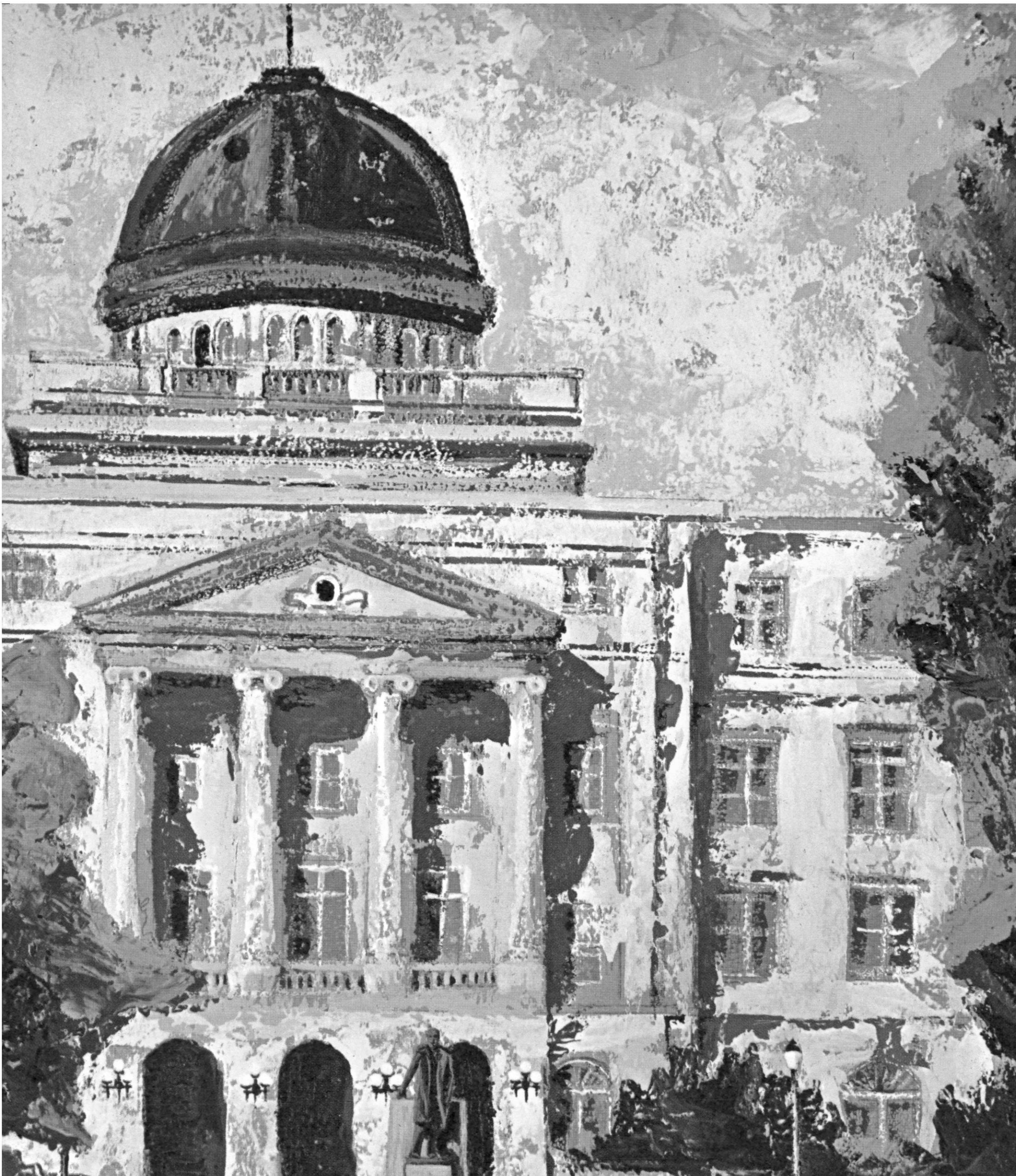
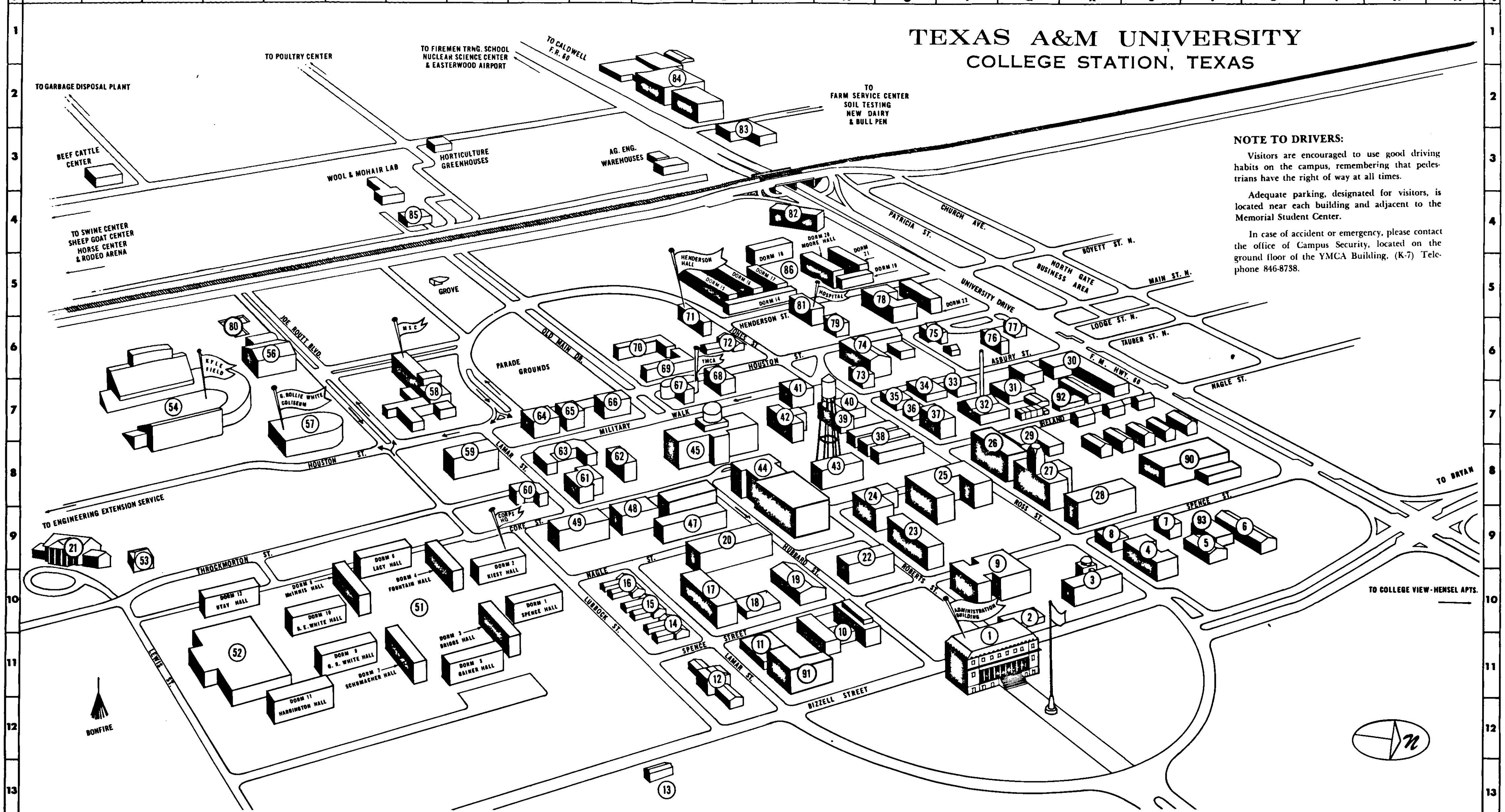


Bulletin of TEXAS A&M UNIVERSITY

The Graduate College ... 1969-70

April 1, 1969

TEXAS A&M UNIVERSITY
COLLEGE STATION, TEXAS



NOTE TO DRIVERS:

Visitors are encouraged to use good driving habits on the campus, remembering that pedestrians have the right of way at all times.

Adequate parking, designated for visitors, is located near each building and adjacent to the Memorial Student Center.

In case of accident or emergency, please contact the office of Campus Security, located on the ground floor of the YMCA Building, (K-7) Telephone 846-8738.

NUMERICAL KEY

1	Administration Building	P-11
2	Museum (Closed)	Q-10
3	Architecture	R-10
4	Civil Engineering	S-9
5	Materials Lab	T-9
6	Hydraulics Lab	T-9
7	Bituminous Lab	S-9
8	Highway Research Center	R-9
9	Agricultural Engineering	P-9
10	Animal Industries	N-10
11	Data Processing Center	M-11
12	Agricultural Information	L-11
13	Golf Clubhouse	K-12
14	Forestry Greenhouses	K-10
15	Beasley Laboratory	K-10
16.	Floriculture Greenhouses	J-10
17	Herman Heep Hall	L-10
18	Dairy Products Processing	L-10
19	Animal Pavilion	M-10
20	Plant Sciences	L-9
21	President's Home	A-9
22	Agriculture	N-9
23	Engineering	O-9
24	Francis Hall	N-8
25	Chemistry	O-8
26	Information Services Building	P-8
27	Geosciences	Q-8
28	Doherty Petroleum Engineering	R-8
29	A&M Press	Q-7
30	B&U	R-6
31	Laundry	Q-7
32	Power Plant	P-7
33	Campus Cleaners	P-7
34	MPC Warehouse	O-7
35	MPC Offices	O-7
36	Radiological Safety	O-7
37	Cottonseed Research Lab	O-7
38	Mechanical Engineering Shops	N-7
39	Mechanical Engineering	N-7
40	Exchange Store	N-7
41	Leggett Hall	M-7
42	Electrical Engineering	M-7
43	Bagley Hall	N-8
44	Cushing Library	M-8
45	Academic Building	L-7
47	Biological Sciences	K-9
48	State Chemist	J-8
49	Agronomy	J-8
50	Music Hall	H-9
51	Cadet Dorm Area (Dorms 1-12)	G-10
52	Duncan Dining Hall	D-11
53	Chancellor's Home	C-9
54	Kyle Field	C-7
56	DeWare Field House Downs Natatorium	E-6
57	G. Rollie White Coliseum	E-7
58	Memorial Student Center	G-7
59	Guion Hall	H-7
60	Military Sciences	I-8
61	Physics	J-8
62	Nagle Hall	J-8
63	Hart Hall	I-7
64	Bizzell Hall	I-7
65	Goodwin Hall	J-7
66	Coke Building	J-7
67	YMCA	K-7
68	Mitchell Hall	L-7
69	Puryear Hall	K-6
70	Law Hall	K-6
71	Henderson Hall	L-5
72	All Faiths Chapel	L-6
73	Milner Hall	N-6
74	Sbisa Dining Hall	N-6
75	Board of Director's Home	O-6
76	Hotard Hall	P-6
77	Post Office	Q-6
78	Walton Hall	O-5
80	Wofford Cain Pool	D-6
81	Hospital	M-5
82	USDA	M-4
83	Entomology Field Lab	L-2
84	Veterinary Medicine Complex	K-2
85	Veterinary Research Lab	G-4
86-89	Cadet Dorm Area	M-5
90	Cyclotron	T-8
91	Space Research Center	M-11
92	System Physical Plants Office	Q-7
93	Engineering Research Center	S-9

ALPHABETICAL KEY

Academic Building (#45)	L-7
Administration Building (#1)	P-11
Agricultural Engineering (#9)	P-9
Agricultural Information (#12)	L-11
Agricultural Building (#22)	N-9
Agronomy (#49)	J-8
All Faiths Chapel (#72)	L-6
A&M Press (#29)	Q-7
Animal Industries (#10)	N-10
Animal Pavilion (#19)	M-10
Architecture (#3)	R-10
Bagley Hall (#43)	N-8
B&U (#30)	R-6
Beasley Laboratory (#15)	K-10
Biological Sciences (#47)	K-9
Bituminous Lab (#7)	S-9
Bizzell Hall (#64)	I-7
Board of Director's Home (#75)	O-6
Cadet Dorm Area (#51) (Dorms 1-12)	G-10
Cadet Dorm Area (#86-89)	M-5
Campus Cleaners (#33)	P-7
Chancellor's Home (#53)	C-9
Chemistry (#25)	O-8
Civil Engineering (#4)	S-9
Coke Building (#66)	J-7
Cottonseed Research Lab (#37)	O-7
Cushing Library (#44)	M-8
Cyclotron (#90)	T-8
Dairy Products Processing (#18)	L-10
Data Processing Center (#11)	M-11
DeWare Field House (#56) Downs Natatorium	E-6
Doherty Petroleum Engineering (#28)	R-8
Duncan Dining Hall (#52)	D-11
Electrical Engineering (#42)	M-7
Engineering Building (#23)	O-9
Engineering Research Center (#93)	S-9
Entomology Field Lab (#83)	L-2
Exchange Store (#40)	N-7
Floriculture Greenhouses (#16)	J-10
Forestry Greenhouses (#14)	K-10
Francis Hall (#24)	N-8
Geosciences (#27)	Q-8
Golf Clubhouse (#13)	K-12
Goodwin Hall (#65)	J-7
Guion Hall (#59)	H-7
Hart Hall (#63)	I-7
Henderson Hall (Athletes) (#71)	L-5
Herman Heep Hall (#17)	L-10
Highway Research Center (#8)	R-9
Hospital (#81)	M-5
Hotard Hall (#76)	P-6
Hydraulics Lab (#6)	T-9
Information Services Building (#26)	P-8
Kyle Field (#54)	C-7
Laundry (#31)	Q-7
Law Hall (#70)	K-6
Leggett Hall (#41)	M-7
Materials Lab (#5)	T-9
Mechanical Engineering (#39)	N-7
Mechanical Engineering Shops (#38)	N-7
Memorial Student Center (#58)	G-7
Military Sciences (#60)	I-8
Milner Hall (#73)	N-6
Mitchell Hall (#68)	L-7
MPC Offices (#35)	O-7
MPC Warehouse (#34)	O-7
Museum (Closed) (#2)	Q-10
Music Hall (#50)	H-9
Nagle Hall (#62)	J-8
Physics (#61)	J-8
Plant Sciences (#20)	L-9
Post Office (#77)	Q-6
Power Plant (#32)	P-7
President's Home (#21)	A-9
Puryear Hall (#69)	K-6
Radiological Safety (#36)	O-7
Sbisa Dining Hall (#74)	N-6
Space Research Center (#91)	M-11
State Chemist (#48)	J-8
System Physical Plants Office (#92)	Q-7
USDA (#82)	M-4
Veterinary Medicine Complex (#84)	K-2
Veterinary Research Lab (#85)	G-4
Walton Hall (#78)	O-5
G. Rollie White Coliseum (#57)	E-7
Wofford Cain Pool (#80)	D-6
YMCA (#67)	K-7

BULLETIN

OF

TEXAS A&M UNIVERSITY

Sixth Series, Vol. 16 | April 1, 1969 | No. 2

GRADUATE COLLEGE CATALOGUE

ANNOUNCEMENTS FOR THE SESSION

1969-70

COLLEGE STATION, TEXAS

Published bimonthly by Texas A&M University

Second class postage paid at College Station, Texas, 77843

THE ACADEMIC CALENDAR FOR 1969-70

SUMMER SESSION 1969

June 2	Monday. Registration for the first term.
June 3	Tuesday. Beginning of classes, 8 a.m.
June 5	Thursday. Last day for enrolling in the University for the first term and for making changes in registration.
July 4	Friday. Independence Day holiday.
July 10	Thursday. Last day of first term classes. Beginning of final examinations, 8 p.m.
July 11	Friday. Last day of first term final examinations.
July 14	Monday. Registration for the second term.
July 15	Tuesday. Beginning of classes, 8 a.m.
July 17	Thursday. Last day for enrolling in the University for the second term and for making changes in registration.
August 21	Thursday. Last day of second term classes. Beginning of final examinations, 8 p.m.
August 22	Friday. Last day of second term final examinations.

REGULAR SESSION 1969-70

FALL SEMESTER 1969

August 15	Friday. Last date on which any student may file his application and submit appropriate credentials for admission or re-admission in September 1969.
September 8-12	Monday through Friday. Late registration.
September 15	Monday. Beginning of Fall Semester classes, 8 a.m.
September 19	Friday. Last day for enrolling in the University for the Fall Semester or for adding courses.
September 30	Tuesday. Last day in the Fall Semester for dropping courses with no grade.
November 10	Monday. Mid-semester grade reports (for undergraduates only).
November 27-30	Thursday-Sunday, inclusive. Thanksgiving holidays.
December 19	Friday. Beginning of Christmas recess, 5 p.m.
January 5, 1970	Monday. End of Christmas recess, 8 a.m.
January 16	Friday. First day of Fall Semester examinations.
January 17	Saturday. Commencement.
January 24	Saturday. Last day of Fall Semester examinations.

SPRING SEMESTER 1970

January 26-30	Monday through Friday. Late registration.
February 2	Monday. Beginning of Spring Semester classes, 8 a.m.
February 6	Friday. Last day for enrolling in the University for the Spring Semester or for adding courses.
February 17	Tuesday. Last day in the Spring Semester for dropping courses with no grade.
March 25	Wednesday. Beginning of spring recess, 5 p.m.
March 31	Tuesday. End of spring recess, 8 a.m.
April 6	Monday. Mid-semester grade reports (for undergraduates only).
May 22	Friday. First day of semester examinations.
May 23	Saturday. Commencement and Final Review.
May 30	Saturday. Last day of semester examinations.

SUMMER SESSION 1970

June 1	Monday. Registration for the first term.
June 2	Tuesday. Beginning of classes, 8 a.m.
June 4	Thursday. Last day for enrolling in the University for the first term or for adding courses.
June 5	Friday. Last day in the first term for dropping courses with no grade.
July 9	Thursday. Last day of first term classes. Beginning of final examinations, 8 p.m.
July 10	Friday. Last day of first term final examinations.
July 13	Monday. Registration for the second term.
July 14	Tuesday. Beginning of classes, 8 a.m.
July 16	Thursday. Last day for enrolling in the University for the second term or for adding courses.
July 17	Friday. Last day in the second term for dropping courses with no grade.
August 20	Thursday. Last day of second term classes. Beginning of final examinations, 8 p.m.
August 21	Friday. Last day of second term examinations.

The Texas A&M University System

Composed of Texas A&M University and all colleges, agencies and services under the supervision of the Board of Directors of Texas A&M University, including:

Texas A&M University
- Texas Agricultural Experiment Station
- Texas Agricultural Extension Service
- Texas Engineering Experiment Station
- Texas Engineering Extension Service
- Texas Transportation Institute
- Texas Maritime Academy

Tarleton State College

Prairie View Agricultural and Mechanical College

Texas Forest Service

Board of Directors

CLYDE H. WELLS, *Rancher*......Granbury
President

A. P. BEUTEL, *Industrial Executive*......Lake Jackson
Vice-President

FORD D. ALBRITTON, JR., *Corporation Executive*......Bryan

WOFFORD CAIN, *Corporation Executive*......Dallas

STERLING C. EVANS, *Rancher*......Houston

H. C. HELDENFELS, *General Contractor*......Corpus Christi

PEYTON MCKNIGHT, JR., *Independent Oil Operator*......Tyler

L. F. PETERSON, *Petroleum Consultant*......Fort Worth

S. B. WHITTENBURG, *Publisher*......Amarillo

Administrative Officers

EARL RUDDER......*President*

JOHN C. CALHOUN, JR......*Vice-President for Programs*

W. C. FREEMAN......*Vice-President and Comptroller*

Texas A&M University

Administrative Officers

EARL RUDDER, B.S., LL.D. .... *President*

HORACE R. BYERS, Sc.D. .... *Academic Vice-President*

THOMAS D. CHERRY, M.S. .... *Vice-President for Business Affairs*

ANDREW D. SUTTLE, Ph.D. .... *Vice-President for Research*

FRED J. BENSON, M.S. .... *Dean, College of Engineering and Director, Texas Engineering Experiment Station*

HORACE R. BYERS, Sc.D. .... *Acting Dean, College of Science*

EARL F. COOK, Ph.D. .... *Acting Dean, College of Geosciences*

JAMES P. HANNIGAN, B.S. .... *Dean of Students*

FRANK W. R. HUBERT, Ph.D. .... *Dean, College of Liberal Arts*

H. O. KUNKEL, Ph.D. .... *Dean, College of Agriculture and Acting Director, Texas Agricultural Experiment Station*

GEORGE W. KUNZE, Ph.D. .... *Dean of the Graduate College*

JOHN EARLE PEARSON, Ph.D. .... *Dean, College of Business Administration*

ALVIN A. PRICE, D.V.M., M.S. .... *Dean, College of Veterinary Medicine*

HAROLD D. BEARDEN, M.A. .... *Director, Texas Engineering Extension Service*

JAMES D. CRAIK, Rear Admiral, U.S.C.G., (Ret.), B.S. .... *Superintendent Texas Maritime Academy*

H. LLOYD HEATON, M.S. .... *Dean of Admissions and Records*

JOHN E. HUTCHISON, M.Ed. .... *Director, Texas Agricultural Extension Service and Associate Dean, College of Agriculture*

TEXAS A&M UNIVERSITY

Graduate College Organization

GEORGE W. KUNZE, *Dean*
LEO BERNER, JR., *Assistant Dean*
HARRY L. KIDD, JR., *Assistant to the Dean*

GRADUATE COUNCIL

GEORGE W. KUNZE, *Chairman*
H. LLOYD HEATON, *Ex-Officio*
CHARLES H. BRIDGES
KENNETH C. BRUNDIDGE
THOMAS C. CARTWRIGHT
WILLIAM P. FIFE
GUY A. FRANCESCHINI
HARRISON E. HIERTH
CHARLES F. KETTLEBOROUGH
EARL H. KNEBEL
OTTO R. KUNZE
ARTHUR E. MARTELL
JARVIS W. MILLER
HASKELL M. MONROE, JR.
GEORGE H. RICE, JR.
RICHARD E. WAINERDI

COMMITTEES ON GRADUATE INSTRUCTION

Agriculture

OTTO R. KUNZE, *Chairman*
DILFORD C. CARTER
RUDOLF J. FREUND
ROBERT G. MERRIFIELD
DONALD S. MOORE
JACK R. RUNKLES
FRANK W. SUGGITT

Business Administration

GEORGE H. RICE, JR., *Chairman*
EARL D. BENNETT
WILLIAM R. SMITH
ROBERT M. STEVENSON
HERBERT G. THOMPSON, JR.

Engineering

CHARLES F. KETTLEBOROUGH, *Chairman*
HOWARD L. FURR
GLEN D. HALLMARK
EDMUND C. KLIPPLE
GLENDON D. SELF
RICHARD E. THOMAS
ROBERT F. WHITE

Geosciences

KENNETH C. BRUNDIDGE, *Chairman*
GEORGE F. CARTER
ALFRED F. CHALK
MELVIN FRIEDMAN
SAYED Z. EL-SAYED

Liberal Arts

HASKELL M. MONROE, JR., *Chairman*
DONALD G. BARKER
ROBERT B. EKELUND
HARRISON E. HIERTH
BARDIN H. NELSON

Science

WILLIAM P. FIFE, *Chairman*
THOMAS C. CARTWRIGHT
RUDOLF J. FREUND
JOSEPH J. MALONE
ARTHUR E. MARTELL
GILBERT N. PLASS
CORNELIUS H. M. VAN BAVEL

Veterinary Medicine

CHARLES H. BRIDGES, *Chairman*
WILLIAM P. FIFE
CHESTER A. GLEISER
RICHARD J. HIDALGO
DAN HIGHTOWER
JOHN M. PRESCOTT
RAYMOND F. SIS

TEXAS A&M UNIVERSITY GRADUATE FACULTY

(Correct as of March 1, 1969)

(Figures in parentheses indicate date of first appointment on the University Staff and date of appointment to present position, respectively.)

Abbott, John Paul, Distinguished Professor of English. (1926, 1956) B.A., Vanderbilt, 1925; Ph.D., Iowa, 1939.

*Ables, Earnest David, Assistant Professor of Wildlife Science. (1967) B.S., Oklahoma State, 1961; M.S., Wisconsin, 1964; Ph.D., 1968.

*Ackerman, Bernice, Associate Professor of Meteorology. (1967) B.S., Chicago, 1948; M.S., 1955; Ph.D., 1965.

Adair, Thomas W., III, Assistant Professor of Physics. (1966) B.S., Texas A&M, 1957; M.A., Rice, 1960; Ph.D., Texas A&M, 1965.

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

Adkisson, Perry Lee, Professor of Entomology and Head of the Department. (1958, 1967) B.S., Arkansas, 1950; M.S., 1954; Ph.D., Kansas State College, 1956.

Aldrich, David V., Associate Professor of Wildlife Science. (1966, 1968) A.B., Kenyon College, 1950; M.A., Rice, 1952; Ph.D., 1954.

*Anderson, Warren Boyd, Assistant Professor of Soil and Crop Sciences. (1964) B.S., Brigham Young, 1958; M.S., Colorado State, 1962; Ph.D., 1964.

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

Applegate, Howard George, Associate Professor of Plant Physiology and Pathology. (1963) B.S., Colorado State, 1950; M.S., 1952; Ph.D., Michigan State, 1956.

*Archer, Stanley Louis, Associate Professor of English. (1962, 1967) B.A., Texas A&M, 1959; M.A., Mississippi, 1961; Ph.D., 1965.

