preparation of instructional materials and testing of laboratory problems pertaining to modern practices and problems in teaching of advanced machine shop.

**634. Ornamental Metal Work. (1-4). Credit 2. I, II, S**

Development and preparation of instructional materials and testing of laboratory problems pertaining to mild steel and tubular metal.

**635. Industrial Design and Development. (3-0). Credit 3. I, S**

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. Prerequisite: I.Ed. 336 or equivalent.

**681. Seminar. (1-0). Credit 1. I, II, S**

General discussions of laws, legislation, certification, professional ethics, and other current problems relating to industrial education teaching profession.

**685. Problems. Credit 1 to 4 each semester. I, II, S**

Designed to enable graduate majors to undertake and complete with credit limited investigations not within thesis research and not covered by any other course.

**691. Research. Credit 1 or more each semester. I, II, S**

Research for thesis or dissertation.

## DEPARTMENT OF INDUSTRIAL ENGINEERING

A. R. BURGESS (Head), J. P. COVAN, D. D. DREW, J. N. NASH, R. L. SMITH, A. W. WORTHAM

The graduate program of this department is concerned with the advanced study of various industrial engineering techniques as they apply to manufacturing plants. Facilities for digital computation, motion study, micromotion, methods analysis, statistical studies, and models of plant layout are available.

Recognizing the ever-increasing role being played by digital computers in the solution of a broad spectrum of engineering design and business system problems, a program leading to a Master of Science degree in Computer Science is available for students desiring to specialize in that field. The normal requirement for admission to this program is an undergraduate degree in engineering, mathematics, or physical science, with undergraduate credit in at least one course in the programming of digital computers, and one in numerical methods. The Computer Science Master's program normally comprises Mathematics 609 and 610, and Industrial Engineering 621, 641, 642, and 643 together with electives and thesis.

**601. Industrial Surveys. (2-0). Credit 2. II**

Engineering problems related to industrial investigations, reports on organizations, personnel, capital equipment, financial policies, market, etc. Prerequisite: I.En. 416.

**603. Human Relations in Industry. (4-0). Credit 4. I**

Causes of misunderstandings between managements and labor; conditions which influence attitudes and productivity of workers; principles of leadership. Direct worker incentive, seasonal bonuses, quality incentives, profit sharing plans. Prerequisites: I.En. 404, 412.

**604. Advanced Time and Motion Studies. (1-6). Credit 3. I**

Advanced methods in time and motion study; balancing operations; learning curves; work sampling; memomotion and chronocyclegraph studies; fatigue effects; determination and application of elemental time data; statistical methods in time study. Prerequisite: I.En. 404.

**608. Industrial Case Analysis. (3-0). Credit 3. II**

Practice in application of principles to solution of actual case problems involving broad management decisions. Special attention given to problems indigenous to Texas industry. Prerequisite: Graduate classification in industrial engineering or approval of Department Head.

**614. Advanced Quality Control. (3-3). Credit 4. I**

Advanced statistical methods applied to quality control problems; significance tests; correlation analysis; sequential sampling; analysis of variance; design of engineering experiments; principles of reliability. Prerequisite: I.En. 414.

**615. Production and Inventory Control. (3-3). Credit 4. II**

Recent developments in technique used to control inventories and production by means of statistical analysis of problems, simulation techniques, and mechanized execution of inventory and production control functions. Prerequisite: I.En. 415.

**620. Principles of Operation Analysis. (4-0). Credit 4. II**

Use of mathematical models in making decisions; optimizing over-all policies; probability methods, linear programming; transportation models; queuing theory; learning curves; information theory; Monte Carlo methods. Prerequisites: I.En. 420, 614.

**621. Computer Methods in Industrial Engineering. (2-3). Credit 3. I, S**

Principles and applications of computers to solution of various industrial engineering problems. May not be taken for credit with I.En. 615 and 620. Prerequisites: I.En. 458; graduate classification in engineering or computer science.

**641. Computer Languages. (2-6). Credit 4. I, S**

Study of design and use of computer oriented and problem oriented languages for digital computers. Prerequisites: I.En. 458; Math. 417.

**642. Computer Methods in Applied Sciences. (2-6). Credit 4. II**

Techniques of analysis and programming required to utilize stored program digital computer for solution of some typical physical systems. Prerequisites: I.En. 458; Math. 609.

**643. Logic of Information Processing. (2-6). Credit 4. II**

Principles and application of digital computers to problems of data reduction, information retrieval, and large scale commercial data processing problems. Prerequisite: I.En. 641.

**645. Data Processing Management. (3-0). Credit 3. S**

Presents comprehensive study of problems associated with management of data processing facility. Particular emphasis placed on problems of machine configuration, personnel, systems planning, and personnel training requirements. Prerequisite: I.En. 641.

**651. Tool Design. (3-3). Credit 4. II**

Design of automatic machine tools; tracer and director control of tool paths; automatic feeding, holding, indexing and ejection of work pieces; tool replacement analysis. Automatic inspection and sorting, assembly, and packaging. Prerequisite: I.En. 453.

**681. Seminar. (2-0). Credit 2. II**

Group study and discussion of current developments in industrial engineering practices as reported in literature and as presented by representatives from industry. Prerequisite: Graduate classification in industrial engineering.

**685. Problems. Credit 1 to 4 each semester. I, II, S**

Investigation of special topics not within scope of thesis research and not covered by other formal courses. Prerequisite: Graduate classification in industrial engineering.

**691. Research. Credit 1 or more each semester. I, II, S**

Research in industrial engineering field; subject to meet needs of individual student.

## DEPARTMENT OF MATHEMATICS

R. E. BASYE\*, B. W. BREWER\*, DAN HALL, J. T. HURT\*, J. T. KENT, E. R. KEOWN,  
E. C. KLIPPLE\* (Head), H. A. LUTHER, W. S. McCULLEY,  
B. C. MOORE, S. A. SIMS, M. E. TITTLE

The Mathematics Department has two main objectives in its graduate offerings. First, it offers courses from which a graduate student may choose an appropriate sequence for an advanced degree in mathematics; second, it attempts to furnish proper mathematical preparation for graduate students majoring in other departments.

\*Graduate Advisor

**600. Fundamental Mathematics in Secondary Schools. (3-0). Credit 3. S**

Basic concepts of arithmetic, algebra, geometry, and trigonometry as viewed from standpoint of higher analysis; famous problems; construction of tables and slide rules; other topics designed to help vitalize teaching of high school mathematics. Prerequisite: Math. 122 or 210.

**601. Higher Mathematics for Engineers and Physicists. (4-0). Credit 4. I, II, S**

Surface integrals, line integrals, vector analysis, partial differential equations, elementary complex variables, applications. Prerequisite: Math. 308.

**602. Higher Mathematics for Engineers and Physicists. (4-0). Credit 4. I, II, S**

Fourier integrals, Bessel and Legendre functions, Laplace's equation, diffusion equation, wave equation, Green's functions. Prerequisite: Math. 601.

**606. Theory of Probability. (4-0). Credit 4. II**

Markov processes, matrix theory applications, special limit theorems, transforms. Prerequisite: Math. 411.

**607. Real Variables. (4-0). Credit 4. I**

Fundamental theory of number sets and point sets, elementary applications to real functions, theory of linear measure. Prerequisite: Math 409.

**608. Real Variables. (4-0). Credit 4. II**

Measurable functions; the Riemann integral, the Lebesgue integral, applications to real functions and series. Prerequisite: Math. 607.

**609. Numerical Analysis. (3-3). Credit 4. I, II**

Linear and non-linear programming; simulation, Monte Carlo techniques, game theory. Laboratory will consist of programming appropriate problems. Prerequisite: Math. 417.

**610. Numerical Methods in Differential Equations. (3-3). Credit 4. II**

Elementary numerical solutions, analytical foundations, systems of equations, higher order equations, two-point boundary problems, numerical methods for partial differential equations. Laboratory will consist of programming a high speed digital computer. Prerequisite: Math. 417.

**611. Ordinary Differential Equations. (4-0). Credit 4. I**

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. II**

General solution of first order equations, second order equations from physics and mechanics. Prerequisite: Math. 611 or equivalent.

**615. Vector Spaces and Matrices. (4-0). Credit 4. I**

Development of fundamental properties of matrices by use of vector spaces and linear transformations. Prerequisite: Math. 409 or 415.

**616. Linear Transformations and Matrices. (4-0). Credit 4. II**

Development of canonical forms for matrices by use of transformations. Prerequisite: Math. 615.

**617. Complex Variables. (3-0). Credit 3. I, S**

Conformal mapping, the Schwartz-Christoffel theorem, infinite products, entire functions, meromorphic functions, the gamma function. Prerequisite: Math. 407.

**618. Complex Variables. (3-0). Credit 3. II**

Hypergeometric functions, elliptic functions, Riemann surfaces. Prerequisite: Math. 617.

**620. Fourier Series and Allied Topics. (4-0). Credit 4. II**

First four chapters of Zygmund plus recent developments in almost everywhere convergence of Fourier series. Prerequisite: Math. 608 or registration therein.

**622. Laplace Transforms. (4-0). Credit 4. II, S**

Fundamental theorems concerning Laplace transforms. Applications to ordinary and partial differential equations, difference equations, and integral equations. Prerequisite: Math. 601.

**623. Higher Mathematics for Chemical Engineers. (4-0). Credit 4. II**

Derivation and solution of differential equations of chemistry and chemical engineering, mathematical theory of distillation, series solutions of differential equations, Bessel functions. Prerequisite: Math. 308.

**624. Higher Mathematics for Chemical Engineers. (4-0). Credit 4. I**

Equations of finite differences, applications of partial differentiation, solution of partial differential equations, Fourier integrals, orthogonal systems, numerical and graphical methods, theory of errors. Prerequisite: Math. 623.

**625. Matrix Algebra and Tensor Calculus. (4-0). Credit 4. I, II, S**

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. I**

Ordered rings, the ring of integers, Euclidean rings, congruences, the Fermat-Euler theorem, residues of powers, quadratic residues, the Legendre and Jacobi symbols, quadratic reciprocity, character sums, diophantine equations, tests of primality. Prerequisite: Math. 409 or 415.

**628. Theory of Numbers. (3-0). Credit 3. II**

Commutative rings; ideals and residue class rings; principal ideal rings; unique factorization rings; quadratic fields; fields of higher degree. Prerequisite: Math. 627.