*Arnold, Keith Alan, Assistant Professor of Wildlife Science. (1966) A.B., Kalamazoo College, 1959; M.S., Michigan, 1961; Ph.D., Louisiana State, 1966.

Ashcraft, Allan Coleman, Associate Professor of History. (1956, 1965) B.A., Texas A&M, 1950; M.A., Columbia, 1951; Ph.D., 1960.

Atkins, Irvin Milburn, Agronomist, Agricultural Research Service, USDA. (1939, 1954) B.S., Kansas State College, 1928; M.S., 1936; Ph.D., Minnesota, 1945.

Atkins, John G., Plant Pathologist of Department of Plant Sciences. (1965) B.S., Central Missouri State College, 1938; M.S., Louisiana State, 1940; Ph.D., Cornell, 1947.

Atkinson, Robert Leon, Associate Professor of Poultry Science. (1955, 1968) B.S., Texas A&M, 1949; M.S., 1950; Ph.D., California, 1958.

Baldauf, Richard John, Professor of Wildlife Science. (1952, 1965) 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, Professor of Education. (1959, 1967) B.A., Baylor, 1952; M.A., 1954; Ph.D., Texas, 1961.

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

*Associate Member

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

*Bassett, James Wilbur, Associate Professor of Animal Science. (1963, 1967) B.S., Texas A&M, 1948; M.S., Montana State College, 1957; Ph.D., Texas A&M, 1965.

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

*Bay, William Wallace, Associate Professor of Veterinary Pathology. (1966, 1968) B.S., Texas A&M, 1948; D.V.M., 1948; M.S., Purdue, 1950; Ph.D., 1952.

*Bearden, Harold D., Director, Texas Engineering Extension Service. (1947, 1957) B.S., Texas Technological College, 1931; M.A., Texas, 1936.

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

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

Benedict, Chauncey Roy, Plant Physiologist (USDA) of Department of Plant Sciences. (1966) B.S., Cornell, 1954; M.S., 1956; Ph.D., Purdue, 1960.

Bennett, Earl Dean, Professor of Accounting and Acting Head of Department; Associate Dean, College of Business Administration. (1968) B.S., John Brown, 1945; M.B.A., Harvard Graduate School of Business Administration, 1947; C.P.A., Louisiana, 1948; Ph.D., Michigan, 1959.

Benson, Fred Jacob, P.E., Dean of College 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.

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

Berg, Robert R., Professor of Geology and Head of Department. (1967) B.A., Minnesota, 1948; Ph.D., 1951.

Berner, Leo, Jr., Associate Professor of Oceanography and Assistant Dean of the Graduate College. (1966, 1967) B.A., Pomona College, 1943; M.S., California at Los Angeles, 1952; Ph.D., 1957.

*Bertrand, Clint Albert, Associate Professor of Industrial Education. (1953, 1965) B.S., Texas A&M, 1953; M.S., 1959; D.Ed., 1964.

*Billingsley, Ray Verne, Associate Professor of Agricultural Economics. (1966) B.S., Oklahoma State, 1949; M.S., 1952; Ph.D., North Carolina State, 1956.

Bills, William E., Visiting Member, Veterinary Medicine and Surgery. (1964) D.V.M., Ohio State, 1936; M.S., 1938; M.P.H., California, 1955.

Bird, Luther Smith, Professor of Plant Physiology and Pathology. (1950, 1966) B.S., Clemson College, 1948; M.S., Texas A&M, 1950; Ph.D., 1955.

Bitter, Harold L., Visiting Member, Veterinary Public Health. (1965) B.S., Maryland, 1947; M.S., 1951; Ph.D., Rochester, 1956.

Blackhurst, Homer T., Professor of Horticulture. (1947, 1950) A.B., Glenville State Teachers College, 1935; M.S., Texas A&M, 1940; Ph.D., 1947.

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.

Boone, James Leroy, Jr., Professor of Industrial Education. (1952, 1967) B.S., Texas A&M, 1947; M.Ed., 1948; D.Ed., 1966.

*Botner, Stanley Benton, Associate Professor of Political Science. (1963, 1966) A.B., Missouri, 1947; M.A., 1960; Ph.D., 1963.

*Associate Member

Bottino, Nestor Rodolfo, Assistant Professor of Biochemistry and Biophysics. (1965) Licentiate in Chemistry, University of La Plata (Argentina), 1951; Doctor of Chemistry, 1954.

*Bottrell, Dale G., Assistant Professor, Texas Agricultural Experiment Station, Lubbock. (1967) B.S., Oklahoma State, 1963; Ph.D., 1967.

Bouma, Arnold H., Associate Professor of Oceanography. (1966) B.S., Groningen (Netherlands), 1956; M.S., Utrecht (Netherlands), 1959; Ph.D., 1961.

*Bourgeois, Anthony Emile, Assistant Professor of Psychology. (1966) B.S., Southwestern Louisiana, 1962; Ph.D., Baylor, 1966.

*Bovey, Rodney William, Research Agronomist, Department of Range Science. (1966) B.S., Idaho, 1956; M.S., 1959; Ph.D., Nebraska, 1964.

*Bowden, Elbert V., Associate Professor of Economics. (1967) B.A., Connecticut, 1950; M.A., Duke, 1952; Ph.D., 1957.

*Bowen, Hollis Hulon, Assistant Professor of Soil and Crop Sciences. (1965) B.S., Arkansas, 1960; M.S., 1961; Ph.D., Rutgers, 1965.

*Bowers, David R., Professor of Journalism. (1964, 1967) B.J., Missouri, 1946; A.M., 1947; Ph.D., Iowa, 1954.

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.

*Breitenkamp, Edward Carlton, Professor of Modern Languages. (1953, 1963) B.A., Drake, 1936; M.A., 1938; Ph.D., Iowa, 1951.

Breuer, Leslie H., Assistant Professor of Animal Science. (1964) B.S., Missouri, 1960; M.S., 1962; Ph.D., Cornell, 1964.

*Brewer, Kenneth Alvin, Assistant Professor of Civil Engineering. (1967, 1968) B.S., Kansas State, 1960; M.S., 1961.

Bridges, Charles Hubert, Professor of Veterinary Pathology and Head of Department. (1955, 1960) D.V.M., Texas A&M, 1945; M.S., 1954; Diplomate, American College of Veterinary Pathologists, 1956; Ph.D., Texas A&M, 1957.

†Brigham, Raymond D., Agronomist, Department of Soil and Crop Sciences. (1957) B.S,. Texas Technological College, 1950; M.S., Iowa State, 1952; Ph.D., 1957.

*Bronson, Jeff D., Assistant Professor of Physics. (1967) B.S., Rice, 1959; M.A., 1961; Ph.D., 1964.

*Brooks, David Whitehead, Assistant Professor of Chemistry (1967) B.A., New York, 1962; M.A., Columbia, 1962; Ph.D., 1965.

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, Professor of Meteorology. (1955, 1968) B.A., Chicago, 1952; M.S., 1953; Ph.D., Texas A&M, 1961.

*Bryant, Jack Douglas, Assistant Professor of Mathematics. (1964) B.A., Texas A&M, 1959; M.S., 1962; Ph.D., Rice, 1965.

Bryant, William Richards, Associate Professor of Oceanography. (1963, 1968) M.S., Chicago, 1961.

Buchanan, Spencer Jennings, P.E., Professor of Civil Engineering. (1946) B.S., Texas A&M, 1926; M.S., Massachusetts Institute of Technology, 1931; C.E., Texas A&M, 1948.

*Associate Member

†Personnel stationed at locations other than the Main Campus at College Station.

*Buhr, Johann Herman, Assistant Professor of Civil Engineering. (1965, 1967) B.S., Capetown (South Africa), 1959; M.S., Northwestern, 1965; Ph.D., Texas A&M, 1967.

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, P.E., Professor of Industrial Engineering. (1948, 1951) B.S., Washington, 1932; M.S., 1938; Ph.D., Texas, 1968.

Burgess, Leonard Randolph, Professor of Management. (1964, 1968) B.A., Brown, 1942; M.B.A., Harvard, 1947; Ph.D., Columbia, 1961.

Burke, Horace Reagan, Associate Professor of Entomology. (1958, 1965) 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.

*Bury, Richard Landon, Associate Professor of Recreation and Parks. (1967) B.S., Purdue, 1950; M.S., Yale, 1955; Ph.D., Connecticut, 1961.

Butler, James J., Visiting Member, Pathology. (1968) M.D., Michigan, 1952.

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.

Byers, Horace Robert, Academic Vice-President; Acting Dean, College of Science; and Distinguished Professor of Meteorology. (1965, 1968) A.B., California (Berkeley), 1929; S.M., Massachusetts Institute of Technology, 1932; Sc.D., 1935.

*Caddess, James Harvey, P.E., Associate Professor of Mechanical Engineering. (1940, 1953) B.S., Texas A&M, 1932; M.S., 1934.

Calhoun, John C., Jr., P.E., Vice-President for Programs, Director of Sea-Grant Program and Distinguished Professor of Petroleum Engineering. (1955, 1967) B.S., Pennsylvania State College, 1937; M.S., 1941; Ph.D., 1946.

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, Professor of Biochemistry and Biophysics. (1956, 1965) B.S., East Texas State Teachers College, 1949; M.S., Texas A&M, 1953; Ph.D., 1956.

Cannon, Garland Hampton, Professor of English. (1966, 1968) B.A., Texas, 1947; M.A., Stanford, 1952; Ph.D., Texas, 1954.

*Canterbury, Samuel Luther, Jr, Visiting Professor of Electrical Engineering. (1966) B.E.E., Marquette, 1934; M.S., Texas A&M, 1937; Ph.D., 1939.

*Capurro, Luis R. A., Lecturer in Oceonography. (1965, 1968) M.S., California, 1949; D.Sc., Buenos Aires, 1951.

Carpenter, Zerle Leon, Associate Professor of Animal Science. (1962, 1966) B.S., Oklahoma State, 1957; M.S., Wisconsin, 1960; Ph.D., 1962.

Carter, Dilford Campbell, Associate Professor of Wildlife Science. (1961, 1968) B.S., Southern Methodist, 1956; M.S., 1956; Ph.D., Texas A&M, 1962.

Carter. George Francis, Distinguished Professor of Geography and Acting Head of the Department. (1967, 1968) A.B., California (Berkeley), 1934; Ph.D., 1942.

Cartwright, Thomas Campbell, Professor of Animal Science. (1958) B.S., Clemson Agricultural College, 1948; M.S., Texas A&M, 1949; Ph.D., 1954.

Case, James Edward, Associate Professor of Geology and of Geophysics. (1966) B.S., Arkansas, 1954; M.S., 1955; Ph.D., California at Berkeley, 1963.

*Associate Member

†Personnel stationed at locations other than the Main Campus at College Station.

*Casey, Albert J., Associate Professor of Psychology. (1962, 1965) B.A., Kansas, 1953; M.A., 1956; Ph.D., 1962.
Ph.D., California, 1965.

Casey, Harold W., Visiting Member, Veterinary Public Health. (1967) A.A., Jefferson City Junior College, 1952; B.S., Missouri, 1957; D.V.M., 1957; M.P.H., Tulane, 1958;

*Cavin, Ralph Keary, III, Assistant Professor of Electrical Engineering. (1968) B.S., Mississippi State, 1961; M.S., 1962; Ph.D., Auburn, 1968.

Chalk, Alfred Franklin, Professor of Economics. (1936, 1951) B.A., Baylor, 1934; M.S., Texas A&M, 1936; Ph.D., Texas, 1950.

*Chevrette, John Maurice, Assistant Professor of Health and Physical Education. (1967) B.S., Springfield College, 1956; M.S., Florida State, 1958; Ph.D., 1966.

*Chin, Edward, Associate Professor of Biology. (1965) B.S., Harvard College, 1948; M.S., New Hampshire, 1953; Ph.D., Washington, 1961.

*Christiansen, James Edward, Associate Professor of Agricultural Education. (1968) B.S., Arizona, 1951; M.Ag.Ed., 1957; Ph.D., Ohio State, 1965.

Clamann, Hans Georg, Visiting Member, Biochemistry and Biophysics. (1965) M.D., Heidelberg, 1929.

Clark, Dale A., Visiting Member, Veterinary Microbiology. (1964) B.A., Hastings College, 1943; M.A., Colorado, 1947; Ph.D., Utah, 1950.

*Clark, Donald L., Associate Professor of Industrial Education. (1967) B.S., Stout State, 1961; M.S., 1962; Ph.D., Ohio State, 1967.

*Clark, Donald Ray, Jr., Assistant Professor of Wildlife Science. (1968) B.S., Illinois, 1961; M.S., Texas A&M, 1964; Ph.D., Kansas, 1968.

*Clark, Donald Raye, Assistant Professor of Veterinary Physiology and Pharmacology. (1963) B.S., Texas A&M, 1958; D.V.M., 1960; M.S., 1966.

*Clark, Lewis Edwin, Assistant Professor of Agronomy. (1962, 1967) B.S., Texas Technological College, 1959; M.S., Texas A&M, 1961; Ph.D., 1967.

Clark, Robert Alfred, Associate Professor of Meteorology. (1960, 1965) B.S., Kansas State, 1948; M.S., Texas A&M, 1959; Ph.D., 1964.

Clark, William Jesse, Associate Professor of Biology and of Wildlife Science. (1957, 1968) B.S., Utah State Agricultural College, 1950; M.S., 1956; Ph.D., 1958.

Clayton, William Howard, Professor of Meteorology and of Oceanography. (1954, 1965) 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.

Conway, Dwight Colbur, Professor of Chemistry. (1963, 1967) 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, Earl Ferguson, Acting Dean, College of Geosciences and Professor of Geology. (1966, 1968) B.S., Washington, 1943; M.S., 1948; Ph.D., 1954.

*Associate Member

Coon, Jesse Bryan, Professor of Physics. (1946, 1957) A.B., Indiana, 1932; M.A., 1935; Ph.D., Chicago, 1949.

Copeland, Murray Marcus, Visiting Member, Surgery. (1968) B.A., Oglethorpe, 1923; M.D., Johns Hopkins, 1927.

*Corbin, Charles Bennett, Assistant Professor of Health and Physical Education. (1967) B.S., New Mexico, 1960; M.S., Illinois, 1962; Ph.D., New Mexico, 1965.

*Corbridge, Ivan L., Visiting Professor of Agricultural Economics. (1967) B.S., Utah State Agricultural College, 1946; M.S., Chicago, 1948; Ph.D., Washington State College, 1952.

Couch, James Russell, Professor of Biochemistry and Biophysics and of Poultry Science. (1948, 1949) B.S., Texas A&M, 1931; M.S., 1934; Ph.D., Wisconsin, 1948.

*CoVan, Jack Phillip, P.E., Professor of Industrial Engineering. (1946, 1956) B.M.E., Ohio State, 1935; B.I.E., 1935; M.S., Illinois, 1942.

*Cox, Elenor Ray (Mrs.), Assistant Professor of Biology. (1967) B.A., Rice, 1952; M.Ed., 1955; M.A., Texas, 1961; Ph.D., 1966.

Coyle, Harry Michael, Associate Professor of Civil Engineering. (1965, 1968) B.S., United States Military Academy, 1950; M.S., Massachusetts Institute of Technology, 1956; Ph.D., Texas, 1965.

†Craigmiles, Julian Pryor, Superintendent, Texas Agricultural Rice-Pasture Research and Extension Center, Beaumont. (1965) B.S., Georgia, 1942; M.S., 1948; Ph.D., Cornell, 1952.

Cramer, Robert L., Visiting Member, Veterinary Microbiology. (1964) A.B., Illinois, 1940; Ph.D., Rochester, 1954.

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., Associate Professor of Biochemistry and of Poultry Science. (1962, 1965) B.S., Kansas State, 1955; M.S., 1956; Ph.D., Texas A&M, 1961.

Cronk, Alfred Edward, P.E., Professor of Aerospace Engineering and Head of Departments of Aerospace Engineering and of Engineering Graphics. (1956, 1965) B.S., College of St. Thomas, 1937; M.S., Minnesota, 1946.

Crookshank, Herman Robert, Animal Nutritionist and Lecturer, Department of Biochemistry and Biophysics, USDA. (1959) B.S., Northeast Missouri State College, 1938; M.S., Iowa, 1940; Ph.D., 1942.

Dabbs, Jack Autrey, Professor of Modern Languages and Head of Department. (1950, 1964) B.A., Texas, 1935; M.A., 1936; Ph.D., 1950.

Darby, Ronald, Associate Professor of Chemical Engineering (1965, 1967) B.A., Rice, 1955; B.S., 1955; Ph.D., 1962.

Darnell, Rezneat, Professor of Oceanography. (1968) B.S., Southwestern College, 1946; M.A., Rice, 1948; Ph.D., Minnesota, 1953.

*Das, Phanindramohan, Assistant Professor of Meteorology. (1967) B.Sc., Dacca (India), 1947; M.Sc., 1948; Ph.D., Chicago, 1963.

*Davenport, Manuel Manson, Professor of Philosophy and Head of the Department of Philosophy and Humanities. (1967) B.A., Bethany Nazarene College, 1950; M.A., Colorado College, 1954; Ph.D., Illinois, 1957.

Davies, David K., Assistant Professor of Geology. (1966) B.S., Wales, 1962; Ph.D., 1966.

*Davis, Daniel Rowland, Associate Professor of Sociology. (1935, 1947) B.S., Texas A&M, 1932; M.S., 1935.

---

*Associate Member

†Personnel stationed at locations other than the Main Campus at College Station.

*Davis, Richard Harvey, Jr., Professor of Veterinary Physiology and Pharmacology. (1951, 1964) D.V.M., Texas A&M, 1941; M.S., 1956.

Davis, William Burson, P.E., Associate Professor of Civil Engineering. (1964, 1968) B.S., Colorado, 1952; S.M., Massachusetts Institute of Technology, 1958; S.E., 1959; Ph.D., Washington, 1968.

Davison, Richard Read, P.E., Professor of Chemical Engineering. (1958, 1968) B.S., Texas Technological College, 1949; M.S., Texas A&M, 1958; Ph.D., 1962.

*Dawson, Jerry T., Associate Professor of History. (1968) B.A., Mississippi College, 1956; M.A., Texas, 1960; Ph.D., 1964.

*Denison, John Scott, P.E., Professor of Electrical Engineering. (1949, 1965) B.S., New Mexico Agricultural and Mechanical College, 1948; M.S., Texas A&M, 1949.

*Dennis, Richard A., Assistant Professor of Veterinary Pathology. (1968) B.S., Texas A&M, 1963; D.V.M., 1964; M.Sc., Ohio State, 1968; Ph.D., 1968.

Derrick, William Sheldon, Visiting Member, Surgery. (1968) B.A., George Washington, 1940; M.D., George Washington Medical School, 1942.

DeWerth, Adolphe Ferdinand, Professor of Floriculture. (1946, 1949) B.S., Ohio State, 1930; M.S., 1931.

Dieckert, Julius Walter, Associate Professor of Biophysics. (1960) B.S., Texas A&M, 1949; M.S., 1951; Ph.D., 1955.

*Dietrich, Raymond Arthur, Assistant Professor of Agricultural Economics. (1967) B.S., Texas A&M, 1956; M.S., 1957; Ph.D., Oklahoma State, 1964.

Dill, Charles W., Associate Professor of Animal Science. (1966) B.S., Berea College, 1954; M.S., North Carolina State, 1957; Ph.D., 1963.

Dillon, Lawrence Samuel, Professor of Biology. (1948, 1961) B.S., Pittsburgh, 1933; M.S., Texas A&M, 1950; Ph.D., 1954.

Dixon, James Ray, Associate Professor of Wildlife Science. (1956, 1967) B.S., Howard Payne College, 1950; M.S., Texas A&M, 1957; Ph.D., 1961.

Dixon, Joe Boris, Professor of Agronomy. (1968) B.S., Kentucky, 1952; M.S., 1956; Ph.D., Wisconsin, 1958.

*Djuric, Dusan, Associate Professor of Meteorology. (1966, 1968) Dipl. Met., Belgrade (Yugoslavia), 1953; Dr.Met.Sc., 1960.

*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, Gerald D., Visiting Member, Diagnostic Radiology. (1968) A.B., Lafayette College, 1945; M.D., Jefferson Medical College, 1947.

Dodd, Jimmie Dale, Associate Professor of Range Science. (1963, 1966) A.B., Ft. Hays Kansas State College, 1956; M.S., 1957; Ph.D., Saskatchewan (Canada), 1960.

Dollahite, James Walton, Professor of Veterinary Physiology and Pharmacology. (1963, 1968) D.V.M., Texas A&M, 1933; M.S., 1961.

*Donovan, Gerard Anthony, Assistant Professor of Biochemistry and Biophysics and of Genetics. (1968) B.S., National of Ireland, 1960; M.S., 1961; Ph.D., California (Davis), 1965.

Doran, Edwin Beale, Jr., Professor of Geography and Head of Department, Assistant Dean, College of Geosciences. (1960, 1969) B.A., Louisiana State, 1938; M.S., 1947; Ph.D., California (Berkeley), 1953.

*Dowdy, Edward Joseph, Assistant Professor of Nuclear Engineering. (1967) B.S., St. Mary's, 1961; B.A., 1961; M.Eng., Texas A&M, 1963; Ph.D., 1965.

Dowell, Linus James, Associate Professor of Health and Physical Education. (1966) B.S.Ed., Northeast Missouri State Teachers College, 1951; B.S., 1951; M.Ed., Missouri, 1957; Ed.D., 1959.

*Associate Member

*Drew, Dan D., Associate Professor of Industrial Engineering. (1960, 1966) B.S., North Texas State College, 1950; M.S., 1951; Ph.D., Texas A&M, 1966.

Drew, Donald Richard, P.E., Professor of Civil Engineering. (1963, 1968) 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.

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, Associate Professor of Civil Engineering. (1959, 1967) B.S., Texas A&M, 1952; M.S., 1955; Ph.D., 1966; M.S. and D.I.C., Imperial College of Science and Technology, London, 1967.

Durbin, Leonel Damien, Associate Professor of Chemical Engineering. (1961, 1966) 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.

*Earle, James Hubert, Associate Professor of Engineering Graphics. (1957, 1964) B.Arch., Texas A&M, 1955; M.Ed., 1962; D.Ed., 1964.

*Eastin, Emory Ford, Assistant Professor of Agronomy. (1968) B.S., Mississippi State, 1962; M.S., 1963; Ph.D., 1966.

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.

*Edwards, Thomas Charles, P.E., Assistant Professor of Civil Engineering. (1966, 1967) B.S., Texas, 1958; M.S., 1962; Ph.D., Texas A&M, 1966.

*Ehrich, Rollo L., Associate Professor of Agricultural Economics. (1968) B.S., Minnesota, 1959; M.S., 1959; M.A., Stanford, 1963; Ph.D., 1963.

*Ekelund, Robert Burton, Jr., Assistant Professor of Economics. (1967) B.B.A., St. Mary's, 1962; M.A., 1963; Ph.D., Louisiana State, 1967.

*Elkins, Rollin Lafayette, Associate Professor of Management. (1935, 1946) B.S., Texas A&M, 1933; M.S., 1935.

*Ellett, Edwin Willard, Professor of Veterinary Medicine and Surgery. (1958, 1967) D.V.M., Georgia, 1953; B.S., Virginia Polytechnic Institute, 1954; M.S., Texas A&M, 1961.

*Elliott, James Marion, Assistant Professor of Psychology. (1965) B.A., Abilene Christian College, 1959; M.A., Houston, 1963; Ph.D., Houston, 1966.

*Elliott, Roger W., Assistant Professor of Industrial Engineering. (1967) B.A., Texas Western College, 1959; Ph.D., Texas, 1965.

Ellis, William C., Associate Professor of Animal Science. (1961, 1963) B.S., Louisiana Polytechnic Institute, 1953; M.S., Missouri, 1955; Ph.D., 1958.

*Elmquist, Karl Erik, Associate Professor of English. (1935, 1947) A.B., Southern Methodist, 1932; M.A., Texas, 1939.

El-Sayed, Sayed Zakaria, Associate Professor of Oceanography. (1961, 1966) B.S., Alexandria, 1949; M.S., 1951; Ph.D., Washington, 1959.

Engleman, E. Mark, Assistant Professor of Biology. (1965) B.S., Oklahoma, 1958; M.S., 1959; Ph.D., California, 1963.

*Ergle, David R., Senior Plant Physiologist, ARS, USDA, of Plant Sciences Department. (1944) B.S., Clemson College, 1926; M.S., North Carolina, 1928; Ph.D., 1930.

Erickson, Howard H., Visiting Member, Veterinary Medicine and Surgery. (1968) B.S., Kansas State; D.V.M., 1959; Ph.D., Iowa State, 1966.

*Associate Member

Eubank, Philip Toby, Professor of Chemical Engineering. (1961, 1968) B.S., Rose Polytechnic Institute, 1958; Ph.D., Northwestern, 1961.

*Fahlquist, Davis Armstrong, Associate Professor of Geophysics. (1963, 1967) B.S., Brown, 1950; Ph.D., Massachusetts Institute of Technology, 1963.

Fanguy, Roy Charles, Associate Professor of Poultry Science. (1958, 1966) B.S., Mississippi State College, 1951; M.S., Alabama Polytechnic Institute, 1953; Ph.D., Texas A&M, 1958.

Farris, Donald Edward, Associate Professor of Agricultural Economics. (1963) B.S.A., Arkansas, 1950; M.S., 1951; Ph.D., North Carolina State, 1958.

Ferguson, Charles E., Professor of Economics. (1968) B.A., Hendrix College, 1949; M.A., North Carolina, 1951; Ph.D., 1958.

Ferguson, Thomas Morgan, Professor of Poultry Science. (1946, 1965) B.A., Southwestern, 1936; M.S., Texas A&M, 1946; Ph.D., 1954.

Fienup, Darrell F., Visiting Professor of Agricultural Economics. (1967) B.S., Iowa State, 1951; M.S., Montana State College, 1952; Ph.D., Wisconsin, 1955.

Fife, William P., Professor of Biology and Assistant Director, Administration, Institute of Life Sciences. (1966) B.S., Oregon, 1956; Ph.D., Ohio State, 1962.

*Fisher, Farley, Assistant Professor of Chemistry. (1966) S.B., Massachusetts Institute of Technology, 1960; Ph.D., Illinois, 1965.

Fitzhugh, Henry Allen, Jr., Assistant Professor of Animal Science. (1966) B.S., Texas A&M, 1961; M.S., 1963; Ph.D., 1965.

Fleeger, James Lee, Assistant Professor of Animal Science. (1965) B.S., Pennsylvania State, 1957; M.S., Delaware, 1959; Ph.D., Pennsylvania State, 1963.

Flowers, Archie Ingram, Professor of Veterinary Public Health and Head of Department. (1957, 1965) B.S., Texas A&M, 1942; D.V.M., 1950; M.S., 1959.

Foster, Billy Glen, Assistant Professor of Biology. (1965) B.S., North Texas State, 1955; M.S., 1962; Ph.D., Iowa, 1965.

Foster, Charles Robert, P.E., Visiting Professor of Civil Engineering. (1964)

Franceschini, Guy Arthur, Associate Professor of Meteorology. (1952, 1961) B.S., Massachusetts, 1950; M.S., Chicago, 1952; Ph.D., Texas A&M, 1961.

Frederiksen, Richard Allan, Assistant Professor of Plant Physiology and Pathology. (1964) B.S., Minnesota, 1955; M.S., 1957; Ph.D., 1961.

Freund, Rudolf J., Professor of Statistics and of Economics. (1962, 1967) M.A., Chicago, 1951; Ph.D., North Carolina State College, 1955.

*Friedman, Melvin, Associate Professor of Geology. (1967) B.S., Rutgers, 1952; M.S., 1954; Ph.D., Rice, 1961.

Fryxell, Paul A., Geneticist, USDA, of Department of Soil and Crop Sciences. (1965) B.A., Augustana College, 1949; M.S., Iowa State, 1952; Ph.D., 1955.

Furr, Howard Lee, Professor of Civil Engineering. (1962) B.S., Mississippi State College, 1941; M.S., Texas A&M, 1948; Ph.D., Texas, 1958.

Furubotn, Erik, Professor of Economics. (1967) A.B., Brown, 1948; M.A., Columbia, 1950; Ph.D., 1959.

Gallaway, Bob Mitchel, P.E., Professor of Civil Engineering. (1944, 1959) B.S., Texas A&M, 1943; M.S., 1946; M.Eng., 1956.

Galvin, Thomas Joseph, Associate Professor of Veterinary Parasitology. (1958, 1964) D.V.M., Texas A&M, 1957; B.S., 1961; M.S., 1961; Ph.D., Tulane, 1964.

*Gangi, Anthony F., Associate Professor of Geophysics. (1967) B.S., California at Los Angeles, 1953; M.S., 1954; Ph.D., 1960.

*Associate Member

Gardner, Frederick Albert, Associate Professor of Poultry Science. (1959, 1963) B.S., Vermont, 1953; M.S., Texas A&M, 1955; Ph.D., Missouri, 1960.

*Gardner, James Russell, Associate Professor of Architecture. (1966) B.Arch., Southern California, 1951; M.C.P., Massachusetts Institute of Technology, 1953; Registered Architect.

Gates, Charles Edgar, Professor of Statistics. (1966) B.S., Iowa State, 1950; M.S., North Carolina State, 1952; Ph.D., 1955.

†*Gerard, Cleveland J., Associate Professor of Agronomy. (1964) B.S., Southwestern Louisiana, 1948; M.S., Kansas State, 1950; Ph.D., Texas A&M, 1954.

German, John Paul, P.E., Professor of Electrical Engineering. (1958) B.S., Texas, 1940; M.S., 1949; Ph.D., 1955.

Geyer, Richard A., Professor of Oceanography and Head of Department. (1966) B.S., New York, 1937; M.S., 1940; M.A., Princeton, 1950; Ph.D., 1951.

Giam, Choo-Seng, Assistant Professor of Chemistry. (1966) B.S., Malaya, 1954; B.S., 1955; M.S., Saskatchewan (Canada), 1961; Ph.D., 1962.

*Giarola, Attillio Jose, Associate Professor of Electrical Engineering. (1968) B.S.E.E., Sao Paulo, 1954; B.S.M.E., 1954; M.S.E.E., Washington, 1959; Ph.D., 1963.

*Gibbons, William Conrad, Professor of Political Science and Head of Department. (1968) B.A., Randolph-Macon, 1949; M.A., Princeton, 1952; Ph.D., 1961.

*Gibson, Daniel Morgan, Jr., Visiting Associate Professor of Nuclear Engineering. (1964) B.S., Texas A&M, 1953; M.S., 1958; M.A., Princeton, 1958; Ph.D., 1962.

Gilmore, Earl C., Jr., Assistant Professor of Agronomy. (1967) B.S., Texas A&M, 1952; M.S., 1957; Ph.D., Minnesota, 1966.

Gilruth, Robert Rowe, Visiting Professor of Aerospace Engineering. (1963) B.S., Minnesota, 1935; M.S., 1936; D.Sc., Indiana Technical College, 1962; D.Sc., George Washington, 1962; D.Sc., Minnesota, 1962.

Gingerich, Karl Andreas, Professor of Chemistry. (1968) B.S., Albert Ludwigs, 1951; M.S., 1954; Ph.D., 1957.

Gladden, James Kelly, Professor of Chemistry. (1959) B.S., Howard College, 1942; M.S., Georgia Institute of Technology, 1944; Ph.D., Northwestern, 1952.

Glazener, Everett Ruthven, Professor of Industrial Education and Head of the Department. (1962, 1967) B.S., Texas A&M, 1942; M.Ed., 1946; D.Ed., Pennsylvania State, 1958.

Gleiser, Chester Alexander, Professor of Veterinary Pathology and of Veterinary Public Health. (1965, 1968) V.M.D., Pennsylvania, 1940; M.S., Ohio State, 1941; M.P.H., Johns Hopkins, 1948; Diplomate, American College of Veterinary Pathologists, 1952.

Glenn, William Grant, Visiting Member, Veterinary Microbiology. (1946) B.S., Trinity, 1948; M.A., 1952; M.S., Rutgers, 1955; Ph.D., 1956.

Godfrey, Curtis L., Professor of Agronomy. (1954, 1967) B.S., Texas A&M, 1939; M.S., 1948; Ph.D., Iowa State College, 1951.

Godwin, Marshall Reid, Professor of Agricultural Economics. (1966) B.S., Florida, 1942; M.S., 1946; Ph.D., Cornell, 1949.

*Goode, Phillip Barron, Professor of Management. (1946, 1949) B.S., Southern Methodist, 1933; LL.B., 1936; LL.M., Texas, 1953; J.D., 1968.

*Gough, Francis J., Plant Pathologist, ARS, USDA, Department of Plant Sciences. (1967) B.S., West Virginia, 1952; M.S., 1954; Ph.D., 1957.

Gould, Frank Walton, Professor of Range Science. (1949, 1964) B.S., Northern Illinois State College, 1935; M.S., Wisconsin, 1937; Ph.D., California, 1941.

*Associate Member

†Personnel stationed at locations other than the Main Campus at College Station.

*Gowing, Gene Martin, Associate Professor of Veterinary Medicine and Surgery. (1959, 1966) B.S., Texas A&M, 1957; D.V.M., 1959; M.S., 1961.

†Graham, Owen Hugh, Investigations Leader, Entomology Research Division, ARS, USDA, Kerrville. (1966) B. S., Texas A&M, 1938; M.S., 1940; Ph.D., 1962.

*Gramm, William Philip, Assistant Professor of Economics. (1967) B.B.A., Georgia, 1964; Ph.D., 1967.

Graves, William Herbert, Jr., Associate Professor of Education. (1964, 1967) B.S., Minnesota, 1938; M.A., Columbia, 1951; Ed.D., 1953.

*Gravett, Howard L., Professor of Biology. (1946, 1954) A.B., James Millikin, 1933; M.A., Illinois, 1934; Ph.D., 1939.

*Greeley, Ralph Gordon, Associate Professor of Veterinary Anatomy. (1960, 1966) B.S., Missouri, 1953; D.V.M., 1953; M.S., Texas A&M, 1966.

*Green, Phillip Joseph, II, Assistant Professor of Physics. (1967) B.S., Southwestern at Memphis, 1963; Ph.D., Louisiana State, 1967.

Greenhut, Melvin L., Professor of Economics and Head of Department. (1966) B.A., Hofstra College, 1940; M.A., Washington, 1947; Ph.D., 1951.

Griffiths, John Frederick, Associate Professor of Meteorology. (1962, 1965) B.S., Kings College (London), 1947; M.S., Imperial College (London), 1949.

*Grigsby, Ronald Davis, Assistant Professor of Biochemistry and Biophysics. (1968) B.S., (Zoology) Oklahoma, 1958; B.S. (Chem.), 1959; Ph.D., 1966.

*Grimes, James E., Assistant Professor of Veterinary Microbiology. (1964, 1968) B.A., Texas Lutheran College, 1950; M.A., Texas 1959; Ph.D., Texas A&M, 1967.

Grumbles, Leland Creed, Professor of Veterinary Microbiology and Head of Department. (1949, 1957) D.V.M., Texas A&M, 1945; M.S., 1957.

*Guinn, John Pollard, Jr., Assistant Professor of English. (1962, 1963) B.A., Texas, 1938; M.A., 1947; Ph.D., 1963.

*Gunderson, Richard Harlan, Assistant Professor of Civil Engineering. (1966) B.S., North Dakota State, 1959; Ph.D., Arizona, 1964.

Gunn, Clare A., Professor of Recreation and Parks. (1966) B.S., Michigan State, 1940; M.S., 1952; Ph.D., Michigan, 1965.

*Haden, Clovis R., Associate Professor of Electrical Engineering. (1968) B.S., Arlington State College, 1961; M.S., California Institute of Technology, 1962; Ph.D., Texas, 1965.

Hall, Charles Franklin, Professor of Veterinary Microbiology. (1959, 1966) B.S., Kansas State College, 1949; D.V.M., 1951; M.S., Michigan State, 1959.

Hall, Claude Hampton, Professor of History. (1951, 1964) B.A., Virginia, 1947; M.A., 1949; Ph.D., 1954.

Hall, Wayne C., Professor of Plant Pathology and of Plant Physiology. (1949, 1954) B.S., Iowa, 1941; M.S., 1946; Ph.D., 1948.

Halliwell, Robert Stanley, Associate Professor of Plant Sciences. (1962, 1967) B.S., Wyoming, 1956; M.S., 1959; Ph.D., Oregon State, 1962.

Hallmark, Glen Duncan, P.E., Professor of Electrical Engineering. (1942, 1966) B.S., Texas A&M, 1935; M.S., 1946; Ph.D., 1953.

Ham, Joe Strother, Professor of Chemistry and of Physics. (1956, 1967) Ph.B., Chicago, 1948; M.S., 1951; Ph.D., 1954.

Hampton, Herbert Elwood, Professor of Agronomy. (1938, 1948) B.S., Texas A&M, 1937; Ph.D., Missouri, 1943.

*Associate Member
†Personnel stationed at locations other than the Main Campus at College Station.

Hampton, Kenneth Gerald, Assistant Professor of Chemistry. (1966) B.S., Wake Forest College, 1961; Ph.D., Duke, 1965.

Hancock, Charles Kinney, Professor of Chemistry. (1946, 1949) B.S., Southwest Texas State Teachers College, 1931; M.A., Texas, 1936; Ph.D., 1939.

Handin, John Walter, Distinguished Professor of Geology and of Geophysics and Director of the Center for Tectonophysics. (1967) A.B., California (Los Angeles), 1942; M.A., 1948; Ph.D., 1949.

*Hann, Roy William, Jr., P.E., Associate Professor of Civil Engineering. (1965, 1967) B.S., Oklahoma, 1956; M.S., 1957; Ph.D., 1963.

Hanna, Ralph Lynn, Associate Professor of Entomology. (1949, 1956) B.A., Stephen F. Austin State Teachers College, 1939; Ph.D., Texas A&M, 1951.

*Hansen, Robert Charles, Assistant Professor of Agricultural Engineering. (1968) B.S., Ohio State, 1962; M.S., 1962; Ph.D., California, 1968.

*Harper, William Weston, Associate Professor of Architecture. (1964, 1967) B.A.E., Oklahoma State, 1953; M.A., Texas A&M, 1966; Registered Architect.

*Harrell, Roger Leon, Associate Professor of Education. (1965, 1968) B.S., Eastern New Mexico, 1956; M.A., 1959; Ed.S., 1963; Ed.D., New Mexico, 1966.

*Harris, William Birch, P.E., Associate Professor of Chemical Engineering. (1956) B.S., Colorado, 1941; M.S., Texas A&M, 1960.

Harris, William Donald, P.E., Professor of Chemical Engineering. (1935, 1949) B.S., Iowa State College, 1929; M.S., 1931; Ph.D., 1934.

†Harrison, Arthur L., Plant Pathologist, Texas Agricultural Experiment Station, Yoakum. (1937, 1947) B.S., Ontario Agricultural College, 1929; Ph.D., Cornell, 1935.

Harrison, G. M., Visiting Member, Pediatrics and Rehabilitation. (1968) B.S., Virginia Military Institute, 1943; M.D., Virginia School of Medicine, 1946.

Harry, Harold William, Associate Professor of Biology. (1964, 1966) B.S., Louisiana State, 1941; M.S., 1942; Ph.D., Michigan, 1952.

*Hart, Gary Elwood, Assistant Professor of Plant Sciences. (1966) B.S., North Dakota State, 1955; Ph.D., California at Berkeley, 1965.

Hartley, Herman Otto, Distinguished Professor of Statistics, Professor of Economics, and Director of the Graduate Institute of Statistics. (1963) Ph.D., Berlin, 1934; Ph.D., Cambridge, 1940; D.Sc., London, 1953.

*Hauer, Louis Frederick, Associate Professor of English. (1937, 1961) B.A., Dubuque, 1931; M.A., Iowa, 1933.

Haupt, Lewis McDowell, Jr., P.E., Professor of Electrical Engineering. (1930, 1948) B.S., Texas A&M, 1927; M.S., 1935.

Hawkins, Leslie Virgle, Professor of Industrial Education. (1954, 1959) B.S., Panhandle Agricultural and Mechanical College, 1938; M.S., Oklahoma Agricultural and Mechanical College, 1946; D.Ed., Pennsylvania State, 1953.

*Heck, Fred Carl, Assistant Professor of Veterinary Microbiology and of Veterinary Public Health. (1959, 1968) B.S., Texas A&M, 1959; M.S., 1962; Ph.D., Texas, 1965.

Hedges, Richard Marion, Professor of Chemistry. (1960, 1967) B.S., Southern Methodist, 1950; Ph.D., Iowa State, 1955.

*Henry, Walter Keith, Associate Professor of Meteorology. (1957, 1967) B.S., Missouri, 1941; M.S., Chicago, 1949.

Hensarling, Paul Reginald, Professor of Education. (1958, 1963) B.S., North Texas State College, 1933; M.S., 1940; Ed.D., Houston, 1957.

*Associate Member

†Personnel stationed at locations other than the Main Campus at College Station.

Herbich, John B., P.E., Professor of Civil Engineering. (1967) B.S., Edinburgh (Scotland), 1949; M.S., Minnesota, 1957; Ph.D., Pennsylvania State, 1963.

Hickey, Robert C., Visiting Member, Surgery. (1968) B.S., Cornell, 1938; M.D., Cornell Medical College, 1942.

*Hidalgo, Richard Jack, Assistant Professor of Veterinary Microbiology. (1966) D.V.M., Texas A&M, 1962; M.S., Louisiana State, 1964; Ph.D., 1966.

Hiebert, John Covell, Associate Professor of Physics. (1965, 1968) A.B., Harvard College, 1956; M.S., Yale, 1960; Ph.D., 1964.

Hierth, Harrison Ewing, Professor of English. (1946, 1965) A.B., Illinois Wesleyan, 1935; B.Ed., Illinois State Normal, 1936; M.A., Illinois, 1942; Ph.D., Wisconsin, 1956.

*Hightower, Dan, Associate Professor of Veterinary Physiology and Pharmacology. (1966) D.V.M., Texas A&M, 1946; M.S., North Carolina State, 1961.

Hiler, Edward Allan, Assistant Professor of Agricultural Engineering. (1966) B.Agr.E., Ohio State, 1963; M.S., 1963; Ph.D., 1966.

*Hill, John C., Assistant Professor of Physics. (1968) B.S., Davidson College, 1957; M.S., Purdue College, 1962; Ph.D., 1967.

Hirsch, Teddy James, P.E., Professor of Civil Engineering. (1956, 1967) B.S., Texas A&M, 1952; M.Eng., 1953; Ph.D., 1961.

Hobgood, Price, P.E., Professor of Agricultural Engineering and Head of Department. (1939, 1958) B.S., Texas A&M, 1938; M.S., 1940.

Hocking, Ronald Raymond, Professor of Statistics and of Economics. (1963, 1967) B.S., Michigan College of Mining and Technology, 1954; M.S., Michigan, 1957; Ph.D., Iowa State, 1962.

*Holcomb, John W., Associate Professor of Agricultural Education. (1960) B.S., Texas A&M, 1940; M.Ed., 1953.

Holcomb, Robert Marion, P.E., Professor of Civil Engineering. (1947) B.S., Arizona, 1936; M.S., Iowa State College, 1941; Ph.D., 1956.

Holdredge, Edwin Sereno, P.E., Professor of Mechanical Engineering. (1939, 1957) B.S., Tennessee, 1938; M.S., 1939.

Holland, Charles Donald, P.E., Professor of Chemical Engineering and Head of Department. (1952, 1964) B.S., North Carolina State College, 1943; M.S., Texas A&M, 1949; Ph.D., 1953.

*Holland, Thomas Edward, Associate Professor of Economics. (1966) B.S., Tennessee, 1957; M.S., 1958; Ph.D., Duke, 1963.

*Hollingsworth, Joe Pettus, Research Agricultural Engineer, USDA, ARS. (1966) B.S., Texas A&M, 1943; M.S., 1961.

Holt, Ethan Cleddy, Professor of Agronomy. (1948, 1957) B.S., Alabama Polytechnic Institute, 1943; M.S., Purdue, 1948; Ph.D., 1950.

*Holt, Oris Milton, Associate Professor of Agricultural Education. (1954, 1957) B.S., Texas A&M, 1942; M.Ed., 1946; Ed.D., Houston, 1962.

*Hoover, William L., Assistant Professor of Soil and Crop Sciences and Head of Agricultural Analytical Services. (1964, 1967) B.S., Texas A&M, 1953; M.S., 1953; Ph.D., 1966.

*Hope, Lannes Homer, Associate Professor of Psychology. (1961, 1966) B.S., Texas Technological College, 1949; M.Ed., 1950; Ph.D., Texas, 1960.

Hopkins, Sewell Hepburn, Professor of Biology. (1935, 1947) B.S., William and Mary College, 1927; M.A., Illinois, 1930; Ph.D., 1933.

*House, William Clyde, Jr., Associate Professor of Management. (1962, 1966) B.B.A., Texas, 1954; M.B.A., 1958; Ph.D., 1965; C.D.P., 1966.

*Associate Member

Howes, James Raymond, Professor of Poultry Science. (1967) B.Sc., London, 1949; National Diploma of Agriculture, Edinburg (Scotland), 1949; M.Sc., McGill, 1951; Ph.D., Florida, 1960.

Hubert, Frank William R., Professor of Education and Acting Head of the Department; Dean, College of Liberal Arts. (1959, 1968) B.A., Texas, 1938; M.A., 1945; Ph.D., 1950.

Hudman, Donald Barton, Extension Animal Husbandman. (1966) B.S., Texas A&M, 1948; M.S., 1954; Ph.D., Iowa State, 1956.

†*Hudspeth, Elmer Benton, Jr., Agricultural Engineer Project Leader, ARS, USDA. (1966) B.S., Texas A&M, 1942; M.S., Michigan State, 1949.

*Huebner, George Lee, Jr., Associate Professor of Electrical Engineering and of Meteorology. (1958, 1968) B.S., Texas A&M, 1946; M.S., 1951; Ph.D., 1953.

Hunter, Parks Caldwell, Jr., Associate Professor of English. (1955, 1962) B.A., Miami, 1948; B.Ed., 1949; M.A., 1950; Ph.D., Texas, 1958.

Hurt, John Tom, Professor of Mathematics. (1936, 1947) B.A., Rice Institute, 1931; M.A., 1932; Ph.D., 1935.

Hutchison, John Elton, Director of Texas Agricultural Extension Service and Associate Dean, College of Agriculture. (1945, 1968) B.S., Texas A&M, 1936; M.S., 1949; M.Ed., 1950.

Hutt, W. H., Visiting Professor of Economics. (1968) B.Com., London, 1928.

Ichiye, Takashi, Professor of Oceanography. (1968) B.S., Tokyo, 1944; D.Sc., 1953.

Inglis, Jack Morton, Assistant Professor of Wildlife Science. (1958, 1965) B.S., Texas A&M, 1950; M.S., 1952; Ph.D., 1967.

*Irby, Harold Dewey, Assistant Professor of Wildlife Science. (1967) B.S., Texas A&M, 1954; Ph.D., Arizona, 1964.

Irgolic, Kurt J., Assistant Professor of Chemistry. (1966) Ph.D., Karl-Franzens Universitaet (Austria), 1964.

Isbell, Arthur Furman, Professor of Chemistry. (1953, 1966) B.A., Baylor, 1937; M.S., Texas, 1941; Ph.D., 1943.

Ivey, Don Louis, P.E., Associate Professor of Civil Engineering. (1964, 1968) B.S., Lamar State College of Technology, 1960; M.Eng., Texas A&M, 1962; Ph.D., 1964.

Jardine, John Henry, Visiting Member, Experimental Animals. (1968) B.S., Louisiana Polytechnic Institute, 1954 D.V.M., Texas A&M, 1962.

Joham, Howard Ernest, Professor of Plant Physiology and Pathology. (1946, 1959) B.A., Santa Barbara College, 1941; M.S., Texas A&M, 1943; Ph.D., Iowa State College, 1950.

*Johnson, Glenn Ross, Assistant Professor of Education. (1967) B.S., Kent State, 1953; M.A., Ohio State, 1960; Ed.D., Columbia, 1967.

Joiner, Gary N., Visiting Member, Experimental Animals. (1968) D.V.M., Texas A&M, 1962; M.S., Michigan, 1967.

Jones, Earl, Professor of Education. (1967) B.S., Oregon State, 1949; M.S., Inter-American Institute of Agricultural Sciences (Costa Rica), 1959; Ed.D., Montana State, 1962.

*Jones, Mortimer Drahn, P.E., Associate Professor of Civil Engineering. (1966) B.S., Texas A&M, 1947; M.S., 1948.

Jones, William B., Jr., Professor of Electrical Engineering and Head of the Department. (1967) B.S., Georgia Institute of Technology, 1945; M.S., 1948; Ph.D., 1953.

Jones, William Prichard, Research Professor of Aerospace Engineering. (1967) B.A., St. David's College, Lampeter (Wales), 1930; B.A., Oxford, 1932; M.A., 1940; D.Sc., 1953.

---

*Associate Member

†Personnel stationed at locations other than the Main Campus at College Station.

*Jungerman, Paul Frank, Professor of Veterinary Microbiology. (1956, 1963) D.V.M., Texas A&M, 1947; M.S., 1959.

Kasahara, Akira, NCAR Affiliate Professor of Meteorology; Program Scientist, National Center for Atmospheric Research, Boulder, Colorado. (1966) B.S., Tokyo, (Japan), 1948; D.Sc., 1953.

*Kattawar, George W., Associate Professor of Physics. (1968) B.S., Lamar State, 1959; M.S., Texas A&M, 1961; Ph.D., 1963.

Kaye, Howard, Assistant Professor of Chemistry. (1967) B.S., Polytechnic Institute of Brooklyn, 1960; Ph.D., 1965.

*Keeley, Larry Lee, Assistant Professor of Entomology. (1966) B.S., Notre Dame, 1962; Ph.D., Purdue, 1966.

Keese, Charles Joseph, P.E., Director of Texas Transportation Institute and Professor of Civil Engineering. (1948, 1962) B.S., Texas A&M, 1941; M.S., 1952.

*Kemler, Arden Grant, Professor of Veterinary Anatomy. (1959, 1966) D.V.M., Kansas State College, 1950; M.S., Georgia, 1959.

Kenefick, Robert Arthur, Associate Professor of Physics. (1965, 1968) B.S., Massachusetts Institute of Technology, 1959; Ph.D., Florida State, 1962.

*Kent, Jack Thurston, Associate Professor of Mathematics. (1936, 1952) A.B., Lambuth College, 1930; M.A., Arkansas, 1931.