**633. Group Representations. (4-0). Credit 4. I**

Representation theory of the rotation and the homogeneous Lorentz group. Prerequisites: Math. 415; approval of instructor.

**636. Topology. (3-0). Credit 3. II**

Axiomatic treatment of topological spaces. The metrization problem. Applications to arcs and curves. Prerequisite: Math. 607.

**638. Calculus of Variations. (3-0). Credit 3. II**

Theory and applications of methods of calculus of variations as applied to optimal problems. Prerequisite: Math. 601.

**639. Iterative Techniques. (3-3). Credit 4. I**

Iterative techniques for solving single equations, systems of equations, and eigenvalue problems. Prerequisite: Math. 615.

**641, 642. Modern Analysis. (4-0). Credit 4 each semester. I, II**

Recent developments in theory of functions. Prerequisite: Math. 608.

**685. Problems. Credit 1 to 4 each semester. I, II, S**

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 curriculum. Prerequisite: Math. 601.

**691. Research. Credit 1 or more each semester. I, II, S**

Research for thesis or dissertation.

## DEPARTMENT OF MECHANICAL ENGINEERING

A. B. ALTER, J. H. CADDESS, E. S. HOLDREDGE\*, T. J. KOZIK, J. M. NASH, T. A. NOYES,  
J. V. PERRY, JR., C. M. SIMMANG\* (Head), J. G. H. THOMPSON,  
W. L. TRUETTNER, R. M. WINGREN\*

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 heat power field, mechanical design, or applied mechanics. Laboratory facilities are available for graduate study and research in metallurgy, stress analysis including photoelasticity,

\*Graduate Advisor

vibrations, internal combustion engines, refrigeration, heat transfer, fluid flow, and computer theory.

The Mechanical Engineering Department and other departments in the College of Engineering and in the College of Arts and Sciences offer a number of courses in engineering mechanics so that the student may specialize in this field if he desires.

Math. 308, Differential Equations, is required for a Bachelor of Science degree in Mechanical Engineering and students planning to do graduate work in mechanical engineering should have completed Math. 308 or its equivalent before entering.

**600. Mechanics for College Teachers: Dynamics. (3-0). Credit 3. S**

Kinematics of absolute and relative displacement, velocity, and acceleration by graphical, algebraic, and vector methods to include Coriolis' component; kinetics and dynamics of translation and rotation, work, energy, impact, momentum, balancing; teaching techniques, associated seminar. Prerequisites: Math. 685 (2 hours); M.E. 599.

**601. Advanced Machine Design. (4-0). Credit 4. II**

Study of special design problems in mechanical engineering such as design of piping systems subjected to thermal expansion, theory of lubrication, curved beams and flat plates. Prerequisites: Math. 308; M.E. 445 or equivalent.

**603. Power Plants. (4-0). Credit 4. II**

Design of central and isolated power plants with special attention to over-all economic operation. Prerequisite: M.E. 417.

**605. Engineering Analysis. (4-0). Credit 4. I, S**

Study of analytical, graphical, and approximate methods of solving problems common to engineering; dimensional analysis and model study; design of experiments; statistical analysis and interpretation of test data including derivation of empirical equations. Prerequisite: Math. 308.

**613. Engineering Dynamics. (4-0). Credit 4. II**

Study of dynamics of particles and of rigid bodies; virtual work principle, Lagrange's and Euler's equations of motion, and Hamilton's principle applied to engineering problems. Prerequisites: Math. 601; M.E. 313.

**615. Advanced Engineering Thermodynamics. (4-0). Credit 4. I**

Theories of thermodynamics and their application to more involved problems in engineering practice. Second law analysis and statistical theory emphasized. Prerequisite: M.E. 328.

**616. Heat Transmission. (4-0). Credit 4. II**

Fundamental laws relating to heat flow, application of these laws to engineering materials used in various industrial processes; study of recent developments by reference to current literature. Prerequisites: Math. 601; M.E. 605.

**617. Mechanical Vibrations. (4-0). Credit 4. I, S**

Theory of vibrations of machines and structures. Vibration of elastic bodies and of non-linear systems. Prerequisites: Math. 308; M.E. 313.

**618. Advanced Air Conditioning. (4-0). Credit 4. II**

Thermodynamics of air-vapor mixtures as applied to air conditioning. Design and selection of equipment with emphasis on system planning, air distribution, controls, noise and vibration elimination, costs and economics. Prerequisite: M.E. 436.

**620. Experimental Stress Analysis. (3-3). Credit 4. I**

Study of photoelasticity, electric strain gauges, stresscoat. Prerequisite: Math. 308 or registration therein.

**621. Fluid Mechanics. (4-0). Credit 4. I**

Study of flow problems encountered in design of water, gas, and steam turbines; centrifugal and axial-flow pumps and compressors. Prerequisites: Math. 308; M.E. 344.

**631. Jet Propulsion. (4-0). Credit 4. I**

Study of fluid mechanics and thermodynamics of turboprop engines, ramjets, turbojets, rocket motors, and electric propulsion systems. Where applicable, analysis of performance of these systems will be made. Prerequisites: Graduate classification in engineering; approval of Department Head.

**640. Ferrous Metallurgical Design. (3-3). Credit 4. II**

A detailed study of the phase transformations in steel, the resulting changes in mechanical properties, the peculiarities of the steels, and their influence upon the design of machine elements. Prerequisites: M.E. 340, 409 or its equivalent.

**685. Problems. Credit 1 to 4 each semester. I, II, S**

Content will be adapted to interest and needs of group enrolled.

**691. Research. Credit 1 or more each semester. I, II, S**

Methods and practice in mechanical engineering research for thesis or dissertation. (See S.M. 601, 602, 603, 604, 605, 606, 607, 608, and 609 for descriptions of related courses.)

**DEPARTMENT OF NUCLEAR ENGINEERING**

V. S. BISHOP, R. G. COCHRAN (Head), D. E. EMON, D. M. GIBSON, JR.,  
W. H. KOHLER, J. D. RANDALL

The rapid growth in the relatively new field of nuclear engineering in the areas of research and power reactors and the utilization of radioisotopes have created quite a demand for trained nuclear engineers. With the present planned utilization of nuclear power in space applications, the need for nuclear engineers has now greatly increased. This need led to the establishment of the Nuclear Engineering Department, which offers the Master of Engineering, Master of Science, 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 Bachelor's degree.

The facilities available for instructional and research purposes are a radiation measurements laboratory, a sub-critical reactor laboratory, an IBM 7094 and an analog computer, a reactor simulator, a radiochemistry laboratory, a low-power nuclear reactor, a 5-megawatt research reactor located at the Texas A&M Nuclear Science Center, and by 1967 a 75 Mev cyclotron will be available for research in nuclear physics.

**Professional Educational Program In Health Physics.** The expanding use of nuclear energy and its byproducts has created an increasing demand for qualified persons in radiological safety. To help meet this demand in the Southwest, Texas A&M University organized an educational program in Health Physics in 1964. This program is offered as a specialized area of study by the Department of Nuclear Engineering, and is strongly based on the fundamental aspects of radiation. The curriculum content is such that students are trained at a professional level in radiological safety activities.

The program requires that a student spend his initial academic year taking formal course work in the Department of Nuclear Engineering and other cooperating departments of the University. His summer is then spent in a government laboratory for three months of on-the-job training. Texas A&M Health Physics students are sent to the National Reactor Test Station at Arco, Idaho, for this training period. After the conclusion of the summer training program, the student is then certified by ORINS as a health physicist. If he wishes a degree in Nuclear Engineering with Health Physics as his specialty, he is then required to return to the University for at least one additional semester to complete the Master of Engineering (Health Physics) degree.

**601. Nuclear Reactor Analysis. (4-0). Credit 4. I**

Neutron balance and cycle. Neutron slowing-down and diffusion in finite systems. Fermi Age and multigroup criticality for bare, homogeneous cores. Reflected homogeneous and heterogeneous reactor. Reactor kinetics. Prerequisites: Math. 308, 601 or registration therein.

**602. Nuclear Reactor Analysis. (4-0). Credit 4. II**

Introductory transport theory, multigroup slowing-down diffusion theory for bare and reflected cores, thermal utilization, resonance escape, fast fission, heterogeneous lattices, temperature coefficients, control rods, reactor kinetics and perturbation theory. Prerequisites: Math. 601; N.E. 601.



**605. Nuclear Measurements Laboratory. (2-3). Credit 3. I**

Basic techniques of nuclear measurements discussed and practiced. Behavior of neutrons in multiplying and non-multiplying media observed. Extensive use made of nuclear reactor. Prerequisite: N.E. 601 or registration therein.

**606. Reactor Experimentation. (2-3). Credit 3. II**

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. 602 or registration therein; N.E. 605.

**608. Thermonuclear Engineering. (3-0). Credit 3. I, S**

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.

**610. Design of Nuclear Reactors. (3-0). Credit 3. S**

Applies fundamentals of nuclear physics and reactor theory with engineering fundamentals to design of nuclear reactors. Prerequisite: N.E. 602 or registration therein.

**612. Radiological Safety and Hazards Evaluation. (3-0). Credit 3. II**

State and Federal regulations concerning radioactive materials. Radiation safety as applied to accelerators, nuclear reactors and radioactive byproducts. Rigorous methods of analysis applied to computation of biological radiation dose and dose rates from various sources and geometries. Radiation effects on physical systems. Prerequisites: Math. 601; N.E. 409; or approval of instructor.

**615. Nuclear Radiation Detection. (3-0). Credit 3. I**

Interaction of radiation with matter and behavior of ion pairs in presence of electric fields. Theory of operation for radiation detection devices. Prerequisite: Math. 307.

**618. Nuclear Control Systems. (3-0). Credit 3. II**

Fundamentals of servocontrol developed and applied to nuclear reactor. Safety aspects of reactor control and operational problems. Prerequisite: N.E. 602 or registration therein.

**621. Nuclear Metallurgy. (3-0). Credit 3. II**

Physical and metallurgical properties of metals used in nuclear reactors and reasons for their use. Prerequisite: M.E. 409.

**622. Nuclear Power Plant Design and Analysis. (3-0). Credit 3. II**

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 328; N.E. 601.

**623. Analytical Nuclear Engineering I. (3-0). Credit 3. I**

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. 622 or 625; N.E. 610.