*Kerley, Sidney Auston, Associate Dean of Admissions, Director of Counseling and Testing Center and Associate Professor of Education. (1952, 1969) B.A., Texas A&M, 1939; M.Ed., North Texas State College, 1950.

Kettleborough, Charles Fred, Distinguished Professor of Mechanical Engineering. (1964, 1965) B.Eng., Sheffield, 1944; Ph.D., 1951.

Kieffer, Nat Mathan, Associate Professor of Plant Sciences and of Animal Science. (1965, 1966) B.S., Southwestern Louisiana Institute, 1952; M.S., Louisiana State, 1956; Ph.D., Oklahoma State, 1959.

*King, General Tye, Associate Professor of Animal Science. (1953, 1960) B.S., Kentucky, 1950; M.S., 1951; Ph.D., Texas A&M, 1958.

Kinman, Murray Luther, Agronomist of the Department of Soil and Crop Sciences. (1950) B.S., Kansas State College, 1942; M.S., Iowa State College, 1944; Ph.D., 1950.

Kleerekoper, Herman, Professor of Biology. (1968) M.S., Michigan, 1948; Ph.D., 1950; D.Sc., Sorbonne of Paris, 1957.

Klemm, William Robert, Associate Professor of Biology. (1966) D.V.M., Auburn, 1958; Ph.D., Notre Dame, 1963.

Klipple, Edmund Chester, Professor of Mathematics. (1935, 1945) B.A., Texas, 1926; Ph.D., 1932.

Knebel, Earl H., Professor of Agricultural Education and Head of Department. (1955, 1961) B.S., Montana State College, 1946; M.Ed., Texas A&M, 1951; Ed.D., Oklahoma State, 1955.

Koenig, Karl Joseph, Associate Professor of Geology. (1955, 1957) B.S., Illinois, 1941; M.S., 1946; Ph.D., 1949.

Kohel, Russell James, Geneticist, Department of Soil and Crop Sciences. (1959) B.S., Iowa State College, 1956; M.S., Purdue, 1958; Ph.D., 1959.

Kohler, Walter H., Associate Professor of Nuclear Engineering. (1965, 1968) B.S., Delaware, 1958; M.S., Massachusetts Institute of Technology, 1962; Dr. Ing., T. H. Karlsruhe (Germany), 1964.

*Konecny, Frank Jack, Executive Assistant, Texas Engineering Extension Service. (1955) B.S., Texas A&M, 1927; M.Ed., 1940.

*Associate Member

*Kosztolnyik, Zoltan Joseph, Assistant Professor of History. (1967, 1968) B.A., St. Bonaventure, 1959; M.A., Fordham, 1961; Ph.D., New York, 1968.

*Kozik, Thomas Joseph, Professor of Mechanical Engineering. (1963) B.S., Rensselaer Polytechnic Institute, 1952; M.S., Ohio State, 1957; Ph.D., 1962.

*Kozub, Raymond L., Assistant Professor of Physics. (1967) B.S., Wisconsin State, 1962; M.S., Michigan State, 1964; Ph.D., 1967.

Krise, George Martin, Professor of Biology. (1959, 1963) B.A., Texas, 1946; M.A., 1948; Ph.D., 1952.

*Krishnamurty, Kotra V., Associate Professor of Oceanography. (1968) B.Sc., Andhra (India), 1946; M.Sc., 1951; Ph.D., Washington (St. Louis), 1958.

Kroitor, Harry Peter, Professor of English. (1958, 1967) B.A., Saskatchewan, 1946; B.A., 1949; M.A., 1950; Ph.D., Maryland, 1957.

Krueger, Willie F., Professor of Poultry Science. (1953, 1959) B.S., Texas A&M, 1943; M.S., 1949; Ph.D., Missouri, 1952.

*Kubis, Joseph John, Assistant Professor of Physics. (1964) S.B., Massachusetts Institute of Technology, 1959; M.S., Princeton, 1961; Ph.D., 1964.

*Kubler, Jurgen, Assistant Professor of Physics. (1968) Prediplom, Giessen (Germany), 1960; M.S., Kansas, 1964; Ph.D., 1964.

Kunkel, Harriott Orren, Dean of the College of Agriculture and Acting Director of Texas Agricultural Experiment Station; Professor of Animal Science and of Biochemistry and Biophysics. (1951, 1968) B.S., Texas A&M, 1943; M.S., 1948; Ph.D., Cornell, 1950.

Kunze, George William, Dean of the Graduate College and Professor of Agronomy. (1952, 1968) B.S., Texas A&M, 1948; M.S., 1950; Ph.D., Pennsylvania State College, 1952.

Kunze, Otto Robert, P.E., Associate Professor of Agricultural Engineering. (1956) B.S., Texas A&M, 1950; M.S., Iowa State, 1951; Ph.D., Michigan State, 1964.

Kuttler, Kenneth Latimer, Professor of Veterinary Microbiology and of Veterinary Pathology. (1965) D.V.M., Colorado State, 1945; M.S., Cornell, 1955; Ph.D., East Africa, 1965.

Kuvlesky, William Peter, Associate Professor of Sociology. (1964, 1968) B.S., Pennsylvania State, 1958; M.S., 1960; Ph.D., 1965.

*Laane, Jaan, Assistant Professor of Chemistry. (1968) B.S., Illinois, 1964; Ph.D., Massachusetts Institute of Technology, 1967.

Landiss, Carl Wilson, Professor of Health and Physical Education and Head of the Department. (1943, 1967) B.S., Abilene Christian College, 1935; M.Ed., Texas A&M, 1947; D.Ed., Pennsylvania State College, 1951.

Landmann, Wendall A., Professor of Animal Science and of Biochemistry and Biophysics. (1964) B.S., Illinois, 1941; M.S., Purdue, 1943; Ph.D., 1951.

*Lane, Gary Thomas, Assistant Professor of Animal Science. (1967) B.S., Berea College, 1963; M.S., Purdue, 1965; Ph.D., 1967.

Lang, Herbert Howard, Professor of History. (1956, 1965) B.A., Texas, 1949; M.A., 1950; Ph.D., 1954.

*Lard, Curtis Franklin, Associate Professor of Agricultural Economics. (1967) B.S., Tennessee, 1957; M.S., Michigan State, 1959; Ph.D., 1963.

*Larsen, John E., Horticulturist, Department of Soil and Crop Sciences. (1962) B.S., Purdue, 1942; M.S., 1946; Ph.D., 1957.

Laverty, Carroll Dee, Professor of English. (1939, 1955) A.B., Colorado, 1933; A.M., 1934; Ph.D., Duke, 1951.

*Associate Member

*Layman, Andrew H., P.E., Assistant Professor of Civil Engineering. (1965) B.S., Arkansas, 1941; M.S., Purdue, 1942; Ph.D., Texas A&M, 1968.

Ledbetter, William Burl, P.E., Associate Professor of Aerospace Engineering and of Civil Engineering. (1964, 1967) B.S., Texas A&M, 1956; Ph.D., Texas, 1964.

Leighton, Rudolph Elmo, Professor of Animal Science. (1947, 1956) B.S., Oklahoma Agricultural and Mechanical College, 1932; M.S., 1943; Ph.D., Texas A&M, 1956.

Leinweber, Charles Lee, Professor of Range Science and Head of Department. (1960) B.S., Texas A&M, 1952; M.S., 1953; Ph.D., 1956.

*Leribaux, Henry Romain, Assistant Professor of Nuclear Engineering and of Physics. (1967, 1968) B.S., Louvain (Belgium), 1959; Engineering Diplomas; 1960; Ph.D., Iowa State, 1963.

*Lewis, Charles William, Assistant Professor of Physics. (1967) B.A., Reed College, 1959; M.S., Minnesota, 1961; Ph.D., 1964.

Liebhafsky, Herman Alfred, Professor of Chemistry. (1967) B.S., Texas A&M, 1926; M.S., Nebraska, 1927; Ph.D., California (Berkeley), 1929.

Linder, John Scott, Associate Professor of Electrical Engineering. (1967, 1968) B.S., Louisiana State, 1956; M.S., 1960; Ph.D., Arizona, 1967.

*Linerode, Phillip Allen, Assistant Professor of Veterinary Public Health. (1967) B.S., Ohio State, 1968; D.V.M., 1958; M.S., Minnesota, 1960; Ph.D., Ohio State, 1966.

Linger, Irving Oscar, Professor of Economics. (1961, 1963) A.B., Ohio, 1939; M.A., Ohio State, 1942; Ph.D., Texas, 1958.

*Litchfield, Charles Carter, Associate Professor of Biochemistry and Biophysics. (1966, 1968) B.S., Rensselaer Polytechnic Institute, 1953; B.F.T., American Institute for Foreign Trade, 1957; Ph.D., Texas A&M, 1966.

*Livingston, Charles Wesley, Jr., Assistant Professor of Veterinary Microbiology. (1963) B.S., Sul Ross State College, 1946; D.V.M., Texas A&M, 1955; M.S., 1961.

*Lowery, Lee Leon, Jr., Associate Professor of Civil Engineering. (1964, 1968) B.S., Texas A&M, 1960; M.Eng., 1961.

*Lowy, Stanley Howard, Associate Professor of Aerospace Engineering. (1964) B.S., Purdue, 1943; M.S., Minnesota, 1947.

†Lukefahr, Maurice J., Investigations Leader of the Department of Entomology, Ent. Res. Div., ARS, USDA. (1967) B.S., Texas College of Arts and Industries, 1950; M.S., Texas A&M, 1953; Ph.D., 1961.

Lunsford, Jack Horner, Associate Professor of Chemistry. (1966, 1968) B.S., Texas A&M, 1957; Ph.D., Rice, 1962.

Luther, Herbert Adesla, Professor of Mathematics and Head of Department. (1937, 1968) B.A., Pittsburgh, 1934; M.S., Iowa, 1935; Ph.D., 1937.

Lyda, Stuart Davisson, Associate Professor of Plant Sciences. (1967) B.S., Montana State, 1956; M.S., 1958; Ph.D., California, 1962.

†Lyerly, Paul J., Research Coordinator, Texas Agricultural Experiment Station, Ysleta. (1942, 1958) B.S., North Carolina State College, 1938; M.S., Iowa State College, 1940; Ph.D., 1942.

*McAfee, Thomas Edison, Professor of Agronomy. (1939, 1957) B.S., Oklahoma Agricultural and Mechanical College, 1939; M.S., 1940; Ph.D., Texas A&M, 1953.

McBee, George Gilbert, Assistant Professor of Agronomy. (1954, 1964) B.S., Texas A&M, 1951; M.S., 1956; Ph.D., 1965.

*McCandless, Charles Emery, Associate Professor of Education and Assistant Dean of College of Liberal Arts. (1961, 1968) B.S., Texas A&M, 1956; M.Ed., 1958; Ed.D., North Texas State, 1966.

*Associate Member
†Personnel stationed at locations other than the Main Campus at College Station.

*McConnell, Stewart, Associate Professor of Veterinary Microbiology. (1968) D.V.M., Texas A&M, 1950; M.Sc., Ohio State, 1960.

McCrady, James David, Professor of Veterinary Physiology and Pharmacology and Head of Department. (1958, 1966) B.S., Texas A&M, 1952; D.V.M., 1958; Ph.D., Baylor College of Medicine, 1965.

*McCulley, William Straight, Associate Professor of Mathematics. (1937, 1957) B.A., Iowa State, 1932; M.S., Texas A&M, 1936; Ph.D., Texas, 1956.

McCully, Wayne Gunther, Professor of Range Science. (1948, 1968) B.S., Colorado State, 1947; M.S., Texas A&M, 1950; Ph.D., 1958.

*McDaniel, Milton Edward, Assistant Professor of Agronomy. (1967) B.S., Oklahoma State, 1960; Ph.D., Virginia Polytechnic Institute, 1965.

*McDonald, Frank Alan, Assistant Professor of Physics. (1964) B.A. (Math.), Southern Methodist, 1958; B.A. (Phys.), 1958; M.S., Yale, 1959; Ph.D., 1964.

McGraw, Joseph James, Associate Professor of Architecture. (1958, 1965) B.A., Oklahoma Agricultural and Mechanical College, 1953; M.C.P., Harvard, 1955; Registered Architect.

McGuire, John Gilbert, Assistant Dean of College of Engineering and Professor of Engineering Graphics. (1935, 1965) B.S., Texas A&M, 1932; M.S., 1937; B.S., 1944.

McIntyre, John Armin, Professor of Physics. (1963) B.S., Washington, 1943; M.A., Princeton, 1948; Ph.D., 1950.

*McLain, Donald Davis, Jr., Associate Professor of Biology. (1962, 1968) B.S., Illinois, 1952; M.S., 1956; Ph.D., 1960.

*McNeal, James Utah, Associate Professor of Marketing and Head of the Department. (1967) B.B.A., Texas College of Arts and Industries, 1959; M.B.A., Texas, 1960; Ph.D., 1964.

McNeely, John Gordon, Professor of Agricultural Economics. (1947, 1950) B.S., South Dakota State College, 1933; M.S., 1934; Ph.D., Wisconsin, 1941.

*McNichols, Roger J., Assistant Professor of Industrial Engineering. (1966) B.S., Ohio State, 1962; M.S., 1964; Ph.D., 1966.

Macfarlane, Ronald Duncan, Professor of Chemistry. (1967) B.A., Buffalo, 1954; M.Sc., Carnegie Institute of Technology, 1957; Ph.D., 1959.

Mackin, John Gilman, Professor of Marine Biology. (1950) B.S., East Central State College, Ada, Oklahoma, 1924; M.S., Illinois, 1927; Ph.D., 1933.

Malone, Joseph J., Associate Professor of Mathematics. (1967) B.S., St. Louis, 1954; M.S., 1958; Ph.D., 1962.

*Mamaliga, Emil, Associate Professor of Health and Physical Education. (1947, 1957) B.S., Ohio State, 1943; M.Ed., Texas A&M, 1950.

*Mann, George J., Assistant Research Professor of Architecture. (1966) B.Arch., Columbia, 1961; M.S.Arch., 1962; Registered Architect.

*Manning, Walter Scott, Associate Professor of Accounting. (1941, 1947) B.B.A., Texas College of Arts and Industries, 1932; M.B.A., Texas, 1940; C.P.A., 1952.

*Marsh, James Hyde, III, P.E., Associate Professor of Architecture. (1957, 1963) B.S., Texas A&M, 1957; M.Arch., 1963.

Martell, Arthur E., Professor of Chemistry and Head of Department. (1966) B.S., Worcester Polytechnic Institute, 1938; Ph.D., New York, 1941; D.Sc., Worcester Polytechnic Institute, 1962.

*Martin, James Rod, Agricultural Economist of the Department of Agricultural Economics and Sociology, ERS, USDA. (1967) B.S., Texas A&M, 1949; M.S., 1957; Ph.D., Oklahoma State, 1963.

*Associate Member

*Martin, Lee Jackson, Professor of English and Head of Department. (1946, 1966) B.S., Texas, 1941; M.A., 1948; Ph.D., Stanford, 1956.

*Martin, Rufus Edward, Assistant Professor of Mechanical Engineering. (1967) B.S., Mississippi, 1961; M.S., Houston, 1965; Ph.D., Texas A&M, 1968.

*Martinez, Jose Edwardo, Assistant Professor of Civil Engineering. (1967, 1968) B.S., Texas A&M, 1963; M.S., 1965; Ph.D., 1967.

Maurer, Fred Dry, Distinguished Professor of Veterinary Pathology and Associate Dean of College of Veterinary Medicine. (1964) B.S., Idaho, 1934; D.V.M., Washington State, 1937; Ph.D., Cornell, 1948.

†*Maxwell, Norman Paul, Assistant Professor, Texas Agricultural Experiment Station, Weslaco. (1946, 1967) B.S., Delaware, 1943; M.S., 1949.

Meier, Wilbur Leroy, Jr., P.E., Associate Professor of Industrial Engineering. (1966, 1968) B.S., Texas, 1962; M.S., 1964; Ph.D., 1967.

Meinke, Wilmon William, Professor of Chemical Engineering. (1936, 1964) B.S., Texas A&M, 1936; Ph.D., Texas, 1949.

*Mellor, David B., Associate Professor of Poultry Science and Poultry Marketing Specialist. (1967) B.S., Pennsylvania, 1956; M.S., Texas A&M, 1957; Ph.D., Purdue, 1965.

*Merki, Donald John, Assistant Professor of Health and Physical Education. (1967) B.S., St. Joseph's College, 1955; M.S., Illinois, 1956; Ph.D., 1967.

*Merkle, Morris Guy, Associate Professor of Agronomy. (1966, 1967) B.S., Auburn, 1955; M.S., 1959; Ph.D., Cornell, 1963.

*Merkle, Owen G., Research Agronomist of the Department of Soil and Crop Sciences, ARS, USDA. (1967) B.S., Oklahoma State, 1951; M.S., 1954; Ph.D., Texas A&M, 1963.

Merrifield, Robert Glenn, Professor of Forest Science. (1967) B.S., Arkansas Agricultural and Mechanical College, 1953; M.F., Louisiana State, 1958; D.F., Duke, 1962.

†*Merrill, Leo Brown, Associate Professor, Texas Agricultural Experiment Station, Sonora. (1964, 1967) B.S., Utah State, 1941; M.S., Texas A&M, 1953; Ph.D., 1959.

*Meyer, Edgar F., Assistant Professor of Biochemistry. (1967) B.S., North Texas State, 1959; Ph.D., Texas, 1963.

*Meyer, Robert Earl, Plant Physiologist, USDA, ARS, of Department of Plant Sciences. (1964) B.S., Purdue, 1956; M.S., 1956; Ph.D., Wisconsin, 1961.

Meyers, Edward Arthur, Professor of Chemistry. (1956, 1966) B.S., Michigan, 1950; Ph.D., Minnesota, 1955.

Miller, Charles Standish, Associate Professor of Plant Sciences. (1958, 1966) B.S., Texas A&M, 1951; M.S., 1956; Ph.D., 1959.

Miller, Jarvis Ernest, Assistant Director, Texas Agricultural Experiment Station. (1958, 1967) B.S., Texas A&M, 1950; M.S., Purdue, 1951; Ph.D., 1954.

Miller, Thomas Lloyd, Professor of History. (1946, 1968) B.A., East Texas State Teachers College, 1935; M.A., 1945; Ph.D., Texas, 1956.

Milliff, John Henry, Professor of Veterinary Anatomy. (1936, 1941) B.S., Texas A&M, 1931; M.S., 1934; D.V.M., 1936; Ph.D., Texas, 1958.

*Mills, Jim Frank, Associate Professor of Agronomy. (1946, 1967) B.S., Texas A&M, 1943; M.S., 1953.

*Moehring, David Marion, Assistant Professor of Forest Science. (1966) B.S.F., Montana State, 1958; M.F., Duke, 1959; D.F., 1965.

---

*Associate Member
†Personnel stationed at locations other than the Main Campus at College Station.

*Moffett, Thomas J., Associate Professor of Education. (1967) B.S., Indiana, 1948; M.S., 1951; Ed. D., Florida, 1965.

Monroe, Haskell Moorman, Jr., Associate Professor of History. (1959, 1966) B.A., Austin College, 1952; M.A., 1954; Ph.D., Rice, 1961.

Moore, Bill C., Associate Professor of Mathematics. (1937, 1948) A.B., Kansas, 1929; A.M., 1931; A.M., Princeton, 1937.

Moore, Donald Sylvester, Associate Professor of Agricultural Economics and Sociology. (1956, 1962) B.S., Oklahoma Agricultural and Mechanical College, 1938; M.S., 1940; Ph.D., Minnesota, 1956.

Moore, Richard Wayne, Professor of Veterinary Microbiology. (1958, 1967) D.V.M., Texas A&M, 1955; M.S., 1956.

*Morgan, David Taft, Assistant Professor of History. (1968) B.A., Baylor, 1959; M.A., North Carolina, 1964; Ph.D., 1968.

Morgan, Ira Lon, Visiting Professor of Interdisciplinary Engineering. (1966) B.A., Texas Christian, 1949; M.A., 1951; Ph.D., Texas, 1954.

Morgan, Page Wesley, Associate Professor of Plant Sciences. (1961, 1966) B.S., Texas A&M, 1955; M.S., 1958; Ph.D., 1961.

Moyer, Vance Edwards, Professor of Meteorology and Head of Department. (1958, 1967) B.S., Pennsylvania State, 1950; M.S., 1951; Ph.D., 1954.

*Nagyvary, Joseph, Associate Professor of Biochemistry. (1967) B.S., Eotvos Lorand, Budapest (Hungary), 1965; M.S., Zurich (Switzerland), 1961; Ph.D., 1962.

Nance, Joseph Milton, Professor of History and Head of Department. (1941, 1958) B.A., Texas, 1935; M.A., 1936; Ph.D., 1941.

Natowitz, Joseph Bernard, Assistant Professor of Chemistry. (1967) B.S., Florida, 1958; Ph.D., Pittsburgh, 1965.

*Naugle, Norman Wakefield, Associate Professor of Mathematics. (1958, 1968) B.A., Texas A&M, 1953; M.S., 1959; Ph.D., 1965.

*Neff, Richard Dean, Associate Professor of Nuclear Engineering. (1966, 1967) B.S., Northwest Missouri State College, 1957; M.S., Kansas, 1959; Ph.D., California (Los Angeles), 1964.

Nelson, Bardin Hubert, Professor of Sociology. (1950, 1956) B.S., Louisiana State 1942; M.A., 1943; Ph.D., 1950.

*Niles, George Alva, Associate Professor of Agronomy. (1953, 1964) B.S., New Mexico State, 1949; M.S., Oklahoma State, 1950; Ph.D., Texas A&M, 1959.

Northcliffe, Lee Conrad, Jr., Associate Professor of Physics. (1965, 1967) B.S., Wisconsin, 1948; M.S., 1951; Ph.D., 1957.

Nowlin, Worth Dabney, Jr., Assistant Professor of Oceanography. (1962, 1963) B.A., Texas A&M, 1958; M.S., 1960; Ph.D., 1966.

*Noyes, Theodore Alvan, P.E., Assistant Professor of Mechanical Engineering. (1954, 1957) B.S., Texas A&M, 1949; M.S., 1957.

Nungeseer, William Charles, Visiting Member, Aerospace Medicine. (1962) B.S., North Carolina, 1949; M.S., 1951; Ph.D., 1953.

Nuttall, John, Associate Professor of Physics. (1964, 1965) B.S., Cambridge, 1957; Ph.D., 1961.

*O'Brien, Daniel Harold, Associate Professor of Chemistry. (1967) B.S., Virginia, 1954; Ph.D., 1961.

*Olson, Robert Merle, P.E., Associate Professor of Civil Engineering. (1959, 1961) B.S., Texas, 1947; M.S., Rice Institute, 1959; Ph.D., Texas A&M, 1966.

*Associate Member

Osoba, Joseph Schiller, Professor of Petroleum Engineering. (1966) B.S., Texas, 1942; Ph.D., Washington, 1949.

*Pace, Carlos Nick, Assistant Professor of Biochemistry and Biophysics. (1968) B.S., Utah, 1962; Ph.D., Duke, 1966.

*Packenham, Edward S., Professor of Accounting. (1947, 1967) B.S., Lombard College, 1928; M.S., Texas A&M, 1950; C.P.A., 1949.

Parker, Travis Jay, P.E., Professor of Geology. (1947, 1963) B.S., Texas Technological College, 1933; M.A., Texas, 1939; Ph.D., 1952.

*Pasika, Wallace Michael, Associate Professor of Chemistry. (1968) B.Sc., Manitoba (Canada), 1957; M.Sc., 1958; Ph.D., Alberta, 1962.

Paterson, Donald R., Associate Horticulturist, Department of Soil and Crop Sciences. (1952, 1956) B.S., Cornell, 1947; M.S., California, 1950; Ph.D., Michigan State, 1952.

*Patterson, James R., Associate Professor of Architecture. (1963, 1967) B.Arch., Texas A&M, 1961; M.S.Arch., Columbia, 1962; Registered Architect.

*Patton, Alton Dewitt, P.E., Assistant Professor of Electrical Engineering. (1966) B.S., Texas, 1957; M.S., Pittsburgh, 1961.

*Pearce, W. A., Assistant Professor of Physics. (1967) B.A., Rice, 1963; M.A., 1965; Ph.D., 1967.

Pearson, John Earle, Professor of Finance and of Management and Acting Head of Department of Finance; Dean, College of Business Administration. (1963, 1968) B.S., North Texas State, 1948; M.S., 1948; Ph.D., Indiana, 1956.

*Pearson, Karl Herbert, Assistant Professor of Chemistry. (1966) B.S., Wayne State, 1957; M.S., 1962; Ph.D., 1966.

*Pedigo, John Randolph, Associate Professor of Petroleum Engineering. (1953) B.S., Texas, 1935; B.A., 1935.

*Pejovich, Svetozar, Associate Professor of Economics. (1967) LL.D., Belgrade (Yugoslavia), 1955; Ph.D., Georgetown, 1963.

Pequegnat, Willis E., Professor of Oceanography. (1963) B.A., California at Berkeley, 1936; M.A., California at Los Angeles, 1938; Ph.D., 1942.

Perry, Bruce A., Professor of Soil and Crop Sciences. (1946, 1964) B.S., Wake Forest College, 1930; M.A., 1936; Ph.D., Virginia, 1942.

*Perry, John Vivian, Jr., P.E., Associate Professor of Mechanical Engineering. (1949, 1963) B.S., Virginia Polytechnic Institute, 1947; M.S., Texas A&M, 1954; Ph.D., 1963.

*Phillips, Clinton A., Professor of Management. (1967) B.A., Baldwin-Wallace College, 1949; Ph.D., Vanderbilt, 1956.

Pierce, Kenneth Ray, Associate Professor of Veterinary Pathology. (1957, 1965) D.V.M., Texas A&M, 1957; M.S., 1962; Diplomate, American College of Veterinary Pathologists, 1964; Ph.D., Texas A&M, 1965.

Pinnell, Charles, Professor of Civil Engineering and Director of Planning and Analytical Studies. (1958, 1969) B.S., Texas Technological College, 1952; M.S., Purdue, 1958; Ph.D., Texas A&M, 1964.

*Piotrowski, Marian L., Associate Professor of Finance. (1967) B.A., Lyceum (Poland), 1926; L.L.M., Warsaw (Poland), 1934; Diplome d'Etudes, Paris (France), 1936; Ph.D., London, 1951.

Plass, Gilbert N., Professor of Physics and Head of the Department. (1968) B.S., Harvard, 1941; Ph.D., Princeton, 1946.

Pope, Leon Spalding, Professor of Animal Science and Associate Dean, College of Agriculture. (1968) B.S., Michigan State, 1947; M.S., Oklahoma State, 1949; Ph.D., 1952.

*Associate Member

†*Porter, Kenneth Boyd, Professor In Charge, Texas Agricultural Experiment Station, Bushland. (1947, 1967) B.S., Kansas State College, 1940; M.S., Iowa State College, 1947; Ph.D., Texas A&M, 1957.

Potts, Richard Carmichael, Associate Dean of College of Agriculture for Agricultural Instruction and Professor of Agronomy. (1936, 1968) B.S., Oklahoma Agricultural and Mechanical College, 1935; M.S., Texas A&M, 1945; Ph.D., Nebraska, 1950.

Powell, Robert Delafield, Associate Professor of Plant Physiology and Pathology. (1963) B.S., Minnesota, 1943; Ph.D., Iowa State, 1950.

Prescott, John Mack, Professor of Biochemistry and Biophysics and Acting Head of the Department. (1952, 1968) B.S., Southwest Texas State Teachers College, 1941; M.S., Texas A&M, 1949; Ph.D., Wisconsin, 1952.

*Preston, James Dene, Assistant Professor of Agricultural Economics and Sociology. (1966) B.S., Middle Tennessee State College, 1962; M.A., Mississippi State, 1964; Ph.D., 1967.

Price, Alvin Audis, Dean of College of Veterinary Medicine and Assistant Director of the Texas Agricultural Experiment Station. (1949, 1962) B.S., Texas A&M, 1940; D.V.M., 1949; M.S., 1956.

*Price, Jack Dean, Leader, Agricultural Chemicals, Extension Service. (1963, 1965) B.S., Texas A&M, 1953; M.S., 1957; Ph.D., 1960.

*Price, Manning A., Associate Professor of Entomology. (1940, 1957) B.S., Texas A&M, 1939; M.S., 1941.

Prince, John E., Visiting Member, Veterinary Microbiology. (1964) M.S., Institutum Divi Thomae; Ph.D., 1956.

*Pully, Paul Eugene, Associate Professor of Industrial Engineering. (1967) B.S., Oklahoma State, 1957; M.S., 1959; Ph.D., 1965.

Quisenberry, John Henry, Professor of Poultry Science and Head of Department. (1936, 1946) B.S., Texas A&M, 1931; M.S., Illinois, 1933; Ph.D., 1936.

Rahbany, K. Philip, Professor of Economics. (1968) B.A., Wisconsin, 1948; Ph.D., Beirut, 1958.

Ramge, John Christian, Professor of Veterinary Medicine and Surgery. (1959, 1965) D.V.M., Ohio State, 1942; M.S., 1950; Ph.D., 1955.

Randall, John Del, Director of Nuclear Science Center and Associate Professor of Nuclear Engineering. (1958, 1965) B.S., California, 1955; M.S., 1956; Ph.D., Texas A&M, 1965.

Randolph, Henry England, Associate Professor of Animal Science. (1967) B.S., Tennessee Polytechnical Institute, 1957; M.S., Ohio State, 1959; Ph.D., 1962.

*Randolph, Neal Malcolm, Associate Professor of Entomology. (1954, 1957) B.S. Texas A&M, 1934; M.S., 1938.

Rao, Jonnagadda N.K., Professor of Statistics and of Economics. (1965, 1967) B.A., Andhra (India), 1954; M.S., Bombay (India), 1956; Ph.D., Iowa State, 1961.

Ray, Sammy Mehedy, Associate Professor of Oceanography and of Biology. (1959, 1963) B.S., Louisiana State, 1942; M.S., Rice Institute, 1952; Ph.D., 1954.

*Read, William Kay, Assistant Professor of Veterinary Pathology. (1967) B.S., East Texas State, 1961; B.S., Texas A&M, 1964; D.V.M., 1964; Ph.D., 1968.

*Reagor, John Charles, Assistant Professor of Biochemistry and Biophysics. (1966) B.S., Texas A&M, 1960; M.S., 1963; Ph.D., 1966.

Reid, Leslie Merle, Professor of Recreation and Parks and Head of Department. (1965) B.S., Michigan State College of Mining and Technology, 1951; M.S., Michigan State, 1955; Ph.D., Michigan, 1963.

*Associate Member

†Personnel stationed at locations other than the Main Campus at College Station.

Reid, Robert Osborne, Professor of Oceanography and of Civil Engineering. (1951, 1959) B.E., Southern California, 1946; M.S., Scripps Institute of Oceanography, 1948.

Reiser, Raymond, Distinguished Professor of Biochemistry and Biophysics. (1949, 1965) A.B., Western Reserve, 1929; Ph.D., Ohio State, 1936.

Rekoff, Michael George, Jr., P.E., Professor of Electrical Engineering. (1954, 1968) B.S., Texas A&M, 1951; M.S., 1955; Ph.D., Wisconsin, 1961.

Reynolds, Tom Davidson, P.E., Associate Professor of Civil Engineering. (1965, 1967) B.S., Texas A&M, 1950; M.S., Texas, 1960; Ph.D., 1963.

*Rezak, Richard, Associate Professor of Oceanography. (1967) A.B., Syracuse, 1947; A.M., Washington (St. Louis), 1949; Ph.D., Syracuse, 1957.

*Rhodes, Robert Raymond, Associate Professor of Forest Science. (1946, 1954) B.S.F., Louisiana, 1937; M.S., Texas A&M, 1951.

*Rhyne, V. Thomas, Assistant Professor of Electrical Engineering and Assistant Research Engineer, Texas Engineering Experiment Station. (1967, 1968) B.S., Mississippi State, 1962; M.E.E., Virginia, 1964; Ph.D., Georgia Institute of Technology, 1967.

Rice, George Hall, Jr., P.E., Professor of Management and Head of Department. (1964, 1968) B.S., Texas A&M, 1950; M.B.A., Denver, 1958; Ph.D., Stanford, 1964.

Richardson, Lester Scott, Associate Professor of Education. (1966) B.S., Texas A&M, 1946; M.Ed., 1948; Ed.D., Houston, 1954.

Richmond, Thomas Rollin, Agronomist, ARS, USDA, of Department of Soil and Crop Sciences. (1931, 1954) B.S., Texas A&M, 1931; M.S., 1938; Ph.D., Minnesota, 1948.

Ridgway, Richard Lee, Entomologist. (1964) B.S., Texas Technological College, 1957; M.S., Cornell, 1959; Ph.D., 1960.

Riggs, John Kamm, Professor of Animal Science. (1941, 1955) B.S., Iowa State College, 1935; M.S., Texas A&M, 1941.

*Riter, Stephen, Assistant Professor of Electrical Engineering. (1968) B.A., Rice, 1961; B.S., 1962; M.S., Houston, 1967; Ph.D., 1968.

*Ro, Kwang Hai, Assistant Professor of Political Science. (1966) B.A., LaGrange College, 1958; M.A., Oklahoma, 1960; Ph.D., 1966.

*Roach, Arthur James, Jr., Assistant Professor of Education. (1966) A.B., St. Michael's College, 1952; A.M., Notre Dame, 1960; Ph.D., 1966.

*Robinson, Richard Michael, Assistant Professor of Veterinary Pathology. (1962, 1965) B.S., Arizona State, 1953; D.V.M., Texas A&M, 1962; M.S., 1964.

*Rodenberger, Charles Alvard, P.E., Associate Professor of Aerospace Engineering. (1960) B.S., Oklahoma State, 1948; M.S., Southern Methodist, 1959; Ph.D., Texas, 1968.

Rodgers, Alan Shortridge, Associate Professor of Chemistry. (1967) A.B., Princeton, 1953; Ph.D., Colorado, 1960.

Röller, Herbert A., Professor of Biology. (1968) Arbitur, (B.S.), Halle/Salle (Germany), 1946; Ph.D., Göttingen (Germany), 1962.

Romieniec, Edward John, Professor of Architecture and Chairman of the School of Architecture. (1956, 1963) B.S., Ilinois, 1947; M.S., 1948; M.Arch., Harvard, 1950; Registered Architect.

*Rooney, Lloyd William, Assistant Professor of Soil and Crop Sciences. (1967) B.S., Kansas State, 1961; Ph.D., 1965.

Rosberg, David William, Professor of Plant Physiology and Pathology and Head of Department of Plant Sciences. (1950, 1960) B.A., St. Olaf College, 1940; M.S., Ohio State, 1946; Ph.D., 1949.

*Associate Member

*Rotsch, Melvin Medford, Professor of Architecture. (1950, 1955) B.S., Texas, 1928; M.Arch., Harvard, 1930.

*Rouse, John Wilson, Associate Professor of Electrical Engineering. (1968) B.S., Purdue, 1959; M.S., Kansas, 1965; Ph.D., 1968.

Rowan, Neilon Joyce, P.E., Associate Professor of Civil Engineering. (1959, 1967) B.S., Texas Technological College, 1957; M.S., Texas A&M, 1959; Ph.D., 1967.

Rudder, James Earl, President of the University. (1958, 1959) B.S., Texas A&M, 1932; LL.D., Baylor, 1960.

Runkles, Jack Ralph, Professor of Soil Physics and Acting Director of the Water Resources Institute. (1964) B.S., Texas A&M, 1950; M.S., 1952; Ph.D., Iowa State, 1956.

*Runnels, Robert Clayton, Assistant Professor of Meteorology. (1963, 1968) B.S., Houston, 1960; M.S., Texas A&M, 1962.

*Russell, Leon Horace, Jr., Associate Professor of Veterinary Public Health. (1959, 1965) B.S., Missouri, 1956; D.V.M., 1956; M.P.H., Tulane, 1958; Ph.D., Texas A&M, 1965; Diplomate, American Board of Veterinary Health, 1965.

*Ryan, Cecil Benjamin, Associate Professor of Poultry Science. (1947, 1962) B.S., Texas College of Arts and Industries, 1938; M.S., Texas A&M, 1947; Ph.D., 1962.

Sackett, William M., Associate Professor of Oceanography. (1968) B.A., Washington (St. Louis), 1953; Ph.D., 1958.

Samson, Charles Harold, Jr., P.E., Professor of Aerospace Engineering and of Civil Engineering and Head of Department of Civil Engineering. (1960, 1964) B.S., Notre Dame, 1947; M.S., 1948; Ph.D., Missouri, 1953.

*Sanders, Darryl Paul, Assistant Professor of Entomology. (1967) B.S., Texas Technological College, 1959; M.S., Purdue, 1964; Ph.D., 1967.

*Sandstedt, John Leonard, Associate Professor of Management. (1954, 1968) B.A., Texas, 1942; LL.B., 1947.

Sarkissian, Igor V., Professor of Biology. (1967, 1968) B.S., Michigan State, 1956; M.S., 1957; Ph.D., Purdue, 1960.

Saving, Thomas, Professor of Economics. (1968) B.A., Michigan State, 1957; M.A., Chicago, 1958; Ph.D., 1960.

Shaffner, Joseph Clarence, Associate Professor of Entomology. (1963, 1968) B.S., Iowa Wesleyan College, 1951; M.S., Iowa State, 1953; Ph.D., 1964.

Schertz, Keith Francis, Lecturer in Soil and Crop Sciences. (1959, 1966) B.S., Illinois, 1949; M.S., 1950; Ph.D., Cornell, 1957.

*Schiller, Robert Edwin, Jr., P.E., Associate Professor of Civil Engineering. (1946, 1955) B.S., Texas A&M, 1940; M.S., 1949.

Schmidt, Jerome P., Visiting Member, Veterinary Medicine and Surgery. (1964) B.S., St. Benedicte College, 1949; M.A., Kansas, 1952; Ph.D., New Hampshire, 1963.

Schroeder, Harry William, Plant Pathologist of Department of Plant Sciences, AMS, USDA. (1957) B.S., Minnesota, 1951; M.S., 1955; Ph.D., 1955.

Schroeder, Melvin Carroll, Professor of Geology. (1954, 1963) B.S., State College of Washington, 1942; M.S., 1947; Ph.D., 1953.

Schweikert, Emile Alfred, Assistant Professor of Chemical Engineering and of Chemistry. (1967) B.S., Paris (France), 1960; Licence'es Science, Toulouse (France), 1962; Ph.D., Paris, Sorbonne, 1964.

*Scoggins, James Roy, Associate Professor of Meteorology. (1967) A.B., Berry College, 1952; B.S., Pennsylvania State, 1954; M.S., 1960; Ph.D., 1966.

*Associate Member

Scrivner, Frank H., Research Engineer, Texas Transportation Institute, and Professor of Civil Engineering. (1964, 1966) B.S., United States Naval Academy, 1931.

Self, Glendon Danna, Associate Professor of Industrial Engineering. (1965, 1968) B.S., Arkansas, 1958; M.S., 1959; Ph.D., Oklahoma State, 1963.

*Seward, Clay Luzenberg, Jr., Associate Professor of Geology. (1948, 1952) B.S., Texas A&M, 1941; M.S., 1950; Geol.E., 1953.

Shafer, Carl Ewing, Associate Professor of Agricultural Economics. (1962, 1966) B.S., Oklahoma State, 1955; M.S., 1958; Ph.D., Pennsylvania State, 1962.

Shapiro, Bernard L., Professor of Chemistry. (1968) B.S., McGill, 1952; A.M., Harvard, 1954; Ph.D., 1957.

Shea, Joseph F., Visiting Professor of Aerospace Engineering. (1966) B.S., Michigan, 1949; M.S., 1950; Ph.D., 1955.

*Shelby, McDalton, Research Engineer, Texas Transportation Institute. (1968) B.S.E.E., Texas, 1931.

*Sheldon, William R., Research Scientist, Graduate Research Center of the Southwest, Dallas, Texas. (1966) B.S., Missouri, 1950; M.S., 1960; Ph.D., 1960.

†Shelton, James Maurice, Professor, Texas Agricultural Experiment Station, McGregor. (1950, 1967) B.S., Tennessee, 1946; M.S., Texas A&M, 1952; Ph.D., 1957.

Sicilio, Fred, Professor of Chemistry. (1961, 1967) B.S., Centenary College, 1951; M.A., Vanderbilt, 1953; Ph.D., 1956.

*Siebert, Horst, Assistant Professor of Economics. (1967, 1968) M.A., Cologne (Germany), 1963; Ph.D., Munster (Germany), 1965.

Simmang, Clifford Max, P.E., Professor of Mechanical Engineering and Head of Department. (1938, 1957) B.S., Texas A&M, 1936; M.S., 1938; Ph.D., Texas, 1952.

Sis, Raymond Francis, Professor of Veterinary Anatomy and Head of the Department. (1966, 1968); B.S. (Agr.) Kansas State, 1953; D.V.M., 1957; B.S. (Arts & Sc.), 1957; M.S., Iowa State, 1962; Ph.D., 1965.

Skrabanek, Robert Leonard, Professor of Sociology. (1949, 1957) B.S., Texas A&M, 1942; M.S., 1947; Ph.D., Louisiana State, 1949.

*Skrivanek, John Marion, Professor of Modern Languages. (1952, 1963) B.A., Texas, 1938; M.A., 1946; Ph.D., Charles (Prague), 1948.

*Smathers, James Burton, Assistant Professor of Nuclear Engineering. (1967) B.N.E., North Carolina State, 1957; M.S., 1959; Ph.D., Maryland, 1967.

Smentowski, Frank Joseph, Assistant Professor of Chemistry. (1965, 1967) B.S., Regis College, 1955; Ph.D., Northwestern, 1960.

*Smith, Fred Emmett, Professor of Geology. (1948, 1956) B.S., Louisiana State, 1930; M.S., 1932.

Smith, James Douglas, Associate Professor of Genetics. (1959, 1964) B.S., Iowa State College, 1950; M.S., 1956; Ph.D., 1960.

*Smith, Leon R., Visiting Plant Scientist of the Department of Plant Sciences. (1967) B.S., Texas A&M, 1952; M.S., 1962; Pd.D., 1964.

Smith, Thor, Professor of Chemistry. (1968) B.S., Wheaton College, 1942; M.S., Illinois Institute of Technology, 1944; Ph.D., Wisconsin, 1948.

*Smith, William Boyce, Assistant Professor of Statistics. (1966, 1967) B.S., Lamar State College of Technology, 1959; M.S., Texas A&M, 1960; Ph.D., 1967.

Smith, William Reed, Professor of Psychology and Head of Department. (1967, 1968) B.S., Utah, 1949; M.S., 1950; Ph.D., 1960.

*Associate Member

†Personnel stationed at locations other than the Main Campus at College Station.

Sonnenfeld, Joseph, Professor of Geography. (1968) B.S., Oregon State, 1952; Ph.D., Johns Hopkins, 1957.

Sorensen, Anton Marinus, Jr., Professor of Animal Science. (1955, 1965) B.S., Texas A&M, 1949; M.S., Cornell, 1951; Ph.D., 1953.

Sorensen, Harold Benjamin, Associate Professor of Agricultural Economics and Sociology. (1951, 1956) B.S., South Dakota State College, 1940; M.S., Oklahoma Agricultural and Mechanical College, 1948; Ph.D., Texas A&M, 1955.

*Sorensen, Robert M., Assistant Professor of Civil Engineering. (1968) B.S., Newark College of Engineering, 1960; M.S., Lehigh, 1962; Ph.D., California (Berkeley), 1966.

Sorenson, Jerome Wallace, P.E., Professor of Agricultural Engineering. (1946, 1956) B.S., Texas A&M, 1935; M.S., 1948.

Spencer, Terry Warren, Professor of Geophysics and Head of Department. (1966) B.A., California at Los Angeles, 1952; Ph.D., California Institute of Technology, 1956.

Sperry John Jerome, Professor of Biology. (1941, 1951) B.A., Nebraska, 1936; M.A., Missouri, 1938; Ph.D., Nebraska, 1942.

Squire, Charles F., Distinguished Professor of Physics. (1962, 1968) Ph.D., Johns Hopkins, 1937.

†*Stansel, James Wilbert, Assistant Professor, Texas Agricultural Experiment Station, Beaumont. (1965, 1967) B.S., Texas A&M, 1956; M.S., 1959; Ph.D., Purdue, 1965.

*Stanton, Robert James, Jr., Associate Professor of Geology. (1967) B.S., California Institute of Technology, 1953; M.A., Harvard, 1956; Ph.D., California Institute of Technology, 1960.

*Staten, Raymond Dale, Associate Professor of Agronomy. (1956, 1960) B.S., Oklahoma Agricultural and Mechanical College, 1947; M.S., Nebraska, 1949; Ph.D., 1951.

Stelly, Randall, Associate Professor of Agricultural Economics and Sociology. (1956, 1960) B.S., Southwestern Louisiana Institute, 1940; M.S., Texas A&M, 1947; Ph.D., Louisiana State, 1956.

Stevenson, Robert M., Professor of Finance. (1947, 1963) B.A., Duke, 1937; M.A., Pennsylvania State College, 1946; C.P.A., 1948; D.B.A., Indiana, 1955; C.L.U., 1955.

*Steward, Weldon Cecil, Associate Professor of Architecture and Associate Chairman of the School of Architecture. (1962, 1967) B.Arch., Texas A&M, 1957; M.Arch., Columbia, 1961; Registered Architect.

*Stewart, Billy Ray, P.E., Assistant Professor of Agricultural Engineering. (1956, 1960) B.S., Texas A&M, 1951; M.S., 1959; Ph.D., 1966.

Stewart, Robert E., Distinguished Professor of Agricultural Engineering. (1968) B.S., Missouri, 1948; M.S., 1950; Ph.D., 1953.

Stinnett, Tim Moore, Visiting Professor of Education. (1966) B.S., Henderson-Brown College, 1922; M.S., Arkansas, 1935; Ed.D., Texas, 1951.

*Stipanovic, Robert Douglas, Assistant Professor of Chemistry. (1967) B.S., Loyola, 1961; Ph.D., Rice, 1966.

Stokes, Elmore Ewing, Jr., Professor of English. (1951, 1963) B.A., Texas, 1943; M.A., 1948; Ph.D., 1951.

Stone, Hubert Lowell, Visiting Member, Veterinary Public Health. (1965) B.A., Rice, 1958; M.S., Illinois; Ph.D., 1961.

Storey, James Burton, Associate Professor of Horticulture. (1957, 1961) B.S., Texas A&M, 1949; M.S., 1953; Ph.D., California, 1957.

*Associate Member
†Personnel stationed at locations other than the Main Campus at College Station.

*Storts, Ralph Woodrow, Associate Professor of Veterinary Pathology. (1967) D.V.M., Ohio State, 1957; M.S., Purdue, 1961; Ph.D., Ohio State, 1966; Diplomate, American College of Veterinary Pathologists, 1967.

*Stover, Virgil G., P.E., Associate Professor of Civil Engineering. (1966, 1967) B.S., Ohio, 1958; M.S., Purdue, 1960; Ph.D., 1963.

Strawn, Robert Kirk, Associate Professor of Wildlife Science and Acting Head of the Department. (1959, 1968) B.S., Florida, 1947; M.S., 1953; Ph.D., Texas, 1957.

Street, Robert Lewis, Assistant Professor of Industrial Engineering. (1962, 1967) B.S., Texas A&M, 1950; M.S., 1965; Ph.D., Texas, 1967.

*Stricklin, James Alvin, Professor of Aerospace Engineering. (1965, 1968) B.S., Mississippi State College, 1955; M.S., Georgia Institute of Technology, 1958; Ph.D., Massachusetts Institute of Technology, 1964.

*Stubbs, Alice C., Associate Professor, Home Economics Research. (1964) B.S., Texas, 1938; M.S., Columbia, 1944; Ph.D., Purdue, 1954.

Suggitt, Frank W., Professor of Recreation and Parks. (1966) B.S., Michigan State, 1942; M.P.A., Harvard, 1952; D.P.A., 1956.

Sugihara, Thomas Tamotsu, Professor of Chemistry. (1967) A.B., Kalamazoo College, 1945; S.M., Chicago, 1951; Ph.D., 1952.

Suttle, Andrew D., Jr., Vice-President for Research and Professor of Chemistry. (1962) B.S., Mississippi State, 1944; Ph.D., Chicago, 1952.

*Sweet, Harry Jerome, P.E., Associate Professor of Mechanical Engineering. (1957, 1968) B.S., Texas A&M, 1956; M.S., 1958; Ph.D., 1965.

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

Swoboda, Allen Ray, Assistant Professor of Agronomy. (1967) B.S., Texas A&M, 1961; M.S., Virginia Polytechnic Institute, 1963; Ph.D., Texas A&M, 1967.

*Szabuniewicz, Michael, Associate Professor of Veterinary Physiology and Pharmacology. (1962, 1966) D.V.M., Veterinary College, Lemberg, 1934; D.V., 1937.

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

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

Taylor, Lloyd Chamberlain, Jr., Associate Professor of History. (1956, 1962) B.A., Lehigh, 1949; M.A., 1951; Ph.D., 1956.

Teer, James Garth, Associate Professor of Wildlife Science. (1962, 1966) B.S., Texas A&M, 1950; M.S., Iowa State, 1951; Ph.D., Wisconsin, 1964.

Tessmer, Carl F., Visiting Member, Veterinary Pathology. (1968) B.S., Pittsburgh, 1931; M.D., Pittsburgh School of Medicine, 1935.

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

*Thomas, Richard Eugene, Professor of Aerospace Engineering. (1964, 1966) B.Aero.E., Ohio State, 1951; B.A., 1953; M.S., 1956; Ph.D., 1964.

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

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

Thompson, John George Hatch, P.E., Professor of Mechanical Engineering. (1938, 1954) B.S., Pennsylvania State College, 1933; M.E., 1938; M.S., Texas A&M, 1950; Ph.D., 1962.

*Associate Member

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

Thompson, Russell Glenwood, Professor of Economics and of Statistics. (1961, 1968) B.A.B.A., Minnesota, 1957; Ph.D., 1962.

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

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

Timm, Tyrus Raymond, Professor of Agricultural Economics and Sociology and Head of Department. (1947, 1953) B.S., Texas A&M, 1934; M.S., 1936; M.P.A., Harvard, 1947; D.P.A., 1949.