**624. Analytical Nuclear Engineering II. (3-0). Credit 3. II**

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. 622 or 625; N.E. 610.

**625. Nuclear Reactor Theory. (4-0). Credit 4. I**

Advanced treatment of neutron transport theory. Methods of solution of integro-differential and integral Boltzmann equations and their adjoints. Multigroup diffusion and transport theory. Prerequisites: Math. 602 or 617; N.E. 602.

**626. Nuclear Reactor Theory. (4-0). Credit 4. II**

Continuation of N.E. 625. Variational principles for discrete and continuous eigenvalues. Milne problem and Wiener-Hopf technique. Serber-Wilson and Feynman methods. Spatially independent and dependent slowing-down theory. Prerequisite: N.E. 625.

**681. Seminar. (1-0). Credit 1. I, II**

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. I, II**

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.

**691. Research. Credit 1 or more each semester. I, II, S**

Research toward thesis or dissertation.

**DEPARTMENT OF OCEANOGRAPHY AND METEOROLOGY**

E. E. ANGINO, K. C. BRUNDIDGE, R. A. CLARK, W. H. CLAYTON, J. C. COCHRANE, B. S. COOPER, S. Z. EL-SAYED, G. A. FRANCESCHINI, J. F. GRIFFITHS, W. K. HENRY, D. W. HOOD, G. L. HUEBNER, JR., D. F. LEIPPER, V. E. MOYER\*, W. E. PEQUEGNAT (Acting Head), S. M. RAY, R. O. REID\*, A. H. THOMPSON

**DEGREES**

Graduate degrees are offered in oceanography and in meteorology.

**OCEANOGRAPHY**

Oceanography is the study of the oceans and their boundaries. It is based upon the unity of the sciences of the sea. Effective study of the subject requires thorough previous training in one of the basic sciences such as biology, chemistry, geology, mathematics, meteorology, physics, or in engineering. Therefore, much of the work in oceanography is conducted at the senior and graduate levels.

Oceanography may be utilized in solving certain problems arising in fisheries work, offshore oil and gas operations, navigation, prevention of beach erosion, weather forecasting, recreation, extraction of raw materials from the sea, marine construction, coastal sanitation, military operations, fresh water supply, and many other activities. It requires broad interest, numerous skills, a real liking for the sea, and an adaptability to shipboard life.

Five options and their corresponding engineering phases are offered in oceanography. These are the biological, chemical, geological, physical, and meteorological. The options differ primarily in the undergraduate work. 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.

To qualify for an advanced degree in oceanography, the student must learn how to apply the training in his basic science to the marine environment, which requires a combination of principles and methods and a certain body of knowledge unique to oceanography; and he must develop an interest in the other marine sciences.

**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.

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

\*Graduate Advisor

extra semesters of work. Programs may be organized to provide specialization in certain applications such as marine, agricultural, radar, dynamical and numerical, chemical, physical, and synoptic meteorology and in climatology.

## 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 for working at sea and several coastal and offshore locations.

### METEOROLOGY

#### 600. Survey of Meteorology. (3-0). Credit 3. II, S

Survey course in meteorology designed for teachers of secondary school science. Prerequisite: Approval of Heads of Departments of Oceanography and Meteorology and of Education and Psychology.

#### 615. Instrument Theory and Design. (3-0). Credit 3. II

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.

#### 625. Applied Climatology. (3-0). Credit 3. I

Practical applications of climate to other disciplines and study of methods used for this coordination. Prerequisite: Met. 425 or approval of instructor.

#### 636. Dynamic Meteorology. (3-0). Credit 3. II

Perturbation theory and applications to barotropic and baroclinic systems; current literature topics. Prerequisites: Math 601; Met. 435. (Offered in 1965-66 and in alternate years thereafter.)

#### 637. Numerical Weather Prediction. (3-0). Credit 3. I

Numerical solution of hydrodynamical relationships; modeling, smoothing, and filtering; stability; accuracy of solutions. Prerequisites: Math. 417; Met. 435.

#### 638. Meteorological Simulation. (2-3). Credit 3. I

Uses of analog computers in research; laboratory practice using general purpose analog computer; application to other disciplines as well as meteorology. Prerequisites: Math. 308; approval of instructor.

#### 645. Cloud and Precipitation Physics. (3-0). Credit 3. I

Physics of clouds and precipitation; convection theories; homogeneous and heterogeneous nucleation; precipitation processes; atmospheric electricity; artificial modification. Prerequisite: Met. 446.

#### 647. Meteorology of the Upper Atmosphere. (3-0). Credit 3. I

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. II

Continuation of Met. 647. Properties and processes of interplanetary medium; atmospheres of other planets; cosmological implications in planetary environments. Prerequisite: Met. 647.

#### 657. Mesometeorology. (2-6). Credit 4. II

Theory and analysis of mesoscale weather system; relationship of mesoscale systems to larger and smaller scale systems. Prerequisite: Met. 453 or approval of instructor.

#### 658. Synoptic Meteorology. (2-6). Credit 4. I

Examination of procedures for analyzing and forecasting macroscale atmospheric structure; detailed studies of specific phenomena; recent developments. Prerequisite: Met. 453 or approval of instructor.

#### 665. Micrometeorology. (3-0). Credit 3. II

Earth-atmosphere interface processes with special emphasis on exchange concepts and resulting modifications to wind, temperature, and moisture. Prerequisites: Math. 308; Met. 445.

**666. Agricultural Meteorology. (3-0). Credit 3. II**

Application of physical concepts of meteorology to problems arising in agriculture, with detailed study of meso- and micro-climates. Prerequisite: Met. 465.

**674. Radar Meteorology. (3-0). Credit 3. II**

Theoretical considerations of principles of electromagnetic propagation; radar applications in cloud physics research. Prerequisite: Math. 601; Met. 475. (Offered in 1964-65 and in alternate years thereafter.)

**676. Hydrometeorology. (3-0). Credit 3. II**

Role of weather and weather processes in land water problems. Prerequisite: Approval of instructor.

**681. Seminar. (2-0). Credit 2. II, S**

Presented by students and based upon their research work and upon surveys of the literature.

**685. Problems. Credit 1 to 4 each semester. I, II, S**

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.

**691. Research. Credit 1 or more each semester. I, II, S**

For thesis or dissertation. Topic subject to approval of Department Head.

**OCEANOGRAPHY****601. Research Methods in Oceanography. (1-0). Credit 1. I, II, S**

Selection of research problem for thesis work; planning program of investigation. Prerequisite: General prerequisites for oceanography.

**603. Sea Laboratory Techniques. (0-6). Credit 2. I**

Practice in techniques used regularly aboard ship and in collecting field data; cruise planning and execution; processing and analysis of data. Prerequisite: Approval of instructor.

**610. Physical Oceanography. (3-0). Credit 3. I**

Physics of sea: physical properties; light and sound transmission; heat and water budgets; distribution of temperature and salinity; hydrostatics; oceanic motions; turbulent transfer; water masses. Prerequisite: General prerequisites for oceanography.

**611. Theoretical Physical Oceanography. (3-0). Credit 3. II**

Kinematics and dynamics of fluids; Eulerian and Lagrangian description; thermodynamic considerations of single and multicomponent fluid mixtures; thermal stability; steady circulation. Prerequisites: Math. 601; Ocn. 610 or approval of instructor.

**612. Theory of Ocean Waves. (3-0). Credit 3. II**

Theories of simple harmonic surface waves, capillary waves, and internal waves; wave energy, wave spectra, propagation, modification in shallow water and superposition. Prerequisites: Math. 601; Ocn. 610 or approval of instructor.

**613. Engineering Aspects of Oceanography. (3-0). Credit 3. I**

Engineering applications of ocean wave theories, including long waves; wave spectra; wave generation and practical wave prediction; wave modification; wave forces. Prerequisites: Math. 308; Ocn. 612 or approval of instructor.

**614. Dynamics of the Ocean and Atmosphere. (3-0). Credit 3. I**

Unified linear perturbation theory of rotating stratified fluid with application to ocean and atmosphere; energy considerations; characteristic modes of motion; approximate methods of analysis. Prerequisites: Math. 602; Ocn. 611.

**620. Biological Oceanography. (3-0). Credit 3. II**

Critical analysis of contribution of biological science to our understanding of sea. Discernable interrelationships between organisms and physico-chemical parameters emphasized. Prerequisite: General prerequisites for oceanography.

**621. Biological Oceanography of the Gulf of Mexico. (1-6). Credit 3. I**

Detailed examination of selected aspects of biological oceanography of major importance to Gulf of Mexico. Prerequisite: Undergraduate major in biology or approval of instructor.

**630. Geological Oceanography. (3-0). Credit 3. I**

Survey of marine geology; structure and composition of ocean basins and continental margins; chemical and physical properties of marine sediments. Prerequisite: General prerequisites for oceanography.

**631. Geological Oceanography of the Gulf of Mexico. (3-0). Credit 3. II**

Theory of sediment transport; marine shorelines and processes operating in coastal zones; beach processes; nature of marine sediments. Prerequisite: Undergraduate major in geology or approval of instructor.

**640. Chemical Oceanography. (3-0). Credit 3. II**

Chemical composition and properties of sea water; 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. I**

Selected topics in chemical oceanography including: industrial utilization of sea water; chemical products of marine biota; water freshening; corrosion; photosynthesis and fertility of sea. Prerequisite: Undergraduate major in chemistry or approval of instructor.

**642. Laboratory Techniques in Oceanography. (0-6). Credit 2. I**

Analytical methods for biological, chemical, and geological investigations. Methods concern salinity, alkalinity, nutrients, organic production, photosynthesis, sediment particle size, trace elements. Prerequisites: Ocn. 610, 620, 630, 640 or approval of instructor.

**643. Geochemistry of the Ocean. (3-0). Credit 3. I**

Study of chemistry of elements in lithosphere, atmosphere and hydrosphere with emphasis on marine environment. Prerequisite: Undergraduate major in geology or approval of instructor.

**644. Isotope Geochemistry. (3-0). Credit 3. II**

Study of isotope geochemistry of different elements in nature. Evaluation of various age dating techniques. Prerequisite: Undergraduate major in geology or approval of instructor.

**651. Meteorological Oceanography. (1-3). Credit 2. I**

Large scale ocean-atmosphere interaction. Ocean emphasis. Interaction in relation to fog, hurricanes, water and air mass modification, and elements of circulations of air and water. Prerequisite: Met. 445 or Ocn. 610.

**652. Ocean Boundary Layer Problems. (3-0). Credit 3. I**

Theory of turbulent transfer of momentum, heat and moisture; mechanics of turbulence; dispersion; methods of analysis of stochastic time sequences. Prerequisites: Math. 414 or equivalent; Ocn. 611.

**681. Seminar. (2-0). Credit 2. I**

Presented by students and based upon their research work and upon surveys of literature.

**685. Problems. Credit 1 to 4 each semester. I, II, S**

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.

**691. Research. Credit 1 or more each semester. I, II, S**

For thesis or dissertation. Topic subject to approval of Department Head.

## DEPARTMENT OF PETROLEUM ENGINEERING

J. C. CALHOUN, JR., P. B. CRAWFORD, H. T. KENNEDY\*, J. R. PEDIGO,  
H. J. RAMEY, R. L. WHITING\* (Head)

Graduate work in petroleum engineering is offered at both the master's and doctorate 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, secondary 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 doctorate level, curricula are offered to give the student a broad understanding of the various phases of the petroleum industry as well as the ability to investigate and solve technical problems arising in the industry by original research. Laboratory facilities are available for advanced studies on all phases of reservoir equilibrium and mechanics, including equipment for work on permeability-saturation relationships, core analysis and interpretation, secondary recovery 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 reservoir behavior at high pressures and temperatures.

Specialized research and analytical equipment available include a potentiometric model, reservoir analog computer, mass spectrometer, low-temperature distillation equipment, and vapor phase chromatograph.

Students are encouraged to become proficient in the programming and utilization of the IBM 7094 high-speed digital computer in engineering and research.

**601, 602. Drilling and Completing Wells. (3-3). Credit 4 each semester. S**

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. I, II**

Advanced course in petroleum production practices with special reference to fundamental principles of flow of reservoir fluids. Prerequisite: Approval of Department Head.

**605. Phase Behavior of Petroleum Reservoir Fluids. Credit 2 to 4 each semester. I**

Study of pressure, volume, temperature, composition relationships of petroleum reservoir fluids. Prerequisite: Approval of Department Head.

**607. Recovery Methods. Credit 2 to 4 each semester. II**

Study of methods of increasing recovery of petroleum from petroleum reservoirs. Prerequisite: Approval of Department Head.

**608. Well Logging Methods. (2-3). Credit 3. II**

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. I, II**

Study and presentation of papers on recent developments in reservoir mechanics. Prerequisite: Approval of Department Head.

**685. Problems. Credit 1 to 4 each semester. I, II**

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.

**691. Research. Credit 1 or more each semester. I, II**

Advanced work on some special problem within field of petroleum engineering. Thesis course. Prerequisite: Approval of Department Head.

## DEPARTMENT OF PHILOSOPHY AND HUMANITIES PHILOSOPHY

**601. Major Philosophical Issues. (2-0). Credit 2. II**

Designed to introduce graduate students to major issues of philosophical thought.

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## DEPARTMENT OF PHYSICS

P. W. BARKER, J. B. COON\*, N. M. DULLER, JR., J. A. EISELE\*, MELVIN EISNER, J. L. GAMMEL, J. S. HAM, G. J. IGO, J. J. KUBIS, F. A. McDONALD, J. A. McINTYRE, JOHN NUTTALL, J. G. POTTER (Head), O. D. SITTNER, C. F. SQUIRE, D. F. WEEKES

The present rapid advance in the development and application of fundamental physical theory has created unparalleled opportunities for specialists in the field. The offerings in physics enable graduates in physics, mathematics, chemistry, or engineering to prepare either for a career in applied physics and industrial research and development or for a career as a scientist in an industrial research or academic physics laboratory.

Phys. 601, 603, 606, and 607, together with courses in mathematics and research in the field of his thesis will normally comprise the program of a candidate for the degree of Master of Science. The four courses mentioned together with Phys. 611, 617, 624, and 625 provide a comprehensive, integrated coverage of the fields of classical and modern physics at the graduate level and constitute the core of required work 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.

The current research activities of members of the Department in nuclear magnetic resonance, molecular structure, magnetic phenomena at very low temperatures, crystalline imperfections, the liquid and solid states, ultrasonics, plasmas, high and low energy nuclear phenomena, and theoretical physics afford superior opportunities for student research in those general fields. Special research facilities include a nuclear reactor, presently operating at 100 kilowatts, and an IBM 7094 digital computer. An 88-inch cyclotron is under construction.

**600. Physics for Secondary School Teachers. (2-3). Credit 3. S**

Fundamentals of classical and modern physics that should be taught in high school; methods of preparing and conducting demonstrations and laboratories. Prerequisite: Graduate classification and approval of Department Head.

**601. Analytical Mechanics. (4-0). Credit 4. I, S**

Dynamics of particles and rigid bodies; hydrodynamics; Hamilton's principle; principle of least action; LaGrange's and Hamilton-Jacobi equations. Prerequisites: Math. 405 or 601; Phys. 405.

**603. Electromagnetic Theory. (4-0). Credit 4. II**

Static and time-varying fields; propagation, reflection and refraction of electromagnetic waves. Prerequisites: Math. 601; Phys. 416; or equivalents.

**606. Quantum Mechanics. (4-0). Credit 4. I, S**

Postulational development. Hamiltonian formalism; canonical transformations; representation and expansion theory; perturbation theory. Prerequisite: Phys. 412.

**607. Statistical Mechanics. (4-0). Credit 4. II**

Maxwell-Boltzmann, Bose-Einstein, and Fermi-Dirac distributions; ensemble theory; statistical thermodynamics; electrons in metals; lattice specific heats. Prerequisite: Phys. 408 or approval of instructor.

**611. Electromagnetic Theory. (4-0). Credit 4. I, S**

Continuation of Phys. 603. Boundary value problems of vector wave equation; effect of matter on waves; anisotropic dielectrics; dispersive media. Prerequisite: Phys. 603.

**612. Introductory Quantum Mechanics. (3-0). Credit 3. S**

Schrodinger wave equation; uncertainty principle; one-dimensional problems; hydrogen atom; angular momentum; transition probabilities. Prerequisite: Phys. 311.

**617. Physics of the Solid State. (3-0). Credit 3. I, S**

Crystalline structure, lattice vibration; dielectric phenomena; luminescence; magnetism; free electron and band theories; semi-conductors. Prerequisites: Phys. 412, 607.

**624. Quantum Mechanics. (4-0). Credit 4. II**

Continuation of Phys. 606. Scattering theory; angular momentum theory; matrix mechanics; application to atomic and nuclear systems; semi-classical radiation theory. Prerequisite: Phys. 606.

\*Graduate Advisor

**625. Nuclear Physics. (3-0). Credit 3. I, S**

The two-nucleon problem; electromagnetic interactions; beta decay; nuclear reactions; subnuclear particle reactions. Prerequisites: Phys. 428, 606 or equivalent.

**631. Quantum Theory of Solids. (3-0). Credit 3. II**

Perfect and imperfect crystal lattices; interaction of electromagnetic radiation with non-conducting crystals; metallic cohesion; transport phenomena; semiconductors, superconductors, superfluids. Prerequisite: Phys. 617.

**632. Molecular Structure. (4-0). Credit 4. II**

Principle of group theory; molecular orbitals; molecular vibrations; the rigid rotator; ultraviolet spectra; infrared and Raman spectra. Prerequisite: Approval of instructor.

**634. Relativistic Quantum Field Theory. (3-0). Credit 3. I**

Perturbation theory and renormalization techniques; dispersion relations, Mandelstam representation. Prerequisite: Phys. 606.

**635. Scattering Theory. (3-0). Credit 3. I**

Scattering of particles by non-central fields; polarized particles; scattering of pions and nucleons by nucleons; the optical model; the deuteron stripping reaction. Prerequisite: Phys. 606.

**636. The Many-Body Problem. (3-0). Credit 3. II**

Nuclear matter, liquid He<sup>3</sup>, the Bose gas, the electron gas, superconductivity. Prerequisite: Phys. 606.

**637. Relativity. (3-0). Credit 3. S**

Special relativity, co-variant formulation of mechanics and electrodynamics; general relativity, tensor calculus and non-Euclidean geometry; cosmological problems and unified field theories. Prerequisites: Phys. 601, 603.

**638. Physics of Plasmas. (3-0). Credit 3. II**

Many-body kinetic theory of plasmas; plasma fluctuations; propagation of electromagnetic waves through plasmas; magnetohydrodynamics; plasma stability and confinement. Prerequisites: Phys. 603, 607, 624.

**639. Magnetic Resonance. (3-0). Credit 3. I**

High resolution spectra; relaxation phenomena; electron resonance; electron-nucleus interaction; resonance in solids and liquids; effects of strong radio-frequency fields. Prerequisites: Phys. 603, 607, 624.

**644. Low Temperature Physics. (3-0). Credit 3. I**

Quantum behavior of matter at extremely low temperatures; superfluid liquid helium; superconductivity; thermal properties of solids; electric and magnetic phenomena. Prerequisites: Phys. 606, 607.

**645. Nuclear Theory. (3-0). Credit 3. I**

Topics of current interest, e.g., multipole theory of electromagnetic interaction, shell model, and collective model of nucleus. Prerequisites: Phys. 606, 625.

**648. Cosmic Rays. (3-0). Credit 3. II**

Phenomenology and theory of contemporary cosmic ray physics with emphasis on subjects of current research interest. Prerequisite: Phys. 603, 606; approval of instructor.

**681. Seminar. (1-0). Credit 1. I, II, S**

Examination of subjects of current importance. Prerequisite: Graduate classification.

**685. Problems. Credit 1 to 4 each semester. I, II, S**

Individual problems not related to thesis.

**691. Research. Credit 1 or more each semester. I, II, S**

Research toward thesis or dissertation.



## PHYSIOLOGY OF REPRODUCTION

A major in physiology of reproduction may be undertaken by selecting appropriate courses in animal science, biology, dairy science, genetics, and poultry science.

## PLANT BREEDING

A major in plant breeding may be undertaken by selecting appropriate courses in genetics and in agronomy, floriculture, or horticulture.