*Todorovic, Radmilo A., Associate Professor of Veterinary Microbiology, Bogota, Columbia. (1968) D.V.M., Belgrade (Yugoslavia), 1953; M.S., Wisconsin, 1963; Ph.D., Illinois, 1967.

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

Traxler, Ralph N., Professor of Chemistry and of Civil Engineering. (1959) A.B., Colorado, 1920; M.A., 1922; Ph.D., Wisconsin, 1926.

*Trock, Warren Leigh, Associate Professor of Agricultural Economics and Sociology. (1964, 1968) B.S., Kansas State, 1950; M.S., 1956; Ph.D., Montana State, 1966.

Truettner, Williard Irving, P.E., Professor of Mechanical Engineering. (1930, 1943) B.S., Michigan, 1928; M.S.E., 1930.

Tsutsui, Minoru, Professor of Chemistry. (1968) B.A., Gifu (Japan), 1938; M.S., Literature and Science, Tokyo, 1941; Ph.D., Yale, 1954.

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

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

Ulvedal, Frode, Visiting Member, Veterinary Public Health. (1967) Artium, St. Svithum's College, 1951; B.A., Drew, 1955; Ph.D., Emory, 1959.

*Umerjee, Ramachandra Krishna, Assistant Professor of Physics. (1966) M.A., Madras (India), 1958; M.Sc., 1961; Ph.D., 1964.

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

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

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

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

van Bavel, Cornelius H.M., Professor of Biology. (1967) B.S., State Agricultural, Wagenigen (Netherlands), 1945; M.S., Iowa State, 1946; Ph.D., 1949.

Vanderveen, John E., Visiting Member, Veterinary Public Health. (1965) B.S., Rutgers, 1956; Ph.D., New Hampshire, 1961.

Vanderzant, Carl, Professor of Animal Science. (1953, 1962) B.S., Wageningen, 1947; M.S., 1949; M.S., Iowa State College, 1950; Ph.D., 1953.

Vanderzant, Erma Schumacher, Biochemist of Department of Biochemistry and Biophysics. (1954) B.S., Iowa State, 1943; Ph.D., 1953.

*Associate Member

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

van Overbeek, Johannes, Professor of Biology and Director of Institute of Life Sciences. (1966) B.S., Leyden (Netherlands), 1928; M.S., Utrecht (Netherlands), 1932; Ph.D., 1933; Doctor Honoris Causa, Gembloux (Belgium), 1960.

Varvel, Walter A., Professor of Psychology. (1941, 1945) A.B., Kansas, 1932; M.A., 1933; Ph.D., 1938.

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

Vite', Jean Pierre, Visiting Member, Entomology. (1967) B.F., Gottingen (Germany), 1949; D.F., 1949.

Wainerdi, Richard Elliott, P.E., Associate Dean of College of Engineering; Head of Activation Analysis Research Laboratory; and Professor of Chemical Engineering. (1957, 1966) B.S., Oklahoma, 1952; M.S., Pennsylvania State, 1955; Ph.D., 1958.

*Wamble, Albert Cecil, Research Engineer of Texas Engineering Experiment Station. (1945) B.S., Texas A&M, 1933.

Watkins, Gustav McKee, Professor of Plant Sciences. (1949, 1965) B.A., Texas, 1929; M.S., 1930; Ph.D., Columbia, 1935.

Watson, Jack Throck, Visiting Member, Biochemistry and Biophysics. (1968) B.S., Iowa State, 1961; Ph.D., Massachusetts Institute of Technology, 1965.

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

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

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

Weekes, Donald Fessenden, Professor of Physics. (1937, 1945) B.S., Middlebury College, 1924; M.A., Amherst College, 1926; Ph.D., Cornell, 1937.

*Wehrly, James S., Associate Professor of Agricultural Economics. (1964, 1965) B.S., Illinois, 1949; M.S., 1951; Ph.D., Purdue, 1962.

*Weiner, Peter Douglas, P.E., Associate Professor of Mechanical Engineering. (1956, 1968) B.S., Texas A&M, 1954; M.S., 1961.

Welch, Billy Edward, Visiting Member, Biochemistry and Biophysics. (1965) B.S., Abilene Christian College, 1950; M.S., Texas A&M, 1952; Ph.D., 1954.

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

Whealy, Roger Dale, Professor of Chemistry. (1958) B.S., Eastern Normal, South Dakota, 1930; M.S., Colorado, 1937; M.S., Oregon, 1948; Ph.D., Colorado, 1953.

White, Robert Frederick, Professor of Architecture. (1947, 1954) B.S., Pennsylvania State College, 1934; M.Land., Michigan, 1951; Registered Architect.

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

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

Whiting, Robert Louis, P.E., Professor of Petroleum Engineering and Head of the Department. (1946, 1954); Director, Texas Petroleum Research Committee. (1966) B.S., Texas, 1939; M.S., 1943.

---

*Associate Member

†Personnel stationed at locations other than the Main Campus at College Station.

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

†Wiese, Allen Franklin, Professor, Texas Agricultural Experiment Station, Bushland. (1966, 1967) B.S., Minnesota, 1949; M.S., 1951; Ph.D., 1953.

*Wildenthal, Bryan H., Assistant Professor of Physics. (1968) B.S., Sul Ross State College, 1958; Ph.D., Kansas, 1964.

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

*Wilkes, Lambert Henry, P.E., Associate Professor of Agricultural Engineering. (1957) B.S., Clemson Agricultural and Mechanical College, 1948; M.S., Texas A&M, 1953.

Wilson, Frank Douglas, Geneticist (USDA), Department of Soil and Crop Sciences. (1965) B.S., Utah, 1950; M.S., 1953; Ph.D., Washington State, 1957.

Wilson, William B., Assistant Professor of Biology. (1967) B.S., Texas A&M, 1948; M.S., 1950; Ph.D., 1966.

Wingren, Roy Matthew, P.E., Professor of Mechanical Engineering. (1928, 1943) B.S., Texas A&M, 1927; M.S., 1934.

*Wolko, Howard Stephen, Professor of Mechanical Engineering. (1967) B.S., Buffalo, 1949; M.S., 1953; D.Sc., George Washington, 1967.

*Wootan, Charley V., Associate Director of Texas Transportation Institute; Head of Transportation Economics Division, and Professor of Economics. (1966, 1967) B.S., Texas A&M, 1950; M.S., 1951; Ph.D., 1965.

Wooten, Alvin Boyd, Professor of Agricultural Economics. (1954, 1965) B.A., Texas A&M, 1948; M.S., 1950; Ph.D., 1955.

Wortham, Albert William, Professor of Industrial Engineering and Head of Department. (1964, 1965) B.A., East Texas State College, 1947; M.S., Oklahoma State, 1949; Ph.D., 1954.

Wright, Samuel Robert, P.E., Professor of Civil Engineering. (1923, 1946) B.S., Texas A&M, 1922; M.S., 1928; C.E., 1931; Ph.D., 1946.

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

Yule, Herbert Phillip, Associate Professor, Activation Analysis Research Laboratory and of Industrial Engineering. (1966) Ph.D., Chicago, 1957.

Zingaro, Ralph Anthony, Professor of Chemistry. (1954, 1964) B.S., City College of New York, 1946; M.S., Kansas, 1949; Ph.D., 1950.

Zwolinski, Bruno John, Professor of Chemistry. (1961, 1965) B.S., Canisius, 1941; M.S., Purdue, 1943; M.A., Princeton, 1944; Ph.D., 1947.

---

*Associate Member

†Personnel stationed at locations other than the Main Campus at College Station.

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 the Graduate College 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 the Graduate College, who is the chief administrative officer of the Graduate Faculty. There is a Committee on Graduate Instruction in each of the several colleges. These committees are responsible for making recommendations for graduate work in the college concerned, for making recommendations regarding general policies, and for other matters pertaining to graduate work in their colleges.

Degrees Offered. 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.)
Master of Urban Planning (M.U.P.)
Doctor of Education (D.Ed.)
Doctor of Philosophy (Ph.D.)

GRADUATE DEGREES CURRENTLY OFFERED

The following graduate degrees are currently offered:

College of Agriculture

Master of Agriculture, with options in

Aerobiology
Agricultural Economics
Animal Science
Crops
Dairy Science
Economic Entomology
Floriculture
Horticulture
Plant Sciences
Poultry Science
Range Science
Recreation and Resources Development
Rural Sociology
Seed Technology
Soils
Wildlife Science
Fisheries Science

Interdisciplinary

Agricultural Chemistry
Agricultural Development
Food Technology
Natural Resource Development
Plant Protection

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 Nutrition
- Animal Parasitology
- Animal Science
- Biochemistry
- Biophysics
- 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
- Recreation and Resources Development
- Sociology
- Soil Chemistry
- Soil Physics
- Wildlife Science

Doctor of Philosophy, with majors in

- Agricultural Economics
- Agricultural Engineering
- Agronomy
- Animal Breeding
- Animal Nutrition
- Animal Parasitology
- Animal Science
- Biochemistry
- 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
- Recreation and Resources Development
- Soil Chemistry
- Soil Physics
- Wildlife Science

College of Architecture and Environmental Design

Master of Architecture

Master of Science, with a major in

- Landscape Architecture

Master of Urban Planning (Interdisciplinary, with College of Engineering), with a major in

- Urban and Regional Planning

College of Business Administration

Master of Business Administration, with concentration in

- Accounting
- Computer Science
- Organization and Administration
- Statistics

Doctor of Philosophy with a major in

- Business Administration

College of Engineering

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
Computer Science and Statistics
Electrical Engineering
Geological Engineering
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

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

College of Geosciences

Master of Science, with majors in

Geography
Geology
Geophysics
Meteorology
Oceanography

Doctor of Philosophy, with majors in

Geography
Geology
Geophysics
Meteorology
Oceanography

College of Liberal Arts

Master of Arts, with majors in

English
History
Modern Language
Political Science

Master of Education, with majors in

Education
Health and Physical Education

Master of Science, with majors in

Economics
Education
Health and Physical Education
Psychology

Doctor of Philosophy, with majors in

Economics
Education
English

College of Science

Master of Science, with majors in

Biology
Botany
Chemistry
Mathematics
Microbiology
Physics
Statistics
Zoology

Doctor of Philosophy, with majors in

Biology
Botany
Chemistry
Mathematics
Microbiology
Physics
Statistics
Zoology

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
- Veterinary Toxicology

Doctor of Philosophy, with majors in

- Veterinary Anatomy
- Veterinary Medicine and Surgery
- Veterinary Microbiology
- Veterinary Pathology
- Veterinary Physiology
- Veterinary Public Health
- Veterinary Toxicology

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 with the application acceptable scores for the Aptitude Test of the Graduate Record Examination. This test must be taken within five (5) years of the date of application for admission to the Graduate College. Applicants in the departments of Biology and Wildlife Science are also required to submit scores on the appropriate Advanced Test. Approximately six weeks are required for scores to be received by the Graduate College after the tests are administered. Scores made on the Graduate Record Examination more than five (5) calendar years prior to application for admission to the Graduate College may not be used to satisfy the GRE requirements.

The GRE during 1969-70 will be given at various centers, including Texas A&M University, throughout the United States and in other countries on the following dates:

October 25, 1969
December 13, 1969
January 17, 1970
February 28, 1970
April 25, 1970
July 11, 1970

To determine the most convenient locations, prospective applicants should write to The Educational Testing Service, 1947 Center Street, Berkeley, Calif., 94704, or The Counseling and Testing Center, Texas A&M University, College Station, Texas, 77843.

Students living in the United States should make application for the Graduate Record Examination not less than four weeks in advance of a scheduled test date (above). Students living outside the continental limits of the United States should make application for the Graduate Record Examination no less than six weeks in advance of a scheduled test date.

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

A formal application is required of all persons seeking admission to the Graduate College. The application forms, which are available at the office of the Dean of Admissions and Records, 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.

Admission to the Graduate College remains valid for five (5) calendar years only, unless the student during this period engages in active graduate work.

Scholastic Record. The normal requirement for admission to the Graduate College is a record during at least the last two years of 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 normally be arranged in conference with the student's committee or the chairman of his major department.

Before accepting a student for graduate study, 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.

Foreign Students. A student from another country who seeks admission to the Graduate College must meet the same requirements for admission and candidacy as students from the United States, including the submission of scores on the Graduate Record Examination. In addition, prospective students from other countries must demonstrate acceptably the ability to speak, write, and understand the English language. Prospective students whose native language is not English must take the **Test of English as a Foreign Language** (TOEFL), administered by the Educational Testing Service, Princeton, New Jersey, in over 200 centers around the world. The fee is $10.00 (U.S.). A registration form and a "Bulletin of Information for Candidates" may be obtained by writing to:

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

More detailed information about Texas A&M University and particularly about enrollment procedures is incorporated in a pamphlet "Information for Prospective Students from Abroad," a copy of which may be obtained by writing to:

Dean of Admissions and Records
Texas A&M University
College Station, Texas, U.S.A., 77843

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 a full-time graduate student is 16 hours per semester or six hours per six-week summer term. The maximum load for Graduate Assistants on one-half time employment is 12 hours per semester or four hours per six-week summer term. Recipients of fellowships and assistantships are normally required to register for the maximum allowable course load.

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 hours of 691 credit each semester or 12-week summer session until all requirements for their degrees 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.

Employees Registering as Students. Subject to the approval of the Head of his department, a full-time member of the staff of Texas A&M University is permitted to register for not to exceed one-fourth of a full semester's course work (exclusive of research (691) credit for research for which he is paid and which is concurrently used for his thesis or dissertation). He may receive time off from his regular work week to attend class, provided that his course load does not exceed four credit hours in any one semester or 12-week summer session and provided that arrangements can be made with the employee's supervisor for making up the time. The employee is subject to the regular matriculation fees.

Full details of the conditions under which Heads of departments may grant approval of employee requests to enroll as students in Texas A&M University may be found in the **Policy and Procedures Manual** (08.13). Study opportunities for faculty and staff are also discussed in the **Faculty-Staff Handbook** (1966), p. 59.

All employees eligible to receive degrees from Texas A&M University must meet degree requirements as set forth in the appropriate catalogue.

Double Registration. 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 six hours of graduation may apply for provisional admission to the Graduate College provided they meet the Graduate Record Examination requirements and have a B average or better for the last three semesters of course work. Such students must complete 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 double registered students is 16 hours in the regular semester or six hours in a six-week summer term.

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

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

Graduate Advisors. A graduate student entering the University for the first time is required to consult with the advisor in his 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.

FEES

The fees set out herein for graduate students for the session 1969-70 are strictly approximations and are subject to change because of economic conditions and/or legislative requirements. Fees for the session of 1969-70 are as follows:

			Summer Session	
	First Semester	Second Semester	First Term	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	$ 30.00	$ 30.00	$ 9.00	$ 9.00
Building Use Fee	$ 20.00	$ 20.00	$ 10.00	$ 10.00

In addition to expenses as outlined above, state law requires the payment of laboratory fees which shall reflect the cost of materials and supplies used and which shall be not less than $2.00 nor more than $8.00 per laboratory course.

Each applicant for an advanced degree is required to pay a graduation fee of $5.00. 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 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 the Graduate College and recorded on the student's records.

Any student withdrawing officially (a) during the first week of classwork in a semester or trimester will receive a refund of four-fifths of the tuition fee; (b) during the second week of classwork, three-fifths; (c) during the third week of classwork, two-fifths; (d) during the fourth week of classwork, one-fifth; (e) after the fourth week of classwork, nothing. Any student withdrawing officially from school during the first week of a semester or trimester will receive a refund of 100% of the Student Services and Building Use Fees; after the first week of school, no refund will be received. 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 four 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.

The student services fee is required of all students and covers the services at the University Hospital, Memorial Student Center, and the Intramural and Student Aid Programs; entitles the student to receive the Battalion newspaper, the University annual and the magazine published by the college in which the student is registered; and covers admission to all athletic events played at the University under the auspices of the Athletic Department, Town Hall Programs, and the Great Issues and Recital Series. Only those students who pay the $30.00 student services fee for the spring semester or the second trimester will be entitled to the University annual.

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

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 $75.00 per month, including normal utilities. Application for a married student apartment should be made directly to the Student Apartments Office, 117 Faculty Exchange, Texas A&M University, College Station, Texas, 77843.

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 the Graduate College 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 3.00 (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

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

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

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

PETITIONS

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

Any changes in membership of a student's committee, program of study, etc., must be proposed by petition to the Dean of the Graduate College 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. The presently offered fields of specialization for both the Master of Science and Doctor of Philosophy degrees which have a multi-departmental orientation are animal breeding, animal nutrition, animal parasitology, food technology, genetics, interdisciplinary engineering, physiology of reproduction, and plant breeding.

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

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 weekend classes. Registration in Problems (685) 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 weekend courses are responsible to the Dean of Admissions and Records for proper procedure and records of registration. Advance approval should be obtained from the Dean of the College concerned and from the Academic Vice-President as to the course, fees, minimum enrollment, instructor, and location each time the course is 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 requirement for the degree of Master of Science is 18 credit hours taken "on campus," with a minimum of 12 credit hours taken on the Main Campus at College Station. In this context, the term "campus" refers to any properties under the jurisdiction of the Texas A&M University System on which academic instruction is offered with the approval of the Academic Council of Texas A&M University. The term "Main Campus" refers to the campus of Texas A&M University located at College Station, Texas.

The 12 credit hours to be taken on the Main Campus at College Station must be taken during one semester, or during two consecutive 6-week summer sessions. Upon recommendation of the student's advisory committee and the approval of the Dean of the Graduate College, a student may be granted exemption from the requirement of 12 credit hours to be taken during one semester or during two consecutive 6-week summer terms. However, such a petition must be approved prior to the student's registration for the final 12 credit hours of required course work.

Full time staff members of the University or of closely affiliated organizations stationed at the Main Campus may fulfill total residence requirements by accumulation of less-than-full registration. Specific authorization for such joint programs must be granted in advance by the employing agency.

The above regulations do not apply in the case of specific programs of "off campus" work which have been approved by the Academic Council of Texas A&M University.

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 fewer than three members of the Graduate Faculty, one of whom must be from outside the major field. The chairman of the committee will direct the student's total graduate program.

Degree Program. The student's committee, in consultation with the student, will develop his Degree Program. This should be completed and filed with the Dean of the Graduate College, whose approval is required, prior to the second semester's registration.

This Degree Program must be submitted on the official form with endorsements by the student's advisory committee. Any prerequisite courses recommended should also be listed on the form.

Thesis Proposal. The student must prepare a thesis proposal for approval by his committee. This proposal must be submitted for the approval of the Dean of the Graduate College at least 14 weeks prior to the close of the semester or summer session in which the student expects to receive 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 Transfer, Extension and Certain Other Courses. If otherwise acceptable, certain courses may be used toward meeting credit-hour requirements for the Master's degree under the following limitations:

1. Not more than a **total** of 12 hours of transfer credit and of credit for extension courses taken under the direction of Texas A&M University (including problems courses (685) taken by a student while not in residence on the Main Campus). Extension courses taken at institutions other than those of the Texas A&M University System **are not transferable for graduate credit.**
2. Not more than 8 hours each of research (691), special problems (685) or research methods—nor more than 12 hours of any combination of these.
3. Not more than 2 hours of seminar.
4. Not more than 8 hours of advanced undergraduate courses (300 or 400 designation).
5. No credit may be obtained by correspondence study, or for any course of fewer than three weeks duration.

Erratum: The following material substitutes for Item 1 of the section on Limitations on the Use of Transfer, Extension and Certain Other Courses on page 44 of the 1969-1970 Graduate College Catalogue:

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

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

1.

a. Not more than a total of 6 credit hours of transfer course work. Only course work taken in residence at an accredited institution will be considered for transfer credit. (Note also b and c, below).

b. Not more than a total of 12 credit hours of course work taken by extension, including Problems (685) taken by a student while not in residence on the Main Campus of Texas A&M University. Credit for course work taken by extension will be granted only for extension courses taken under the direction of Texas A&M University. Extension courses taken at institutions other than those within the Texas A&M University System are not acceptable for transfer credit. (Note also c, below).

c. Not more than a total of 12 credit hours of any combination of (1) transfer credit for course work taken at an accredited institution and (2) credit for course work taken by extension.

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

Time Limit. Effective September 1, 1969, no student will be granted a Master's degree from Texas A&M University unless all requirements accepted for fulfillment of the degree are completed within a period of seven (7) consecutive calendar years. All students who were enrolled in the Graduate College for Master's degree work prior to September 1, 1969, must complete all requirements for the degree no later than August 31, 1976.

Transfer of Credit. A student who has earned 12 hours of graduate resident credit at Texas A&M University may be authorized, upon the advice of his committee and with the advance approval of the Dean of the Graduate College, to transfer from another institution more than 12 hours of specified courses, **if these courses are not available at Texas A&M University.** Otherwise the limitations stated in the preceding section (see 1) apply. Courses for which transfer credits are sought must have been completed with grades of B or better, and must be approved by the student's committee and the Dean of the Graduate College. Credit for thesis or dissertation research is not transferable.

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 Architecture, Master of Business Administration, and Master of Urban Planning. The thesis should embody original work on the part of the candidate. It must be grammatically correct, reflecting the ability of the candidate to express himself clearly. In general, the format should be consistent with that used in scholarly journals in the candidate's field. An abstract not exceeding 600 words and a vita page are included in the thesis. Instructions relating to specific requirements of the Graduate College may be obtained from the office of the Dean.

The original and the first two copies of the thesis in its final form must be filed with the Dean of the Graduate College, 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 the Graduate College before the degree can be conferred.

Application for Degree. Formal application for the degree must be filed both in the office of the Dean of the Graduate College and the Registrar not later than 90 days prior to the end of the semester, or 30 days prior to the end of the summer term in which the student expects to complete his requirements for graduation.

Final Examination. The candidate must pass a final examination not less than two weeks before the date on which the degree is to be conferred. Three copies of the thesis in final form signed by the student's committee and the head of the department must be submitted to the Graduate College, together with the announcement for the final examination, at least two weeks in advance of the scheduled date for the examination.

The final examination covers the thesis and all work taken on the Degree Program and at the option of the committee may be written or oral or both. The examination is open and is conducted by the student's committee as finally constituted.

Candidates may exempt the final examination provided their grade point ratio for the course work completed is equal to 3.5 or better and provided the exemption has the approval of the student's committee and the Dean of the Graduate College. The petition requesting the exemption should be submitted to the Graduate College with the final copies of the thesis.

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

THE DEGREE OF MASTER OF AGRICULTURE

The program of study leading to the degree of Master of Agriculture is designed to serve those who desire graduate professional training in an agricultural discipline. A student holding a baccalaureate degree or a qualified senior during his last semester may apply for admission to the Graduate College to work toward the nonthesis degree of Master of Agriculture. The candidate's committee shall specify prerequisite work where necessary.

The degree may be earned in any department in the College of Agriculture and also in the interdisciplinary areas of 1) Agricultural Chemistry, 2) Agricultural Development, 3) Food Technology, 4) Natural Resource Development and 5) Plant Protection.

The minimum residence requirement for the degree of Master of Agriculture is 18 credit hours taken "on campus," with a minimum of 12 credit hours taken on the Main Campus at College Station. This regulation does not apply in the case of specific programs of "off campus" work which have been approved by the Academic Council of Texas A&M University.

Approximately 12 of the 36 required credit hours will be taken outside of the student's option. Each candidate will normally be required to prepare one or more written reports (not necessarily involving results of research conducted by the candidate) in addition to papers required as a part of regular course work. The reports are expected to be of a scholarly nature and may carry up to four hours of credit by registration in 685 (Problems) courses.

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

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

THE DEGREE OF MASTER OF ARCHITECTURE

The College of Architecture and Environmental Design offers both thesis and nonthesis graduate programs leading to the degree of Master of Architecture.

If the student elects the (optional) thesis program, the requirements for the degree of Master of Architecture are identical in all respects with those for the degree of Master of Science.

If the student elects the (optional) nonthesis program, the degree of Master of Architecture requires the completion of 36 hours of course work and a satisfactory comprehensive final examination. The minimum residence requirement for the nonthesis degree of Master of Architecture is 18 credit hours taken "on campus" with a minimum of 12 hours taken on the Main Campus at College Station.

THE DEGREES OF MASTER OF ARTS

The degree of Master of Arts currently is offered to students majoring in English, History, or Political Science. The residence requirements for this degree are exactly the same as for the Master of Science degree, as is the requirement of a thesis. The thesis is expected to be a competently phrased narrative of the student's original research topic. Of the total of 30 semester hours required for the Master of Arts degree, no more than six credit hours for thesis research may be counted toward the degree. At least 24 hours of credit must be for course work, including at least 16 hours of course work at the graduate level. The degree program for students seeking the M.A. must include study in more than one area of specialization, but these areas may be contained within the course offerings of a single department.

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 programs offered by the College of Business Administration lead to the degree of Master of Business Administration. Students may concentrate 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 graduate courses in a professional field which requires a minimum of 36 credit hours. The holder of a Bachelor's degree not in Business Administration will be required to take preprofessional courses as explained in the section **Graduate Courses by Departments.**

The minimum residence requirement for the degree of Master of Business Administration is 18 credit hours taken "on campus," with a minimum of 12 credit hours taken on the Main Campus at College Station. This regulation does not apply in the case of specific programs of "off-campus" work which have been approved by the Academic Council of Texas A&M University.

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

THE DEGREE OF MASTER OF COMPUTING SCIENCES

The degree of Master of Computing Sciences is a nonthesis degree, designed to complement the Master of Science degree in Computer Science. The degree requires the completion of 36 hours of course work and a satisfactory comprehensive final examination.

The minimum residence requirement for the degree of Master of Computing Sciences is 18 credit hours taken "on campus" with a minimum of 12 hours taken on the Main Campus at College Station. This regulation does not apply in the case of specific programs of "off campus" work which have been approved by the Academic Council of Texas A&M University.

The candidate is not eligible to petition for an exemption from the final examination as outlined for the degree of Master of Science. The announcement for the final examination must be submitted to the Graduate College at least two weeks in advance of the scheduled date. Except as noted above, the requirements for the degree of Master of Computing Sciences are identical with those for the degree of Master of Science.

THE DEGREE OF MASTER OF EDUCATION

Graduate students majoring in agricultural education, education, health and physical education, or industrial education may become candidates for the degree of Master of Education. This is a nonthesis degree which requires 36 hours of course work and a satisfactory comprehensive final examination.

The minimum residence requirement for the degree of Master of Education is 18 credit hours taken "on campus," with a minimum of 12 credit hours taken on the Main Campus at College Station. This regulation does not apply in the case of specific programs of "off campus" work which have been approved by the Academic Council of Texas A&M University.

The candidate is not eligible to petition for an exemption from the final examination as outlined for the degree of Master of Science. The announcement for the final examination must be submitted to the Graduate College at least two weeks in advance of the scheduled date. Except as noted above, the requirements for the degree of Master of Education are identical with those for the degree of Master of Science.

THE DEGREE OF MASTER OF ENGINEERING

A student holding a Bachelor of Science degree in engineering or a qualified senior during his last semester may apply for admission to the Graduate College to work toward the nonthesis 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.

The minimum residence requirement for the degree of Master of Engineering is one full semester, or the equivalent, on the Main Campus at College Station. This regulation does not apply in the case of specific programs of "off campus" work which have been approved by the Academic Council of Texas A&M University.

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

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

THE DEGREE OF MASTER OF URBAN PLANNING (Interdisciplinary)

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

The minimum residence requirement for the degree of Master of Urban Planning (Interdisciplinary) is 18 credit hours taken "on campus," with a minimum of 12 credit hours taken on the Main Campus at College Station. This regulation does not apply in the case of specific programs of "off campus" work which have been approved by the Academic Council of Texas A&M University.

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

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

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

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

Procedure	Initiate Through Approved By	Time
1. Apply for admission	D. A. & R. DH & Dean	At least 4 weeks prior to registration (3-4 months prior to registration for foreign students; use foreign student application)
2. Become familiar with general regulations in Master's Degree section of catalogue		Before registration
3. Meet with Graduate Advisor assigned by department head to plan course of study for first semester	DH & GA GA	Before first semester registration
4. Establish Advisory Committee; prepare Degree Program	GA & DH ADCom, DH & Dean	Before second semester registration
5. If thesis is required, submit Thesis Proposal	ADCom DH & Dean	14 weeks prior to graduation
6. Apply for degree	Dean	See deadlines in Graduate College Calendar
7. Check to be sure Degree Program and Advisory Committee are up to date and all course work is complete	ADCom Dean	Well before final examination. Follow regular procedures for changes (see catalogue)
8. File the completed, approved thesis with the Graduate College and announcement for final oral examination	ADCom & DH Dean	At least 2 weeks prior to final oral examination (see catalogue for specific details)
9. File letter-of-intent to continue for Doctorate, if you so plan	DH Dean & D. A. & R.	Immediately upon completion of all requirements for Master's degree
10. Arrange for cap and gown at Exchange Store		See deadline in Graduate College Calendar. (There is no graduation exercise in August)

THE DEGREE OF DOCTOR OF PHILOSOPHY

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

Residence. Students who enter doctoral degree programs with baccalaureate degrees must spend two academic years in resident study on the Main Campus at College Station. Students who hold Master's degrees when they enter doctoral degree programs must spend one academic year in resident study on the Main Campus. In either case, one academic year beyond the first year of graduate study must be in continuous residence on the Main Campus of Texas A&M University at College Station. One academic year many include two adjacent regular semesters or one regular semester and one adjacent 12-week summer session.

To satisfy the continuous residence requirement, the student must register for a minimum of 12 credit hours per semester or 12-week summer session for the required period. Those students who enter doctoral degree programs with baccalaureate degrees may fulfill residence requirements in excess of one academic year (24 credit hours) on the Main Campus at College Station by attendance during summer sessions or by less-than-full registration (in this context full registration is considered 12 credit hours per semester) on a proportionate basis. Full time staff members of the University or of closely affiliated organizations stationed at the Main Campus may fulfill total residence requirements by accumulation of less-than-full registration.

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

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

Time Limit. Effective September 1, 1969, no student will be granted a doctoral degree (Ph.D., D.Ed. or equivalent degree) from Texas A&M University unless all requirements for that degree are completed within a period of ten (10) consecutive calendar years.

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

Student's Committee and Degree Program. 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 fewer 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 chairman of the advisory committee must be a Full Member of the Graduate Faculty. An Associate Member of the Graduate Faculty may serve with a Full Member as a co-chairman of an advisory committee if it is held desirable by the student's administrative department for him to do so.

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 must be submitted prior to the third semester's registration. The degree program will be submitted on standard forms for the approval of the Dean of the Graduate College, who will, at the time of approval, appoint a representative of the Graduate Council to the student's 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.

Transfer of Credit. Courses for which transfer credits are sought must have been completed with a grade of B or better, and must be approved by the student's advisory committee and the Dean of the Graduate College.

Languages. All students are required to possess a competent command of English. In addition, candidates for the PhD. at Texas A&M University may 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 the Graduate College, provided it is shown 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. Certification shall be by making an acceptable score on the appropriate Educational Testing Service Examination, if available, or if not available, by the Modern Languages Department Examination.
2. Successfully completing a comprehensive examination in one language when such a substitution has been approved in advance by the Dean of the Graduate College.

   Certification shall be by the present Modern Languages Department Examination or other methods as deemed advisable by the Dean of the Graduate College. A description of the requirements of the tests used currently may be secured from the Department of Modern Languages.
3. Successfully passing the reading knowledge examination in one language and taking a minimum of six to eight hours of additional course work.

   Certification shall be by making an acceptable score on the appropriate Educational Testing Service Examination if available or, if not available, by the Modern Languages Department Examination.

   The additional course work must be taken at the Main Campus at College Station, must be in disciplines outside the major or supporting fields, and must not include courses that may be required courses in the field of study, but may be either graduate or undergraduate courses. No grade less than C will be acceptable for these courses.

   Each College shall allow or disallow Option 3. The Degree Program of each student shall list the courses proposed to satisfy the requirement if Option 3 is chosen. The student's committee would, as usual, approve the course program and thus, approve or disapprove the use of Option 3.

Courses designed to satisfy this option should be selected from those courses listed by the various departments of the University as suitable for use under Option 3 of the Ph.D. language requirements (see Graduate College Memorandum No. 68-11).

Examinations currently available through the foreign language test program of the Educational Testing Service are German, Russian, French and Spanish. These tests will be administered locally four times a year by the Counseling and Testing Center. The students must indicate their intent to take the examination by registering in advance with the Center. The costs of the tests will be borne by the students.

Preliminary Examination and Admission to Candidacy. To qualify for the preliminary examination, the student must have satisfied the language requirements (including the completion of all Option 3 course work) and have completed all but approximately six hours of the formal course work on the Degree Program, excluding 691 (Dissertation Research). The examination shall be both oral and written unless otherwise recommended by the student's committee and the Graduate Council Representative and approved by the Dean of the Graduate College. The written part of the examination will cover each field of study included in the student's program and both parts of the examination must be completed within a length of time approved by the Dean of the Graduate College, usually not exceeding two weeks. The formal announcement of the preliminary examination must be received in the office of the Dean of the Graduate College no less than one week prior to the date of the first scheduled written examination. Credit for the preliminary examination is not transferable.

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 to the Dean of the Graduate College the results of the examination. By permission of his committee and the Dean of the Graduate College, 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.

In reporting the results of the preliminary examination, the committee should make recommendations regarding admission to candidacy. To be admitted to candidacy, a student must have (1) satisfied the language requirements, (2) passed the preliminary examination, (3) filed with the Dean of the Graduate College the dissertation proposal approved by his graduate committee, and (4) completed the formal course work. 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.

After a student has passed the required preliminary oral and written examinations for the doctoral degree, he must complete all remaining requirements for the degree within three (3) calendar years, or he will be required to repeat the preliminary examinations. Any student who completed his doctoral preliminary examinations prior to September 1, 1969, must complete all remaining requirements for the degree no later than August 31, 1972; otherwise, he will be required to repeat the preliminary examinations.

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 course 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 the Graduate College 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 of the dissertation 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 as to 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 the Graduate College three copies of the dissertation in final form. The dissertation must be completed with all suggestions and corrections of the student's committee incorporated and must bear the signatures of the department head and the student's committee, with the exception of the Graduate Council Representative. These must be approved by the Dean of the Graduate College before the final examination can be given.

An abstract not exceeding 600 words and a vita page are included in the dissertation. Two additional copies of the abstract must be submitted with the dissertation for microfilming.

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

Application for Degree. Formal application for the degree must be filed both in the office of the Dean of the Graduate College and the Registrar not later than 90 days prior to the end of the semester, or 30 days prior to the end of the summer term in which the student expects to complete his requirements for graduation.

Final Examination. The candidate for the doctoral degree must pass a final examination not less than two weeks before the date on which the degree is to be conferred. Three copies of the dissertation in final form signed by the department head and the student's committee, with the exception of the Graduate Council Representative, must be submitted to the Graduate College, together with the announcement for the final examination, at least two weeks in advance of the scheduled date for the final examination. The student's 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 the Graduate College 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.

The announcement for the final examination must be submitted to the Graduate College at least two weeks in advance of the scheduled date. Except as noted above, the requirements for the degree of Doctor of Education are identical with those for the degree of Doctor of Philosophy.

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

DH — Department Head
GA — Graduate Advisor
ADCom — Advisory Committee

Dean—Dean of Graduate College
D. A. & R.—Dean of Admissions and Records

	Procedure	Initiate Through / Approved By	Time
1.	Apply for admission	D. A. & R. / DH & Dean	At least 4 weeks prior to registration (3-4 months prior to registration for foreign students; use foreign student application)
2.	Familiarize yourself with general regulations and Doctor's Degree section of catalogue		Before registration
3.	Meet with Graduate Advisor assigned by department head to plan course of study for first semester	GA & DH / GA	Before first semester registration
4.	Establish Advisory Committee; prepare Degree Program	GA & DH / ADCom, DH & Dean	Before third semester registration
5.	Fulfill Foreign Language Requirement	Dean	Prior to Preliminary Examination (not required for D.Ed.)
6.	Complete course work detailed on Degree Program	ADCom / Dean	Prior to Preliminary Examination (see catalogue for specific details)
7.	Arrange Preliminary Examination	ADCom / Dean	At least 7 months prior to expected graduation date
8.	Submit Dissertation Proposal	ADCom / Dean	At least 7 months prior to expected graduation date
9.	Request ADCom to recommend admission to Candidacy; completion of 6, 7, and 8 above required	ADCom / Dean	At least 7 months prior to expected graduation date
10.	Prepare rough draft of Dissertation	ADCom	
11.	Apply for degree	Dean	During final semester; see Graduate College Calendar for deadlines
12.	Submit 3 approved copies of Dissertation and 2 extra copies of Dissertation Abstract and announcement for final examination	ADCom, DH & Dean	At least 2 weeks prior to final examination (see catalogue for specific details)
13.	Arrange for cap, gown, and hood at Exchange Store		See deadline in Graduate College Calendar. (There is no graduation exercise in August)

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 the degree is conferred, a student must be officially registered in the University.

Candidates for advanced degrees who expect to complete their work at the end of a given semester must give separate written notice to both the Dean of the Graduate College 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 the degree conferred.

Each candidate for a degree must attend the commencement exercises in appropriate academic regalia unless a petition to be excused is approved by the Dean of the Graduate College. 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 materials that may subsequently be used as a part of the thesis or dissertation, provided the Dean of the Graduate College 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 must be furnished the Dean of the Graduate College. Acknowledgement should be given in the publication that the work is for partial fulfillment of graduate degree requirements.

FINANCIAL ASSISTANCE

Assistantships, both teaching and nonteaching, which require one-half time service are available to qualified students. An appointment to the latter is normally for nine months, whereas the appointment to a teaching assistantship may vary from 9 to 12 months. Research Graduate 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 are normally required of graduate assistants.

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

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 the Graduate College 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. Ordinarily such fellowships require no service except satisfactory academic performance. However, at the discretion of the Head of the student's major department, a Graduate College Fellow may be required to spend up to one-fourth-time on relevant teaching activities during one semester only (or during one 12-week summer session) during a 12-month period. Since Graduate College Fellowships normally permit full-time study and research, the holder of such a grant will be expected to register for 16 credit hours per semester and six hours per six-week summer term.

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 and Summer Traineeship 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 these 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 the Graduate College on or before March 1 preceding the academic year for which awards are to be made.

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

LIBRARY FACILITIES

University Library: The University's principal research collections, numbering in excess of 600,000 volumes, are housed in a new, centrally located facility providing seating for 2,000 readers and an ultimate shelving capacity of 1,000,000 volumes. The upper two floors have perimeter carrels and lockers for assignment to graduate students. There are, in addition, approximately 150 closed studies for use by faculty members and doctoral candidates engaged in research requiring extensive or constant use of library materials.

The collections are organized for use on the subject division plan with a basic collection (first floor), documents division (second floor), humanities and social sciences division (third floor), and science and technology division (fourth floor). In addition there is a special collections area (third floor) to house rare books, microfilms and other special collections. Reference assistance pertinent to the subject matter is available in each of these areas, and a general reference desk is maintained in the basic collection.

An "open stack" arrangement allows free access to all materials except those in the special collections area. Tables are interspersed among shelving to provide convenient study space in all areas.

Although the library has been developed with an emphasis on reference and technical materials, its collections are being expanded to meet the broadened role of the University.

Over 9,000 serials titles are received currently as well as some 50 state, national and foreign newspapers. The library is a depository for selected United States federal documents. Deposits also are maintained for the unclassified reports of the Atomic Energy Commission and the National Aeronautics and Space Administration.

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 one month. Bound periodicals are loaned for outside use on a one week charge only to faculty and staff. Graduate students, on written request of their department heads, also will be granted one-week periodical charges. Unbound periodicals are not checked out for circulation.

Veterinary Branch: This branch is located in the Veterinary Medicine Building and is primarily a reference library with over 16,000 volumes. The library subscribes to approximately 450 American and foreign periodicals and receives pertinent publications from other colleges and experiment stations.

Architecture Branch: This branch, located in the Architecture Building, furnishes reading room space and offers reference service. The collections number approximately 8,000 volumes.

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.

VETERANS AND WAR ORPHANS ADVISORY SERVICE

Texas A&M University provides advisory service to Veterans and 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 1-A, Puryear Hall. 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, Y.M.C.A. Building, within 48 hours of the time that they are brought on the campus.

Students are assigned parking areas according to their housing assignments. 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 to cover costs beyond those provided for by the Student Services Fee. This is available at a 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 on 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 nonsectarian, but its high objective 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.

The Y.M.C.A. on campus has a strong and challenging program directed to student needs, and it invites the participation of graduate students in its many facets of service.

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 students. The campus religious leadership is deeply conscious that students are in perhaps the most formative period of their lives and feels keenly the responsibility for their spiritual development.

Many of the churches have distinct student departments with specialized leadership whose sole responsibility is that of ministering to students. The pastors of the churches also give as much time as is necessary to students for personal counseling. The churches serving the campus have a program similar to that of a 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 as well as 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: Bridge, Talent, Dance, Radio, Camera, Contemporary Arts, Travel, Leadership, Great Issues, Flying Kadets, Recreation, 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. The Student Services Fee and the sale 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, on various other entertainment programs, and is 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 the first two weeks 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 registrations is too small to justify the offering of the course.

DEPARTMENT OF ACCOUNTING

E. D. BENNETT* (Acting Head), W. S. MANNING, E. S. PACKENHAM

The graduate courses in the Department of Accounting provide further professional preparation for careers in public or private accounting. A graduate program consisting of 36 semester hours of course work and including work in a related field such as computer science, management, economics, etc., leads to the M.B.A. degree with a major in accounting.

The holder of a Bachelor's degree in accounting will normally be prepared to go directly into graduate courses in accounting. The holder of a Bachelor's degree in some other field will take additional prerequisite courses in accounting and related fields in business administration.

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: Acct. 401.

602. Consolidated Statements. (3-0). Credit 3. II, S

Consolidated balance sheets, consolidated income and surplus statements, holding companies, mergers. Prerequisite: Acct. 401.

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

612. Advanced Taxes. (3-0). Credit 3. II, S

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: Acct. 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: Acct. 328; Econ. 412 recommended.

640. Accounting Concepts and Procedures. (3-0). Credit 3. I, S

Accounting concepts and relationships essential to administrative decisions; use of accounting statements and reports as policymaking and policy execution tools. Prerequisites: Graduate classification; 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.

*Graduate Advisor for all Ph.D. Candidates in the College of Business Administration.

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.

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

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 AEROSPACE ENGINEERING

A. E. CRONK* (Head), R. R. GILRUTH, W. P. JONES, W. B. LEDBETTER, S. H. LOWY, C. A. RODENBERGER, C. H. SAMSON, J. F. SHEA, J. A. STRICKLIN, R. E. THOMAS, R. S. WICK

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. Introduction to unsteady aerodynamics. 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. Compressible Flow. (3-0). Credit 3. I
Interfering flow fields in supersonic flows, shock wave boundary layer interactions, control surfaces in supersonic flow. Prerequisite: Aero. 472 or approval of instructor.

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.

607. Hypersonic Aerodynamics. (3-0). Credit 3. II
Analysis of very high speed flows, including second-order small disturbance theory, Newtonian theory, numerical computation schemes for blunt body flows. Prerequisite: Aero. 472 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.

*Graduate Advisor

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.

631. Nonequilibrium Flows. (3-0). Credit 3. I
Analysis and character of nonequilibrium flow fields in rocket and wind tunnel nozzles and behind shock waves is studied by introducing reaction rate equations into the fundamental aerodynamic relations. Prerequisite: Aero. 435 or approval of instructor.

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.

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

677. Rarefied Gas Dynamics. (3-0). Credit 3. II
Analysis of phenomena occurring in low density flow presented with emphasis on slip regime problems and solutions based on second-order solutions to the Boltzmann equation. Prerequisite: Aero. 477 or approval of instructor.

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 1 or more each semester. I, II, S
Technical research projects approved by Department Head.

(The Aerospace Engineering courses in applied mechanics such as elasticity, plasticity, continuum mechanics, etc., are listed under the section entitled Structural Mechanics.)

DEPARTMENT OF AGRICULTURAL ECONOMICS AND SOCIOLOGY

W. G. ADKINS, R. V. BILLINGSLEY, R. E. BRANSON, I. L. CORBRIDGE, D. R. DAVIS, R. A. DIETRICH, V. W. EDMONDSON, R. L. EHRICH, D. E. FARRIS, D. F. FIENUP, R. J. FREUND, M. R. GODWIN, H. O. HARTLEY, E. JONES, W. P. KUVLESKY, C. F. LARD, J. G. McNEELY, J. R. MARTIN, D. S. MOORE, B. H. NELSON, C. E. SHAFER, R. L. SKRABANEK, H. B. SORENSEN, R. STELLY, W. L. TROCK, 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 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.

*Graduate Advisor

AGRICULTURAL ECONOMICS

602. Agricultural Market Organization and Structure. (3-0). Credit 3. I
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—Static. (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.

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. I
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. Market Development Research Theory. (3-0). Credit 3. II
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. II
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.Ana. 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 basic for public agriculture programs; economic, social, political, and organizational considerations in agriculture programs. Prerequisite: Approval of Department Head.

632. Production Economics-Dynamic. (3-0). Credit 3. I
Proceeding from static partial equilibrium analysis into dynamic theories of production economics. Study in depth of decision-making process. Consideration of risk, uncertainity, farmer life cycles, and goals other than profit maximizing. Exploring interdisciplinary approaches in study of decision-making. Prerequisite: Ag.Ec. 611.

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.

634. Economics of Agricultural Production. (3-0). Credit 3. I
Application of economic principles to crop and livestock units, stressing amounts and combinations of inputs required for most profitable production. Design of experiments in the physical sciences to permit economic evaluation of results. For graduate students in the College of Agriculture other than in agricultural economics. Prerequisites: Six hours of mathematics or statistics; 15 hours of advanced technical agriculture.

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.Ana. 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, S
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. Urban Sociology. (3-0). Credit 3. II, 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.

608. Social Organization. (3-0). Credit 3. I
Analysis of human pluralities and groups, including nature of social cohesion and levels of communication. Consideration of structural and functional aspects of human groups from simplest informal to most complex formal types: voluntary associations, cliques, families, bureaucracies, societies. Prerequisites: Soc. 205 or equivalent; nine additional hours of social science.

609. Social Change. (3-0). Credit 3. I, S
Systematic analysis of concepts, theories and processes significant to social change. Relationship of social change to universals, consistent mechanisms, regularities, and incentives. Functional approach to the process of innovations. Prerequisite: Approval of Department Head.

610. Sociological Theory. (3-0). Credit 3. II
Advanced study of contemporary trends in theory-development in sociology, including comparative study of general sociological frameworks and application of these systems to particular substantive areas of sociology. Prerequisite: Soc. 611.

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

613. Social Systems. (3-0). Credit 3. I, II
Systematic presentation of contemporary sociology, including functional analysis of social structures within major conceptual frames of reference; social systems model.

616. Occupational Sociology. (3-0). Credit 3. II
Sociological analysis of changing occupational structures, labor force demography. Concepts in social structures relating to significance of work, job mobility, changing occupational ideologies, values, and choices. Prerequisites: Soc. 205; six additional hours of social science.

618. Educational Sociology. (3-0). Credit 3. II, S
The school system and the democratic way of life. Relationship of education to social organization, social change, and social control. Analysis of role of education in society. Prerequisite: Soc. 205 or a degree in education.

620. Human Ecology. (3-0). Credit 3. II
Interrelationships between man and his social environment; emphasis upon human aggregations and their forms of settlement and organization. Prerequisites: Soc. 205; six additional hours of social science.

621. Social Psychology. (3-0). Credit 3. I, S
Personality, social and cultural systems; development and interrelationships. Cognitive activities, motivational determinants and selectivity. Goals, structures, coordination and related factors influencing complex social groupings. Analysis of theory and research in social psychology. Prerequisites: Soc. 205; 12 additional hours of social science.

622. Demography. (3-0) Credit 3. II, S
Sources and characteristics of demographic data and the methods and problems of population data analysis. Prerequisite: Approval of Department Head.

623. Measurement of Sociological Parameters. (3-0). Credit 3. II
Investigation of sociological research including scaling, scale analysis, and experimental design. Prerequisites: Graduate classification; three hours of statistics.

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

J. E. CHRISTIANSEN, B. D. COOK, J W. HOLCOMB, O. M. HOLT, E. H. KNEBEL* (Head), E. S. WEBB*

Advanced study in agricultural education provides an opportunity for teachers of vocational agriculture to improve their efficiency as master teachers. Agricultural extension personnel and other professional workers in agricultural departments of developing countries may also improve themselves through selected courses designed to meet the needs of professional persons in building programs for implementing changes. Course content and teaching procedures used in graduate courses are selected to assist in the development of skills in recognizing and analyzing professional problems and initiating plans of action for the solution of these problems.

Candidates for advanced degrees in agricultural education should have at least one year of successful professional experience. However, evidence of maturity, purposefulness and scholastic ability may be considered in lieu of experience upon the approval of the Agricultural Education staff and the Head of the Department.

*Graduate Advisor

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

601. Advanced Methods in Agricultural Education. (3-0). Credit 3. I 1969; S 1970
Advanced course in methods of teaching. Prerequisite: Professional experience or approval of Department Head.

605. Supervision of Occupational Experience Programs in Agriculture. (3-0). Credit 3. I 1970; S 1969, 1971
Advanced study of occupational experience programs—their nature and scope in relation to supervised farming, part-time agricultural cooperative experiences and pre-employment laboratories. Prerequisite: Professional experience or approval of Department Head.

607. Youth Leadership Programs. (3-0). Credit 3. I 1969, 1971
Methods and procedures of organizing and conducting youth programs. Prerequisite: Professional experience or approval of Department Head.

610. Principles of Adult Education. (3-0). Credit 3. I 1970; S 1970
Identification of the basic principles that motivate adults to learn. Procedures are examined that are purported to implement these principles in bringing about changes in adult behavior. 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. 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. 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 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. 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, 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, extension education, 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

R. C. HANSEN, E. A. HILER, P. HOBGOOD (Head), J. P. HOLLINGSWORTH, E. B. HUDSPETH, O. R. KUNZE*, J. W. SORENSON, B. R. STEWART, R. E. STEWART*, L. H. WILKES

Agricultural engineering is a relatively new field. As the name implies, it involves both agriculture and engineering, but more specifically it 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 crops, soil, and climatic conditions; the creation of new applications for the utilization of electricity and other developments 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. Research Instrumentation. (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 non-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.

*Graduate Advisor

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. Small Watershed Hydrology. (3-0). Credit 3. I

Hydrology of agricultural watersheds, with emphasis on soil and water, conservation, precipitation frequency analysis, infiltration, ground water, runoff, erosion theory, sediment transport theory, evapotranspiration, reduction of water losses, and experimental techniques. Prerequisites: Ag.En. 428; C.E. 463.