## DEPARTMENT OF PLANT SCIENCES

H. G. APPLGATE, J. V. AMIN, L. J. ASHWORTH, JR., E. C. BASHAW, L. S. BIRD, M. S. BROWN, T. C. CARTWRIGHT\*, D. R. ERGLE, R. A. FREDERIKSEN, JOSEPH HACSKAYLO, W. C. HALL, R. S. HALLIWELL, A. L. HARRISON, H. E. JOHAM\*, F. R. H. KATTERMANN, R. A. KILPATRICK, R. G. LANGSTON, R. E. MEYER, C. S. MILLER, P. W. MORGAN, H. L. MORTON, R. D. POWELL, T. R. RICHMOND\*, D. W. ROSBERG\* (Head), K. F. SCHERTZ, H. W. SCHROEDER, D. L. SHAVER, J. D. SMITH\*, W. H. THAMES, JR., J. P. VAN BUIJTENEN, G. M. WATKINS, P. A. YOUNG

### GENETICS SECTION

Training in both theoretical and applied genetics is provided by associated departments. Students should consult the Dean of Graduate Studies, who will advise them concerning the department that can best administer their program.

Laboratory facilities are available for research with various species of plants and animals. Active investigations are in progress on most of the agronomic and horticultural crops in this region and also with sheep, swine, poultry, and cattle.

Students may be encouraged to participate in genetical and cytogenetical research now in progress in corn, grain sorghums, cotton, and species related to these crops. Species, genetic stocks, and hybrids are maintained for these phases of research. In this work cytogenetics and cytotaxonomy of species hybrids are emphasized.

In the animal field, progress is being made with studies of inheritance of economic characters in large animals and poultry. Students interested in both theoretical and practical aspects of animal and poultry breeding are given opportunity to do research on poultry and large animal breeding projects as well as research of more theoretical nature using laboratory animals.

#### 603. Genetics. (3-0). Credit 3. I

Development of fundamental concepts including dominance, chromosome theory of heredity and linkage, sexuality, mutation and position effect, gene concept and extra nuclear inheritance. Prerequisite: Gen. 301.

#### 604. Genetics Laboratory. (0-3). Credit 1. I

Inheritance studies principally with *Drosophila* including laboratory techniques and methods. Arranged to complement Gen. 603 and required for genetics majors.

#### 612. Plant Genetics. (3-3). Credit 4. II

Specialized study of genetics as related to plant breeding. Emphasis placed on quantitative inheritance, heterosis, selection, ploidy, reproductive systems and processing of quantitative data. Prerequisites: Gen. 603; Stat. 406.

#### 620. Cytogenetics. (3-3). Credit 4. II

Study of correlated genetical and cytological phenomena. Prerequisites: Biol. 615; Gen. 603.

#### 623. Special Topics in Genetics. Credit 1 to 3. I

Content will depend upon interest of students and speciality of instructor. Lecturers who have attained distinction in genetics or related fields will conduct course.

#### 624. Statistical Genetics. (2-0). Credit 2. I

Probability as applied to genetic systems; derivation of genetic expectations; theory of inbreeding; estimation and testing of genetics parameters; statistical aspects of quantitative inheritance. Prerequisites: Gen. 603; Stat. 406.

\*Graduate Advisor

**625. Speciation. (2-0). Credit 2. I**

Study of genetic and environmental forces which operate in species formation together with critical examination and comparison of more important current explanations of speciation. Prerequisites: Biol. 349; Gen. 301. (Offered in 1964-65 and in alternate years thereafter.)

**631. Biochemical Genetics. (2-0). Credit 2. I**

Study of genetic control of cellular metabolism; mechanism of gene action; genetic capacity for biosynthesis; gene-enzyme relationships; pleiotropism; chemical nature of agents of heredity. Prerequisites: B.N. 410 or Chem. 227; Gen. 301.

**633. Forest Genetics. (2-0). Credit 2. I**

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 1965-66 and in alternate years thereafter.)

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

Methods and techniques in forest genetics, forest tree breeding; crossing, grafting, air layering, field layouts, seed handling, greenhouse techniques. Prerequisite: Gen. 633. (Offered in 1964-65 and in alternate years thereafter.)

**685. Problems. Credit 1 to 4 each semester. I, II, S**

Technical research problems subject to approval of Department Head.

**691. Research. Credit 1 or more each semester. I, II, S**

Prerequisite: Gen. 603.

(See An.Sc. 616, 628; P.S. 613; Stat. 605 for descriptions of related courses.)

### PLANT PHYSIOLOGY AND PATHOLOGY SECTION

Facilities are available for research on various phases of plant physiology and plant diseases. The major objectives are concerned with basic training in plant physiology and plant pathology for majors and minors in the plant sciences and also for the professional training of plant physiologists and plant pathologists. Greenhouse space and field plots are available for experimental work. Laboratory facilities include equipment for maintenance of microbiological cultures, preparation of slides for microscopic study, studies on effects of light on plants, radiochemical and isotope studies, and analysis of plant tissues for various chemical constituents. Special emphasis is placed on physiological studies of cotton, plant hormones, breeding for resistance to diseases of cotton, tomatoes, small grains, peanuts, and corn, plant parasitic nematodes, and on new fungicides for various crops.

**605. Plant Metabolism. (3-0). Credit 3. I**

Metabolic pathways of major classes of plant compounds, respiration and photosynthesis as metabolic processes and bioenergetics. Prerequisite: P.P.P. 314. (Offered in 1965-66 and in alternate years thereafter.)

**607. Physiology of the Fungi. (3-0). Credit 3. II**

General course in physiological activities of fungi, including growth and development, mineral nutrition, carbon and vitamin nutrition, chemistry of metabolic products, fungicides, and physiology of parasitism and resistance. Prerequisite: P.P.P. 314. (Offered in 1965-66 and in alternate years thereafter.)

**609. Quantitative Plant Physiology. (2-6). Credit 4. II**

Methods employed in various types of physiological investigations and interpretation of results obtained by them. Prerequisite: P.P.P. 314.

**611. Plant Nutrition. (3-0). Credit 3. II**

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.P.P. 314 or equivalent. (Offered in 1966-67 and in alternate years thereafter.)

**612. Phytohormones and Plant Growth Regulators. (3-0). Credit 3. I**

Classification, properties, and action of naturally occurring plant hormones as well as synthetic growth regulators and their practical application. Prerequisite: P.P.P. 314 or equivalent. (Offered in 1965-66 and in alternate years thereafter.)

**613. Plant Growth and Development. (3-0). Credit 3. I**

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.P.P. 314 or equivalent.

**616. Methods in Plant Pathology. (2-6). Credit 4. II**

Familiarization with standard techniques and equipment used in investigation of plant disease and various plant pathogens. Prerequisite: P.P.P. 301 or equivalent. (Offered in 1965-66 and in alternate years thereafter.)

**617. Parasitism in Plant Disease. (3-3). Credit 4. I**

Critical review of literature on parasitism and mechanisms of host defense. Processes studied by histological preparations and experimentation. Prerequisite: P.P.P. 301. (Offered in 1965-66 and in alternate years thereafter.)

**618. Bacterial Plant Diseases. (2-3). Credit 3. II**

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: P.P.P. 301 or equivalent. (Offered in 1966-67 and in alternate years thereafter.)

**620. Plant Viruses. (2-0). Credit 2. II**

Study of nature and properties of plant viruses and plant virus diseases. Prerequisite: P.P.P. 301 or equivalent. (Offered in 1965-66 and in alternate years thereafter.)

**621. Plant Parasitic Nematodes. (2-3). Credit 3. I**

Morphology, identification, and biology of plant parasitic and soil-borne nematodes; damage they cause; methods of control. Prerequisite: Approval of instructor.

**622. Plant Nematology. (1-6). Credit 3. II**

Advanced study of principal groups of plant parasitic and soil-borne nematodes with emphasis on biology. Prerequisite: P.P.P. 621 or equivalent. (Offered in 1966-67 and in alternate years thereafter.)

**623. Diseases of Field Crops. (2-3). Credit 3. I**

Intensive study of both fundamental and practical aspects of more important and representative diseases of field crops. Plant disease problem peculiar to extensive cultivation methods will be stressed. Prerequisite: P.P.P. 301.

**624. Diseases of Fruits, Vegetables, and Ornamentals. (2-3). Credit 3. II**

Identification and control of important diseases of fruit, vegetable, and ornamental crops in Texas. Various diseases and types of decay affecting products in shipment and storage. Prerequisite: P.P.P. 301. (Offered in 1965-66 and in alternate years thereafter.)

**681. Seminar. (1-0). Credit 1 each semester. I, II**

Reports and discussions of topics of current interest in plant physiology and plant pathology, including reviews of literature on selected subjects.

**685. Problems. Credit 1 to 4 each semester. I, II, S**

Individual problems or research not pertaining to thesis or dissertation. Prerequisite: P.P.P. 314 or equivalent (for physiology), 301 or equivalent (for pathology).

**691. Research. Credit 1 or more each semester. I, II, S**

Original investigations in support of thesis or dissertation.

## DEPARTMENT OF POULTRY SCIENCE

R. L. ATKINSON, J. R. COUCH, C. R. CREGER, R. C. FANGUY, T. M. FERGUSON, F. A. GARDNER,  
W. F. KRUEGER, J. H. QUISENBERRY\* (Head), 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 and marketing more necessary or more rewarded than in the modern intensive methods of producing poultry meat and eggs.

\*Graduate Advisor

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 poultry and poultry products; and to give men 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 college curriculum.

Through cooperation with the Departments of Agricultural Economics and Sociology, Biochemistry and Nutrition, 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 Science and Doctor of Philosophy degrees in the fields of poultry genetics and breeding, poultry nutrition and feeding, avian physiology, incubation, brooding and rearing, poultry processing and marketing, and poultry products technology.

**603. Principles and Practices of Incubation. (3-3). Credit 4. II**

Study of basic principles underlying successful artificial incubation of eggs. Relation of egg characters to hatchability. Developmental stages of chick during incubation. Prerequisite: P.S. 308 or equivalent.

**604. Principles of Brooding and Rearing. (3-3). Credit 4. I**

Intensive literature review and analysis of environmental and physiological factors influencing growth and development of domestic birds. Density, seasonal rhythms, social behavior, plane of nutrition, etc. are considered. Prerequisites: P.S. 201, 303 or equivalent.

**609. Avian Physiology. (3-3). Credit 4. I**

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, Storing, and Distribution. (3-0). Credit 3. II**

Studies of poultry and egg quality and of methods of maintaining product quality. Effects of storage condition and time on egg and meat quality. Production factors affecting product quality. Evaluation of commercial methods of product assembly, processing and distribution.

**612. Laboratory Problems in Poultry Processing, Storing, and Distribution. (0-3). Credit 1. II**

Survey of methods of processing poultry and eggs. Selected processing plants visited and study made of operating methods. Poultry and egg products analyzed using standard quality control methods. Effects of processing methods on market quality.

**613. Breeding and Genetics of Poultry. (3-3). Credit 4. II**

Advanced poultry breeding; emphasis on estimation of genetic parameters, measuring genetic improvement, effective population size, general and specific combining ability, fitness, diallel crossing, efficiency of breeding systems in poultry. Prerequisite: Approval of instructor.

**615. Avian Nutrition. (3-0). Credit 3. I**

To cover metabolism and nutritional requirements of domestic fowl to include proteins, carbohydrates, fats, minerals, vitamins and related feed additives. Prerequisites: Chem. 228; P.S. 411.

**681. Seminar. (1-0). Credit 1 each semester. I, II**

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.

**685. Problems. Credit 1 to 6 each semester. I, II, S**

Intensive study of newer principles and methods in various specialized fields of poultry science — breeding, nutrition, market technology. Prerequisite: Approval of Department Head.

**691. Research. Credit 1 or more each semester. I, II, S**

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 RANGE SCIENCE

J. D. DODD, E. J. DYKSTERHUIS, F. W. GOULD, D. L. HUSS, C. L. LEINWEBER\* (Head),  
W. G. McCULLY, L. B. MERRILL, R. R. RHODES, O. E. SPERRY, W. J. WALDRIP

Research in progress in range science deals with the fundamental and practical problems associated with the management of range lands. This includes studies on proper utilization, range ecology, soil and water conservation, range reseeding, and revegetation practices of range and forest areas. Other specific problems deal with eradication and control of brush and poisonous plants and the application of proper management practices.

The natural plant resources of Texas are adapted to the various phases of research in the Department. An experimental range of approximately 1200 acres near the University is used for research. Several of the sub-stations of the Texas Agricultural Experiment Station cooperate on experimental projects. Many small grazing areas as well as outstanding ranches throughout the state lend themselves to our research needs. Equipment and supplies for range research are maintained to meet all the demands of the problems undertaken.

Students who take work in the Department of Range Science must have adequate preparation in botany, agronomy, and animal husbandry, as well as in the fundamentals of economics, chemistry, and mathematics.

### 605. Range Research Methods. Credit 2. I

Study of research methods in range management and related subjects. Review of scientific investigation in field and analysis of results. Prerequisite: Graduate majors in range science.

### 606. Range Economics. (2-0). Credit 2. II

Range management practices, land utilization, and ranch operation as they affect economics of livestock industry and nation. Prerequisite: Graduate majors and minors in range science.

### 607. Vegetation Influences. (3-0). Credit 3. I

Interrelationships between ecological factors and vegetation, influence of forest and range vegetation on watershed management and soil conservation. Prerequisite: R.S. 316.

### 609. Plant and Range Ecology. (3-0). Credit 3. I

Detailed study of plant communities, successions, and effect of various degrees of utilization in vegetation types and edaphic factors. Prerequisite: R.S. 316 or equivalent.

### 610. Range Grasses and Grasslands. (2-3). Credit 3. II

Study of 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. 303, 316; approval of Department Head.

### 611. Control of Noxious Range Plants. (3-0). Credit 3. II

Advanced study of noxious and poisonous plants detrimental to good management of ranges in Texas and Southwest. Distribution, reproduction, dissemination, economic importance, and alternative methods for controlling these undesirable plants stressed. Field trips.

### 612. Range Management Practices, Policies, and Administration. (3-0). Credit 3. I

Advanced studies dealing with development of policy through political process, national to local philosophical values and social goals, administrative decision making, and technical objectives. Emphasis on current policy problems related to land resource use. Prerequisite: R.S. 415 or equivalent.

### 681. Seminar. (1-0). Credit 1 each semester. I, II

Current scientific work in range management and related subjects in American and foreign fields. Prerequisite: Majors and minors in range science.

\*Graduate Advisor

**685. Problems. Credit 1 to 4 each semester. I, II, S**

Course designed for investigations not included in student's research for thesis or dissertation. Problems selected in applied ecology, range management or forestry. Lectures, conferences, field work, reports. Prerequisite: Graduate majors or minors in range science.

**691. Research. Credit 1 or more each semester. I, II, S**

Research for thesis or dissertation. Prerequisite: Graduate major in range science.

**DEPARTMENT OF SOIL AND CROP SCIENCES**

W. B. ANDERSON, L. M. ATKINS, E. C. BASHAW, H. T. BLACKHURST\*, M. E. BLOODWORTH (Head), M. S. BROWN, EARL BURNETT, E. E. BURNS, J. W. COLLIER, E. D. COOK, A. F. DEWERTH\*, M. H. FERGUSON, C. J. GERARD, C. L. GODFREY, H. E. HAMPTON\*, E. C. HOLT, M. L. KINMAN, R. J. KOHEL, G. W. KUNZE, P. J. LYERLY, T. E. McAFEE, N. P. MAXWELL, J. F. MILLS, H. L. MORTON, G. A. NILES, E. O. OLSON, D. R. PATERSON, B. A. PERRY, K. B. PORTER, R. C. POTTS, T. R. RICHMOND, G. W. RIVERS, J. R. RUNKLES, K. F. SCHERTZ, J. C. SMITH, R. D. STATEN, J. B. STOREY, G. W. THOMAS, E. L. WHITLEY, T. G. WHITE

**AGRONOMY SECTION**

The Agronomy Section of the Department of Soil and Crop Sciences offers graduate programs designed as preparation for careers in research, teaching, extension, and other professional work. Facilities and equipment are available for advanced study in the various phases of agronomy.

Terminal programs leading to the M.S. degree are offered in crop production, soil and crop management, soil conservation, and turf management. Thesis research in these phases may be of an applied nature.

For those planning a career in research and teaching, a more basic program of study and research leading to the M.S. degree is recommended. Research problems for the Ph.D. degree in field crop science and soil science are expected to be basic in approach.

Research is in progress in cytology, genetics and breeding of field and forage crops, as well as in the various phases of production. Soil investigations are in the areas of soil chemistry, fertility, mineralogy, physics, and morphology and development.

Cooperative programs can be arranged with the Departments of Biochemistry and Nutrition and of Plant Sciences.

**601. Grain and Cereal Crops. (3-0). Credit 3. S**

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. I**

Advanced study of forage production, utilization, ecology, physiology, and morphology. Factors affecting initiation of regrowth and seed and forage quality. Review of world literature reporting recent investigations in this field.

**605. Pedology. (3-0). Credit 3. I**

Advanced study of development, morphology, constitution, and classification of soils.

**617. Advanced Soil Physics. (3-3). Credit 4. II**

Physical constitution and properties of soil, including consistence and structure, aeration, soil water, and thermal relationships. Prerequisites: Agro. 445 or equivalent and a two-semester course in physics. (Offered in 1964-65 and in alternate years thereafter.)

**618. Advanced Soil Analysis. (2-3). Credit 3. II**

Designed to familiarize student with more difficult problems of soil analysis and interpretation of data. Prerequisite: Agro. 422. (Offered in 1965-66 and in alternate years thereafter.)

\*Graduate Advisor

**624. Physical Chemistry of Soils. (3-3). Credit 4. I**

Physical chemistry of clay minerals and inorganic and organic soil colloids. Prerequisites: Agro. 617, 618, 626; Chemistry 324. (Offered in 1964-65 and in alternate years thereafter.)

**626. Soil Mineralogy. (3-3). Credit 4. I**

Study of crystal structures and properties of more important agricultural and industrial clays combined with identification techniques involving X-rays, differential thermal analysis, and electron microscopy. (Offered in 1965-66 and in alternate years thereafter.)

**627. Soil Fertility Relationships. (2-0). Credit 2. II**

Advanced study of behavior of nutrient elements in soils and plants. Emphasis placed on nitrogen, phosphorus, and potassium. Prerequisites: Agro. 422; P.P.P. 314. (Offered in 1964-65 and in alternate years thereafter.)

**681. Seminar. (1-0). Credit 1 each semester. I, II**

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.

**685. Problems. Credit 1 to 4 each semester. I, II, S**

Advanced problems in some phase of agronomy not directly related to thesis or dissertation.

**691. Research. Credit 1 or more each semester. I, II, S**

Investigations leading to thesis or dissertation.

(See Gen. 612 for description of related course.)

**FLORICULTURE SECTION**

The field of research in floriculture and landscape horticulture 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 investigation.

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.

**609. Taxonomy of Ornamental Plants. (2-2). Credit 3. I**

Specialized study of genera, species, varieties, and clons of woody and herbaceous ornamental plants including identification, structure, use, and adaptability to climatic conditions in Southwest. Problems in taxonomy, physiology, and anatomy of these plants.

**610. Tropical Foliage Plants. (2-2). Credit 3. II**

Intensive study of rare and exotic plants of tropical and subtropical regions of world. Identification, adaption, cultural requirements, propagation, and economic importance. Specific problems in taxonomy, physiology, and anatomy of these plants.

**615. Greenhouse Problem Diagnosis. (0-3). Credit 1. I**

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. Prerequisite: Graduate classification.

**685. Problems. Credit 1 to 4 each semester. I, II, S**

Individual problems or research not pertaining to thesis or dissertation. Prerequisite: Approval of Department Head.

**691. Research. Credit 1 or more each semester. I, II, S**

Research for thesis or dissertation.

**HORTICULTURE SECTION**

Advanced work in horticulture will be conducted in the major fields of fruit production, vegetable production, and fruit and vegetable products. The minor work, which supports the thesis research, will usually include courses in at least two addition-

al departments. Supporting work may be required in several of the related fields, such as chemistry, botany, plant pathology and 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.

**601. Environmental Relations of Fruit Plants. (3-3). Credit 4. I**

Principles of nutrition, water, and temperature related to management practices of fruits. Practice in soil moisture relationships, leaf analyses by flame spectrophotometry, and control of dormancy with growth regulators. (Offered in 1964-65 and in alternate years thereafter.)

**602. Factors Influencing Fruit Production. (3-3). Credit 4. II**

Influence of light, growth regulators, pruning, and structural factors on fruit setting. Chromatographic separation, spectrophotometric identification, biological assay of endogenous growth regulators, chemical fruit setting, and hybridization. (Offered in 1965-66 and in alternate years thereafter.)

**603. Structure of Vegetable Plants. (3-3). Credit 4. II**

Morphological and anatomical features of important groups of vegetable plants related to production and progressive improvement of crop.

**604. Physiology of Vegetable Plants. (3-3). Credit 4. I**

Nutrition, light, vernalization, seed treatment, water, and temperature related to fruit setting and vegetable production. Current developments in hormones, herbicides, and greenhouse vegetable production.

**681. Seminar. (1-0). Credit 1. I, II**

Student and staff participation in review of literature and reporting of current developments in research on production and processing of horticultural crops. Required of all graduate students in Horticulture.

**685. Problems. Credit 1 to 4 each semester. I, II, S**

Review of fundamental principles and methods in horticultural research. Practice involves instrumentation and techniques related to research problems.

**691. Research. Credit 1 or more each semester. I, II, S**

Research in horticultural problems for thesis or dissertation.

## SOIL CHEMISTRY

See the Agronomy Section of the Department of Soil and Crop sciences.

## SOIL PHYSICS

See the Agronomy Section of the Department of Soil and Crop sciences.

## INSTITUTE OF STATISTICS

W. S. CONNOR, E. E. DAYHOFF, R. J. FREUND, H. O. HARTLEY (Director),  
R. R. HOCKING, A. W. WORTHAM

The Institute of Statistics offers a graduate program leading to the Master of Science or Doctor of Philosophy degrees. The Institute also cooperates closely with all subject matter area departments in setting up a flexible graduate minor program in statistics.

The aim of the M.S. program is to provide a balanced training in Statistical Methods and Statistical Theory and yet to keep the requirements sufficiently flexible to permit students to develop their specific interests.

The aim of the Ph.D. program is to provide a 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.



Normally, three semesters of calculus (Math. 307) are required for entry into this program.

**601. Statistical Analysis. (3-2). Credit 4. I, II**

Intended for students in engineering, physical, and mathematical sciences. Introduction to probability, probability distributions, and statistical inference;  $t$ ,  $F$  tests and analysis of variance; regression analysis; elements of experimental design. Prerequisite: Math. 122 or 210.

**603. Biological Statistics Including Bio-Assay. (3-0). Credit 3. II**

Bio-assay for quantitative and quantal responses; absolute and comparative potencies, dose-, time-, and dose x time response curves; stationary and dynamic models for biological populations, prey-predator studies. Prerequisite: Stat. 601 or 605.

**604. Special Problems in Statistical Computation and Analysis. (3-0). Credit 3. I**

Introduction to Fortran programming with emphasis on programming statistical analyses; 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 605. Prerequisite: Stat. 601 or 605.

**605. Statistical Analysis. (3-3). Credit 4. I, II**

Intended for students in life, agricultural, and social sciences. Review of estimation and testing hypotheses; analysis of variance and covariance; simple, multiple, and curvilinear regression; introduction to experimental design; introduction to non-parametric methods. Prerequisite: Stat. 406 or equivalent.

**606. Design of Experiments. (2-3). Credit 3. II**

Fundamental principles of design and analysis of experiments; randomized blocks, Latin squares, split plots, factorial experiments; confounding; missing plot techniques. Prerequisite: Stat. 601 or 605.

**607. Sampling. (3-0). Credit 3. I**

Planning, execution, and analysis of sampling from finite populations; simple, stratified, multi-stage, and systematic sampling; ratio estimates. Prerequisite: Stat. 601 or 605.

**608. Least Squares and Regression Analysis. (3-0). Credit 3. II**

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 605.

**609. Order Statistics and Non-Parametric Methods. (3-0). Credit 3. II**

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 605.

**611. Theory of Statistics. (4-0). Credit 4. I**

The concept of probability, probability distribution, moment generating functions and limit theorem; the theory of estimation and testing hypotheses. Prerequisite: Math. 307.

**612. Theory of Linear Models. (3-0). Credit 3. I**

Theory of least squares; theory of general linear hypothesis and associated small sample distribution theory; analysis of multiple classifications. Prerequisites: Math. 416; Stat. 611.

**613. Intermediate Theory of Statistics. (3-0). Credit 3. I**

General theory of estimation and sufficiency, including maximum likelihood, minimum variance estimation; Neyman-Pearson theory of testing hypothesis; elements of decision theory. Prerequisites: Math. 409; Stat. 611.

**614. Advanced Theory of Statistics. (3-0). Credit 3. II**

Probability measures and distribution functions, random variables, characteristic functions, asymptotic distributions. Prerequisites: Math. 607; Stat. 613.

**615. Stochastic Processes and Time Series. (3-0). Credit 3. I**

Stationary and non-stationary 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. I**

Multivariate normal distributions and multivariate generalizations of classical test criteria. Hotellings T, discriminant analysis and elements of factor and canonical analysis. Prerequisites: Math. 409; Stat. 601 or 605, 611.

**617. Theory of Sampling. (3-0). Credit 3. II**

General randomization theory of multistage sampling of finite populations, sampling with and without replacements and with equal and unequal probabilities, ratio and regression estimates in multiphase sampling, analytic studies and multiframe problems. Prerequisites: Stat. 607, 611.

**625. Statistical Methods in Reliability. (2-3). Credit 3. S**

Statistical theories pertinent to solution of engineering problems in reliability introduced, established, and applied. Distribution and failure theory include exponential, log normal, gamma, and Weibull. Parameters studied include mean time to failure, failure rate, variances, and standard deviations, confidence limits, and tests of hypothesis. Prerequisites: I.En. 614; Stat. 601; or approval of instructor.

**685. Problems. Credit 1 to 4. I, II, S**

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.

**691. Research. Credit 1 or more. I, II, S**

Research for thesis or dissertation. Prerequisite: Graduate classification.

## STRUCTURAL MECHANICS

**601. Theory of Elasticity. (4-0). Credit 4. I, S**

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. Structural Stability. (4-0). Credit 4. II**

Primary buckling of centrally or eccentrically loaded columns; primary buckling of centrally loaded columns by torsion; buildup columns; lateral buckling of beams; buckling of rings. Prerequisites: Math. 308; approval of instructor.

**603. Theory of Plates and Shells. (4-0). Credit 4. I**

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.

**604. Vectors and Tensors in Mechanics. (2-0). Credit 2. I, S**

Unified study of continuous media using vectors and tensors.

**605. Flow and Fracture of Solids. (4-0). Credit 4. II**

Study of deformation of solids; elastic, very viscous, and ideally plastic substances. Prerequisite: S.M. 601.

**606. Theory of Thermal Stresses. (4-0). Credit 4. II**

Basic study of heat conduction, thermoelasticity and thermoinelasticity as related to thermal stresses. Prerequisites: S.M. 601; approval of instructor.

**607. Matrix Methods of Structural Analysis. (3-0). Credit 3. II, S**

Unified treatment of two- and three-dimensional frames by specialized matrix methods. Prerequisite: S.M. 468.

**608. Experimental Structural Analysis. (1-3). Credit 2. II, S**

Study of observations and measurements, dimensional analysis, prediction equations, and theory of similitude; design, construction, and use of structural models. Prerequisites: S.M. 468, 470 or registration therein.

**609. History of Structural Mechanics. (2-0). Credit 2. II, S**

Study of history of development of structural mechanics to present time. Prerequisite: Approval of instructor.

**610. Theory of Shells. (4-0). Credit 4. II**

Continuation of study of theory of shells introduced in S.M. 603. Limited to study of linear shell theory. Equations formulated using Lamé's surface parameters. Membrane analysis, bending analysis, and shallow shell theory. Prerequisite: S.M. 603.

**DEPARTMENT OF VETERINARY ANATOMY**

L. W. GIBBS, A. G. KEMLER, J. H. MILLIFF\* (Head)

**601. Veterinary Anatomy. (1-9). Credit 4 each semester. I, II**

Topographical dissection of domestic animals. Prerequisite: V.A. 302.

**602. Veterinary Anatomy. (2-6). Credit 4. I, II**

Microscopic structure of anatomical systems of domestic animals. Prerequisite: V.A. 303.

**603. Neuroanatomy. (2-6). Credit 4. II**

Study of gross, developmental, and microscopic anatomy of nervous systems of domestic animals. Prerequisite: V.A. 406.

**604. History of Anatomy. (1-0). Credit 1. I, II, S**

Discussion of biographies and contributions to field of anatomy of most important anatomists from 500 B.C. to present. Prerequisite: Graduate major in veterinary anatomy.

**681. Seminar. (1-0). Credit 1. S**

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. I, II, S**

Problems in either gross or microscopic anatomy along lines chosen by individual. Prerequisites: V.A. 406; approval of Department Head.

**691. Research. Credit 1 or more each semester. I, II, S**

Original research on selected thesis problem in anatomy. Prerequisite: Graduate major in veterinary anatomy.

**DEPARTMENT OF VETERINARY MEDICINE AND SURGERY**

W. C. BANKS, M. R. CALLIHAM\* (Head), E. W. ELLETT, D. L. PIERMATTEI, J. C. RAMGE

**603. Veterinary Surgery. Credit 1 to 8 each semester. I, II**

Special surgery of large or small animals. Prerequisite: Degree of Doctor of Veterinary Medicine.

**612. Diagnostic Radiology. Credit 2 or 3 each semester. I, II, S**

Radiographic interpretation of large and small animals with special emphasis on film reading. Use of special techniques including contrast media as diagnostic aids discussed and demonstrated. Prerequisite: Degree of Doctor of Veterinary Medicine.

**621. Reproduction Diseases of Female Domestic Animals. (2-0). Credit 2. I, II, S**

Advanced study of diagnosis, treatment, and control of diseases primarily affecting reproduction in female domestic animal. Prerequisite: Degree of Doctor of Veterinary Medicine.

**622. Veterinary Andrology. (2-0). Credit 2. I, II, S**

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: Degree of Doctor of Veterinary Medicine.

**685. Problems. Credit 1 to 8 each semester. I, II**

Original investigations of problems in field of surgery, therapeutics, or radiology. Prerequisite: Degree of Doctor of Veterinary Medicine.

**691. Research. Credit 1 or more each semester. I, II**

Research for thesis.

\*Graduate Advisor

## DEPARTMENT OF VETERINARY MICROBIOLOGY

A. I. FLOWERS, T. E. FRANKLIN, L. C. GRUMBLES\* (Head), C. F. HALL,  
P. F. JUNGERMAN, C. W. LIVINGSTON, R. W. MOORE

### 643. Veterinary Microbiology. (3-4). Credit 4. I, II

Study of pathogenic microorganisms; their cultural and biological characteristics and pathogenicity.

### 646. Avian Virus Diseases. Credit 1 to 4. I

Study of viral diseases of poultry including methods of isolation and identification of causative agents. Practice consists of conducting post mortem examinations and special diagnostic procedures on birds received daily for necropsy. Prerequisite: Degree of Doctor of Veterinary Medicine or equivalent.

### 647. Veterinary Virology. Credit 1 to 4. II

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: Degree of Doctor of Veterinary Medicine or equivalent.

### 648. Veterinary Mycology. Credit 1 to 4. II

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: Degree of Doctor of Veterinary Medicine or equivalent.

### 649. Immunology. (3-3). Credit 4. I

Comprehensive study of various immune phenomena correlated with study of biological production, potency, and safety testing. Prerequisites: V.Mi. 335, 438, or the equivalent.

### 681. Seminar. (1-0). Credit 1. I, S

Review and discussion of current scientific work and research in field of microbiology and related subjects. Prerequisite: Graduate major or minor in microbiology or related fields.

### 685. Problems. Credit 1 to 4 each semester. I, II

Problems course in microbiology. Prerequisites: Degree of Doctor of Veterinary Medicine; approval of Department Head.

### 691. Research. Credit 1 or more. I, II

Research for thesis or dissertation.

## DEPARTMENT OF VETERINARY PARASITOLOGY

See also Animal Parasitology

R. B. BELL, T. J. GALVIN, R. D. TURK\* (Head)

### 601. Parasitology. Credit 1 to 4 each semester. I

Detailed study of more important helminth parasites of domestic animals, including their identification, distribution, and life history. Prerequisite: V.C. 503 or equivalent.

### 685. Problems. Credit 1 to 4 each semester. I, II, S

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. I, II, S

Research for thesis.

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\*Graduate Advisor

## DEPARTMENT OF VETERINARY PATHOLOGY

J. N. BEASLEY, C. H. BRIDGES\* (Head), J. B. HENSON, F. D. MAURER

**643. Gross Pathology. Credit 1 to 6. I, II, S**

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: Degree of Doctor of Veterinary Medicine or equivalent.

**644. Locomotor and Skeletal Diseases. Credit 1 or 2. I, S**

Changes taking place in diseased bones, joints, and muscles studied with respect to their nature and probable causes, and with special reference to lameness of horse. Frequent use made of Mark Francis Collection of Bone and Joint Pathology. Prerequisite: Degree of Doctor of Veterinary Medicine or equivalent.

**645. Neoplastic Diseases. Credit 1 to 8. I, II, S**

Theoretical, histopathological, and clinical aspects of neoplasia. Diagnosis of neoplastic and related conditions in all species. Prerequisite: Degree of Doctor of Veterinary Medicine or equivalent.

**646. Nutritional Diseases. Credit 2 to 4. II**

Gross and microscopic tissue changes found in experimentally produced nutritional deficiencies are considered in comparison with clinically encountered deficiencies and with other conditions from which they must be differentiated. Prerequisite: Degree of Doctor of Veterinary Medicine or other suitable preparation.

**647. Metabolic Diseases. Credit 1 or 2. S**

Pathology of diseases due to major disorders of metabolism, non-nutritional and non-infectious. Prerequisite: Degree of Doctor of Veterinary Medicine or equivalent.

**648. Reproductive Diseases. Credit 1 to 4. S**

Theoretical and practical pathology of gross and microscopic lesions in reproductive organs with especial reference to bovine sterility. Prerequisite: Degree of Doctor of Veterinary Medicine or equivalent.

**649. Gross Post-Mortem Diagnosis. Credit 1 to 6. I, II, S**

Advanced training in recognition, interpretation, and description of tissue changes encountered. Specific diagnoses are derived and defended. Prerequisites: At least 4 semester hours of credit in V.Pat. 643.

**650. Neuropathology of Animals. Credit 1 to 4. I, S**

In addition to study and interpretation of gross and microscopic lesions of central and peripheral nervous systems, major attention given in theory and practice to special laboratory techniques necessary to demonstrate such lesions. Prerequisite: Degree of Doctor of Veterinary Medicine or equivalent.

**651. Microscopic Diagnosis. Credit 1 to 6. I, II, S**

Advanced training in diagnosis, applied especially to "problem" cases currently encountered in Department's pathological diagnostic service. Routine and special histopathological methods employed. Prerequisites: Total of at least 10 semester hours of credit in V.Pat. 643, 645.

**658. Pathological Technique. Credit 1 to 6. I, II, S**

Art and science of preparing animal tissues, fluids, and exudates for microscopic or other special examination. Enrollment limited to number who can be accommodated in routine of departmental laboratory. Prerequisite: Fair knowledge of general chemistry.

**659. Sheep Diseases. Credit 1 to 4. I**

Pathology, etiology, and symptomatology of economically important diseases affecting sheep in all major sheep-producing countries of world. Prerequisite: Degree of Doctor of Veterinary Medicine or equivalent.

**681. Seminar. (1-0). Credit 1. I, II, S**

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.

\*Graduate Advisor

**685. Problems. Credit 1 to 4. I, II, S**

Advanced special problems concerned with pathogenesis and pathology of disease. Prerequisite: V.Pat. 444 or equivalent; approval of Department Head.

**691. Research. Credit 1 or more each semester. I, II, S**

Research reported by writing of thesis or dissertation as partial requirement for Master of Science or Doctor of Philosophy degree.

## DEPARTMENT OF VETERINARY PHYSIOLOGY AND PHARMACOLOGY

P. W. BURNS\* (Head), R. H. DAVIS, JR., J. D. McCRADY

**601, 602. Animal Physiology. (3-3). Credit 4 each semester. I, II**

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 and organic chemistry.

**605, 606. Veterinary Toxicology. (3-3). Credit 4 each semester. I, II**

Original investigations and detailed studies of poisons or poisonous plants and their effects on domestic animals. Prerequisite: V.P.P. 530.

**607, 608. Veterinary Pharmacology. (3-3). Credit 4 each semester. I, II**

Modern methods of research in pharmacology and pharmaceutical processes. Original research in studying actions and uses of drugs. Prerequisite: V.P.P. 529.

**611, 612. Veterinary Physiology. (3-3). Credit 4 each semester. I, II**

Detailed study of specific phases of physiology of domestic animals. Prerequisites: V.A. 304; V.P.P. 429.

**685. Problems. Credit 1 to 4 each semester. I, II**

Problems in physiology, pharmacology, or toxicology. Prerequisite: Degree of Doctor of Veterinary Medicine or appropriate specialized training.

**691. Research. Credit 1 or more each semester. I, II**

Original investigations in veterinary physiology, pharmacology, or toxicology to be submitted by writing of thesis as partial fulfillment for Master of Science degree. Prerequisite: Approval of Department Head.

## DEPARTMENT OF VETERINARY PUBLIC HEALTH

F. P. JAGGI, JR.\* (Head), L. H. RUSSELL, JR.

**601. Food Hygiene. (3-4). Credit 4. I**

Study of causes and evidence of spoilage, and detection of adulterants in fresh, canned, and cured foods of animal origin. Prerequisite: V.P.H. 591 or 595.

**685. Problems. Credit 1 to 4 each semester. I, II**

Problems course in veterinary public health. Prerequisite: Degree of Doctor of Veterinary Medicine or approval of Department Head.

## DEPARTMENT OF WILDLIFE SCIENCE

R. J. BALDAUF, D. C. CARTER, W. B. DAVIS\* (Head), J. G. TEER

Graduate work in the Department of Wildlife Science is intended to train the student in original work in vertebrate systematics, ecology, and management. Graduates in this field should be well equipped for a variety of work in vertebrate systematics and ecology, whether in museum, college or university teaching, wildlife or park management, or various phases of land use.

Lines in which this department is especially qualified to direct graduate research are: (1) ecology, life history, and management of vertebrates; (2) their distribution, differentiation, and taxonomy; (3) limnology. Facilities are available through cooperative arrangements with the Texas Parks and Wildlife Department for students to work on problems basic to the management of both game and non-game species of wildlife and to pursue basic investigations in both fresh water and salt water fisheries.

The Department has a research and reference collection of some 40,000 fish, 18,000 amphibians and reptiles, 8,000 birds, 15,000 mammals, and can secure additional materials on loan from other institutions for use in distributional and taxonomic studies.

**601, 602. Vertebrate Systematics. (1-6). Credit 3 each semester. I, II**

Theory and practice of taxonomy as applied to vertebrates. Prerequisites: W.S. 311, 315, 401, or 402, depending on group selected. (Offered in 1964-65 and in alternate years thereafter.)

**603. Vertebrate Ecology. (1-6). Credit 3. II**

Ecology and life histories of vertebrates with special reference to birds and mammals. Considerations given to community and environmental relations. Prerequisite: W.S. 403 or equivalent. (Offered in 1964-65 and in alternate years thereafter.)

**608. Techniques of Wildlife Management. (2-0). Credit 2. II**

Special techniques and current development in wildlife management practices. Prerequisite: W.S. 408 or equivalent. (Offered in 1964-65 and in alternate years thereafter.)

**609. Wildlife Research Methods. (2-0). Credit 2. I**

Study of research methods applied to wildlife management. (Offered in 1964-65 and in alternate years thereafter.)

**681. Seminar. (1-0). Credit 1 each semester. I, II**

Important current developments in wildlife field with special reference to literature. Prerequisite: Senior or graduate classification.

**685. Problems. Credit 2 to 6 each semester. I, II, S**

Credit adjusted in accordance with requirements of each individual case.

**691. Research. Credit 1 or more each semester. I, II, S**

Original research on selected wildlife problem to be used in thesis or dissertation.

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