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

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

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

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. For more information, see listing under Genetics.

ANIMAL NUTRITION

Advanced studies may be undertaken in the Departments of Animal and Poultry Sciences and Biochemistry and Biophysics 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 nonruminant nutrition.

ANIMAL PARASITOLOGY

S. O. BROWN, R. L. HANNA, S. H. HOPKINS*, M. A. PRICE

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

Graduate instruction in parasitology 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.

Biology 627, 630.
Entomology 613, 614, 615, 617, 618, 619, 691.
Veterinary Parasitology 601, 691.

---

*Graduate Advisor

DEPARTMENT OF ANIMAL SCIENCE

J. W. BASSETT*, L. H. BREUER*, O. D. BUTLER, JR.* (Head), Z. L. CARPENTER*, T. C. CARTWRIGHT*, F. I. DAHLBERG, C. W. DILL*, W. C. ELLIS*, H. A. FITZHUGH, JR.*, J. L. FLEEGER*, D. B. HUDMAN, N. M. KIEFFER*, G. T. KING*, H. O. KUNKEL, W. A. LANDMANN*, GARY T. LANE, R. E. LEIGHTON*, L. S. POPE, H. E. RANDOLPH*, J. K. RIGGS*, J. M. SHELTON, A. M. SORENSEN, JR.*, C. VANDERZANT*, D. F. WESELI*

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

Animal Breeding	(M.S. and Ph.D.)
Animal Nutrition	(M.S. and Ph.D.)
Dairy Manufacturing	(M.S. and Ph.D.)
Dairy Production	(M.S. and Ph.D.)
Food Technology	(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 agricultural economics, biochemistry, biophysics, biology, genetics, statistics, and in veterinary anatomy, microbiology, parasitology, pathology, physiology, pharmacology and public health.

Laboratories available for graduate research include cytogenetics, dairy manufacturing, food technology, immunogenetics, meats, meat chemistry, nutrition and reproductive physiology. Special equipment available in these laboratories or in readily available facilities, such as at the large Data Processing Center, offer a wide array of opportunities for study and research.

Dairy, beef and swine herds and sheep and goat flocks at the Main Station or at Research Centers afford opportunities to study various problems in artificial insemination, breeding, management, nutrition and production. A dairy processing plant equipped to manufacture all dairy foods on a semi-commercial scale, is in operation and is available for research problems. Experiment Station projects in all subject matter fields offer opportunities for graduate students to participate in current research activity.

Minors or joint majors in such areas as biochemistry and biophysics, economics, genetics and statistics may be readily arranged.

ANIMAL SCIENCE SECTION

600. Advanced Livestock Management. Credit 3. S

Special three-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.

602. Protein and Energy Nutrition. (3-0). Credit 3. I

Study of transformation of dietary protein and energy by homeotherms to provide for organisms nutritive requirements for protein and energy in health and production. Physical, physiological, and biochemical aspects and their applications in practice emphasized. Prerequisites: An.Sc. 444; Bi. Ch. 410.

603. Experimental Nutrition. (1-3). Credit 2. I

Laboratory experiments designed to familiarize the student with basic and specialized research techniques, their limitations and applications. Prerequisite: An.Sc. 602.

604. Ruminant Nutrition. (3-0). Credit 3. II

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. Prerequisite: An. Sc. 444; Bi. Ch. 410 or 603 and/or approval of Department Head.

*Graduate Advisor

605. Advancements in Beef Cattle Production. (3-0). Credit 3. I, S 1969, 1972
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.

606. Advancements in Beef Cattle Production. (3-0). Credit 3. II, S 1969, 1972
Continuation of An.Sc. 605.

607. Meat Science and Research Techniques. (2-2). Credit 3. II 1970, 1972
Emphasizes biochemical, histological, anatomical, and physical factors associated with transformation of muscle cell into meat. Prerequisite: Approval of Department Head.

616. Animal Genetics. (3-3). Credit 4. II 1970, 1971, 1973; S 1969, 1972
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. 602.

619. Advancements in Sheep and Angora Goat Production. (3-0). Credit 3. I 1969, 1971, 1972, 1973; S 1970
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.

620. Advancements in Sheep and Angora Goat Production. (3-0). Credit 3. II 1969, 1970, 1971, 1972, 1973; S 1970
Continuation of An.Sc. 619.

621. Advancements in Swine Production. (3-0). Credit 3. II 1969, 1973; S 1971
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.

622. Advancements in Swine Production. (3-0). Credit 3. II 1970, 1972
Continuation of An.Sc. 621.

628. Animal Breeding. (2-0). Credit 2. I 1969, 1971, 1973
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. S 1971; II 1969, 1970, 1972, 1973
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, II
Important current developments in field of animal science. Review of current literature and presentation of papers on selected animal science topics. Prerequisites: Graduate classification; major in animal science.

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.

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

DAIRY SCIENCE SECTION

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.

605. Chemistry of Foods. (2-3). Credit 3. I

Advanced study of chemistry of dairy foods and meats relating to their composition and characteristic properties important to their subsequent manufacture into food products. Prerequisite: BiCh. 410 or 603.

606. Microbiology of Foods. (2-3). Credit 3. II

Nature and function of beneficial and defect-producing bacteria in dairy products, meats, and related foods. Effects of processing, storage, and distribution. Techniques for isolation and identification from foods. Prerequisite: D.S. 326 or approval of Department Head.

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

Study of research methods and review of scientific literature dealing with individually selected problems in production or manufactures and not pertaining to thesis or dissertation.

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

Research leading to thesis or dissertation in respective fields of dairy production and dairy manufactures.

DEPARTMENT OF ARCHITECTURE

W. W. HARPER*, G. J. MANN, J. H. MARSH*, J. R. PATTERSON*, E. J. ROMIENIEC, M. M. ROTSCH, W. C. STEWARD, R. F. WHITE*

Graduate study in architecture is essentially a matter of individual effort. For this reason the graduate programs are sufficiently broad in scope to encourage individual research in building design, construction management, health facilities, history, interior space design, systems development and urban design. These programs embody academic and research programs in environmental studies which require active student participation in actual, significant community service problems of major regional, national, or international orientation.

ARCHITECTURE

601. Environmental Design. (3-9). Credit 6. I, S

Advanced course centered on design problems for development of man-made urban environment to meet man's needs. Gives student opportunity to study his design specialization (e.g., architectural design, landscape design, urban design, construction, etc.) in depth and in complexity of environmental problems. Prerequisite: Approval of Chairman of School.

602. Environmental Design. (3-9). Credit 6. II, S

Continuation of Arch. 601. Terminal semester design project of major significance and complexity for the development of the human environment to meet man's need. Prerequisite: Approval of Chairman of School.

603. Building System Development I. (0-9). Credit 3. I

General course dealing with total building system designs for various building types as specifically related to modern technological capabilities of industry. Field trips to research and development organizations will illustrate on-going programs in industry. Prerequisite: Approval of Chairman of School.

604. Building System Development II. (0-9). Credit 3. I

Deals with direct application of building system concepts and principles to actual architectural problem. Individual students given specific responsibilities within a group working under direct supervision of professional research architect. Prerequisite: Approval of Chairman of School.

*Graduate Advisor

611. Architectural Design. (1-5). Credit 3. I, S
Introductory course for non-architects in visual communication utilizing various graphic techniques, methods, and means of drawing and reproduction. Prerequisite: Approval of Chairman of School.

612. Architectural Design. (1-5). Credit 3. II, S
Design course in architecture for engineers and others not having an architectural design background. Studio program will concern aesthetic, special, and general environmental consequences of physical design. Prerequisite: Approval of Chairman of School.

627. Contemporary and Creative Structures. (2-2). Credit 3. I
Studies and analysis of contemporary and creative structures as related to architectural design, with emphasis on aesthetic 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 analysis of contemporary and creative structures as related to architectural design with emphasis on aesthetic 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.

635. Environmental Technology. (3-0). Credit 3. I, S
Study of complex or special environmental problems in physical conditioning of architectural spaces. Prerequisite: Approval of Chairman of School.

636. Environmental Technology. (3-0). Credit 3. II, S
Continuation of Arch. 635; with emphasis placed on a specific area of study that parallels the terminal project in Arch. 602. Prerequisite: Approval of Chairman of School.

653. Research and Development Programming I. (3-0). Credit 3. I
Studio course introducing theory and techniques of research and development programming. Introduces PERT, CPM, and other developed systems of time-effort-resource programming. Prerequisite: Approval of Chairman of School.

654. Research and Development Programming II. (3-0). Credit 3. II
Research and development programming course dealing with actual application of programming techniques to on-going research and development work. Students develop programs corresponding to assigned sections of overall group project. Individual evaluation made upon actual performance of individually developed programs over time span of assigned work. Prerequisite: Approval of Chairman of School.

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 1 or more each semester. I, II, S
Research for thesis.

DEPARTMENT OF BIOCHEMISTRY AND BIOPHYSICS

N. R. BOTTINO, B. J. CAMP, H. G. CLAMANN, J. R. COUCH, C. R. CREGER, H. R. CROOKSHANK, J. W. DIECKERT, T. B. GRIFFIN, R. D. GRIGSBY, H. O. KUNKEL, W. A. LANDMANN, C. C. LITCHFIELD, E. F. MEYER, J. NAGYVARY, C. N. PACE, J. M. PRESCOTT* (Acting Head), R. REISER, E. S. VANDERZANT, B. E. WELCH

The Department of Biochemistry and Biophysics offers graduate studies leading to the degrees of Master of Science and Doctor of Philosophy. In both programs, emphasis is placed upon the acquisition of a sound fundamental grasp of the student's major and supporting disciplines, and upon the ability to perform research of high quality.

*Graduate Advisor

Facilities are available for advanced instruction and student research in various phases of biochemistry and biophysics. Among the specialized items of equipment available are a high resolution mass spectrometer, X-ray diffraction equipment, analytical and preparative ultracentrifuges, an electron microscope, automated gamma ray spectrometers, several types of zone and moving-boundary electrophoresis appratus, amino acid analyzers, and a spectropolarimeter. There is a wide array of equipment for gas chromatography, spectrophotometry, and for counting radioactive isotopes.

Research is in progress in protein chemistry, lipid chemistry and metabolism, enzymology, intermediary metabolism, nucleic acid chemistry, structural determination of natural products, plant biochemistry and microbial genetics.

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

HEALTH PHYSICS

An interdisciplinary program is available in health physics, encompassing physics, biology, chemistry, and engineering from the standpoints of radiation effects and radiation safety. The curriculum consists of basic courses in radiation physics, radiation biology, and radiation chemistry with provisions for training and research in a student's specialized area of interest.

Students wishing to enter this program should have an undergraduate degree in science or engineering, including mathematics through differential equations, physics through atomic or modern physics, a full year of chemistry, and a full year of biology. Deficiencies may be made up during the summer prior to entering the program or the first semester of participation.

Graduate studies in health physics may also be undertaken in the Department of Nuclear Engineering (see page 113).

BIOCHEMISTRY

603. General Biochemistry. (3-0). Credit 3. I

Study of the constituents of living cells and their chemical reactions. Particular emphasis is placed on the chemistry of proteins, carbohydrates, lipids, and nucleic acids. The role of enzymes as catalysts in biological reactions is stressed, and the topic of intermediary metabolism is introduced. Prerequisites: Chem. 228, 238, 316, 318.

604. General Biochemistry. (3-0). Credit 3. II

Continuation of Bi.Ch. 603, devoted to the dynamic aspects of biochemistry. Emphasis is on intermediary metabolism and biologically important reactions of amino acids, proteins, carbohydrates, nucleic acids, and lipids. Prerequisite: Bi.Ch. 603.

605. Experimental Techniques in Biochemistry. (0-6). Credit 2. I

Laboratory course designed to familiarize the student with the properties of biologically important chemical compounds, and with fundamental techniques for the isolation, identification, and quantitative determination of such compounds in natural products. Prerequisite: Bi.Ch. 603 or registration therein.

606. Experimental Techniques in Biochemistry. (0-6). Credit 2. II

Continuation of the laboratory study introduced in Bi.Ch. 605, emphasizing the principles and techniques involved in the study of intermediary metabolism and enzyme chemistry. Prerequisites: Bi.Ch. 604 and 605 or registration therein.

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

Advanced course in lipid chemistry and metabolism. Prerequisite: Bi.Ch. 603.

624. Enzymes. (3-0). Credit 3. I

General principles of enzyme chemistry. Physical chemistry of enzyme action. Types of enzymes and coenzymes. Enzymes in patterns of metabolism. Prerequisites. Bi.Ch. 603; Chem. 324 or 342; or approval of instructor.

629. Nutritional Basis of Metabolism. (3-0). Credit 3. II

Nutritional and metabolic interrelationship in the utilization of proteins, fats and carbohydrates. The functions of vitamins and mineral elements, particularly at the molecular level. Prerequisite: Bi.Ch. 604.

630. Current Topics in Metabolism. (3-0). Credit 3. I
Advanced consideration of current developments in the field of metabolism. The emphasis is on the most recently published results of metabolic studies at the molecular level. Prerequisite: Bi.Ch. 604.

640. Clinical Chemistry. (2-6). Credit 4. II, S
Study of the quantitative distribution of body constituents and their physiological interpretations. Prerequisite: Bi.Ch. 312 or 410 or 603, or Biol. 433, or V.P.P. 427.

650. Biochemistry of Macromolecules. (3-0). Credit 3. I
An advanced consideration of the chemical, physical, and biological characteristics of proteins, nucleic acids, and polysaccharides. Prerequisite: Bi.Ch. 604.

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

685. Problems. Credit 1 or more each semester. I, II, S
Advanced course in biochemical laboratory procedures including preparations and instrumentation. Problems assigned according to experience, interests, and needs of individual students.

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. Prerequisite: Approval of major advisor.

See Genetics 631 for full description of related course.

BIOPHYSICS

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

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

685. Problems. Credit 1 or more each semester. I, II, S
Individual problems or research not pertaining to thesis or dissertation.

691. Research. Credit 1 or more each semester. I, II, S
Research for thesis or dissertation.

DEPARTMENT OF BIOLOGY*

See also ANIMAL PARASITOLOGY and

PHYSIOLOGY OF REPRODUCTION

S. O. BROWN, E. CHIN, W. J. CLARK, E. R. COX, L. S. DILLON, W. J. DOBSON, E. M. ENGLEMAN, W. P. FIFE, B. G. FOSTER, V. E. GRANT, H. L. GRAVETT, H. W. HARRY, S. H. HOPKINS, H. KLEEREKOPER, W. R. KLEMM, G. M. KRISE, D. D. McLAIN, J. G. MACKIN, S. M. RAY, H. A. ROLLER, I. V. SARKISSIAN, J. J. SPERRY, M. H. SWEET, W. A. TABER, C.H.M. van BAVEL, J. van OVERBEEK (Head), U. G. WHITEHOUSE, W. B. WILSON

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 programs in botany, microbiology, and zoology. All courses, irrespective of

*All department members of the Graduate Faculty serve as Graduate Advisors.

subject matter area, bear the departmental designation (Biology) and a course number from a single numerical sequence.

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 of Education Departments.

617. Ultrastructure of Microorganisms. (3-0). Credit 3. I

Fine structure of algae, protozoa, and bacterial cells discussed on a comparative basis; ultrastructure of nucleus and all known cytoplasmic organelles; ultrastructure of mitosis and of cell division; ultrastructure of viruses and rickettsias. Prerequisite: Graduate classification in a biological or agricultural science.

640. Neurobiology. (3-3). Credit 4. S

Scope includes most aspects of neurobiology, ranging from function of single cells to integrated interactions in spinal cord and brain. Emphasis on present-day research and implications for future research, especially brain research. Prerequisite: Biol, 434 or V.P.P. 427 or equivalent.

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. 654; graduate classification.

660. Aquatic Ecology. (2-3). Credit 3. I

Study of fresh water as an environment; its physical and chemical characteristics and characteristics of plant and animal communities which inhabit it. Prerequisite: Approval of instructor.

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. II, II

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

BOTANY

608. Phycology. (3-3). Credit 4. I

Morphology, taxonomy and physiology of algae. Reproduction and life cycles. Stressing cultural studies. Prerequisites: Biol. 327 and 353; approval of instructor.

615. Cytology. (3-3). Credit 4. I

Intensive study of cell structure in all kinds of organisms. Structure of organelles is related to their occurrence in different taxa, their changes during cell development, and their relation to metabolism. Prerequisites: Chem. 228, 238 or equivalent; twelve hours of biological science.

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

Study of criteria used in plan identification, classification and phylogeny; floral and vegetative characters of selected orders, families and·tribes of flowering plants; application of the rules of botanical nomenclature; summary of major historical developments. Prerequisites: Six hours of biological sciences, including Biol. 101 or 113 or their equivalents.

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. 102 or approval of instructor.

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 1969-70 and in alternate years thereafter.)

MICROBIOLOGY

610. Immunology. (3-4). Credit 4. I

Study of immunological reactions as related to the diagnosis of human disease. Both basic immune phenomena and practical laboratory experience will be stressed. Prerequisite: Biol. 351 or equivalent.

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

Advanced consideration of physiological activities of bacteria with special emphasis on metabolism, regulatory mechanisms, cell composition, and use of 14C-substrates in physiology. Prerequisite: Bi.Ch. 312 or 410. (Offered in 1970-71 and in alternate years thereafter.)

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

Microorganisms as basis of industrial processes. Practice includes antibiotic assay; analysis of products of metabolism and fermentation balances. Prerequisite: Bi.Ch. 312 or 410. (Offered in 1969-70 and in alternate years thereafter.)

See Biology 608, 630, 651; Plant Pathology 618, 620; Plant Physiology 607 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. 318, 343, 344, or equivalent.

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

Comparative and experimental studies of mechanics of embryonic development. Prerequisites: Biol. 318, 343, 344, or equivalent. (Offered in 1970-71 and in alternate years thereafter.)

627. Helminthology. (3-3). Credit 4. II

Study of parasitic worms, especially Trematoda, Cestoda, Nematoda, and Acanthocephala. Prerequisite: Biol. 436.

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

Morphology, taxonomy, physiology, reproduction, phylogeny, ecology, and life history of both free living and parasite protozoa. Prerequisite: Biol. 108.

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. Prerequisite: 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. Prerequisites: Twelve hours of biological sciences including at least three 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, 237.

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.

663. Biology of the Crustacea. (3-3). Credit 4. S

Lectures, conferences, and laboratory work on classification, life history, morphology, physiology, ecology, diseases, parasites, and predators of crustaceans. Economic aspects of crustaceans considered. Study of original literature emphasized. Prerequisites: Biol. 435 or equivalent; graduate classification or approval of instructor.

665. Invertebrate Zoology. (3-3). Credit 4. I

Morphology, taxonomy, biology, and phylogeny of invertebrate animals, including an individual project. Special attention to invertebrates (not including insects) of interest to entomologists, wildlife students, and oceanographers, including economic forms. Prerequisite: Six hours of zoology.

668. Biology of Invertebrate Symbioses. (3-2). Credit 4. II, S

Review of physiology, ecological relations, and populations significance of various types of symbiotic associations with emphasis on parasitism and mutualism, and with consideration of economics of these associations. Prerequisites: Graduate classification in biology, approval of instructor.

DEPARTMENT OF BUSINESS ANALYSIS AND RESEARCH

B. J. ADAMS (Acting Head)

Graduate courses in Business Analysis and Research provide the quantitative business tools and concepts for students with a professional concentration in Accounting, Organization and Administration, Computer Science or Statistics. The department does not offer a separate graduate program leading to the M.B.A. degree.

Students in M.B.A. programs, and those who meet the prerequisites in programs of colleges other than Business Administration, may take graduate courses in the Business Analysis and Research Department to acquire business research designs and methodologies.

646. Business Trends, Fluctuations, 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.

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.

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 in field of quantitative methods applied to business.

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. G. ANTHONY, R. DARBY, R. R. DAVISON, L. D. DURBIN, P. T. EUBANK*, D. T. HANSON, W. B. HARRIS, W. D. HARRIS, C. D. HOLLAND (Head), W. W. MEINKE, E. A. SCHWEIKERT, R. E. WAINERDI

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, rheology, thermodynamics, distillation, extraction, process control, water purification, microbiological transformations, electrochemistry, energy conversion, chemical reactor design and optimization, chemical engineering kinetics and catalysis, activation analysis, chemurgic research, and environmental research.

The research facilities include, in addition to standard laboratory equipment, several precision analytical distillation columns, vapor-phase chromatograph, ultraviolet and infrared spectrometers, high-speed movie and other photographic equipment, Burnett P-V-T apparatus, high-speed recorders, digital data logging equipment, a medium size electronic analog computer, a Weissenberg Rheogoniometer, other rheological research equipment, and an experimental fuel cell system. 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. 424.

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. 424.

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

Theoretical principles of conduction, radiation, and forced convection are presented as well as steady and unsteady state conduction problems with chemical reactions and phase changes. Boundary layer theory is stressed in connection with forced convection problems. Prerequisite: Ch.E. 424.

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

Process and process design calculations involving distillation of multicomponent and complex systems. Extractive and azeotropic distillation are covered. Prerequisite: Ch.E. 424.

613. Unsteady State Processes. (3-0). Credit 3. II

Formulation of exact models for, and solution of, corresponding equations for problems involving process equipment such as distillation columns, packed columns, evaporators, and adsorption columns at unsteady state operation. Prerequisites: Ch.E. 606, 612.

*Graduate Advisor

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. 424.

623. Applications of Thermodynamics to Chemical Engineering. (3-0). Credit 3. II
Study of application of thermodynamics to chemical engineering operations and processes. Prerequisite: Ch.E. 354.

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. 424.

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.

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. 424.

630. Activation Analysis. (1-3). Credit 2. II
The theoretical and practical bases of nuclear activation analysis are developed. Applications of the method in the physical and life sciences are presented. Prerequisites: Graduate classification in the sciences or engineering and one appropriate course in nuclear engineering or nuclear chemistry.

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, nonlinear, and stochastic dynamic analysis and optimal design policies to processes in chemical and allied fields. Prerequisite: Ch.E. 631.

640. Rheology. (3-0). Credit 3. II
Principles of stress, deformation and flow with emphasis on vector and tensor equations of fluid mechanics. Behavior of Newtonian, non-Newtonian, and viscoelastic fluids stressed. Prerequisites: Ch.E. 629; Math. 601.

650. Electrochemical Processes. (3-0). Credit 3. I
Fundamentals of reversible and irreversible electrode processes with emphasis on energy conversion devices. Porous electrode phenomena and the interaction between mass transport and kinetic mechanisms. Industrial applications and corrosion considered. Prerequisites: Ch.E. 428, 464.

681. Seminar. (1-0). Credit 1. 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

D. W. BROOKS, D. C. CONWAY, F. FISHER, C. S. GIAM, K. A. GINGERICH, J. K. GLADDEN, J. S. HAM, K. G. HAMPTON, C. K. HANCOCK, R. M. HEDGES, K. J. IRGOLIC, A. F. ISBELL, HOWARD KAYE, JAAN LAANE, H. A. LIEBHAFSKY, J. H. LUNSFORD, R. D. MACFARLANE, A. E. MARTELL (Head), E. A. MEYERS, J. B. NATOWITZ, D. H. O'BRIEN, W. M. PASIKA, K. H. PEARSON, A. S. RODGERS, E. A. SCHWEIKERT, B. L. SHAPIRO*, F. SICILIO, F. J. SMENTOWSKI, T. SMITH, R. D. STIPANOVIC, T. T. SUGIHARA, A. D. SUTTLE, Y. N. TANG, R. N. TRAXLER, M. TSUTSUI, R. L. WATSON, R. D. WHEALY, R. C. WILHOIT, R. A. ZINGARO, B. J. ZWOLINSKI

Graduate work in chemistry is offered at both the Master's and Doctorate levels. The program leading to the Master's degree is designed to provide the student with a strong fundamental knowledge and understanding in the major areas of chemistry. In addition, a thesis is required which affords the student an opportunity to actively participate in experimental or theoretical research.

The program leading to the Ph.D. degree is designed so that the student has the opportunity to spend more of his time in research. The dissertation which results from this research must satisfactorily demonstrate (1) that the student is capable of independent and creative research in a specialized area of chemistry and (2) that the student has a superior knowledge and understanding of 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. As part of the training of the graduate student pursuing the M.S. or Ph.D. in chemistry, the Department of Chemistry requires each to participate in the teaching program of the department every year during his graduate program.

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 opportunties are found in the areas of kinetics, passivity of aluminum, molecular ultraviolet 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 nonaqueous solvents, phase studies, and inorganic compounds. Too, research is being done in the chemical deposition of semiconducting 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 nonaqueous 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.

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.

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 equivalents.

*Graduate Advisor

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.

616. Statistical Chemistry and Chemical Dynamics. (3-0). Credit 3. I

Advanced treatment of statistical mechanics and chemical dynamics including properties of real gases, non-equilibrium phenomena, and microscopic chemical dynamics. Prerequisites: Chem. 621, 631.

619. Analytical Absorption Spectroscopy. (3-0). Credit 3. II

Theory, principles, and applications of absorption techniques to modern problems of analytical chemistry. Topics covered include visible, ultraviolet, polarimetry, optical rotatory dispersion, circular dichroism, atomic absorption, flame and emission spectroscopy. Prerequisite: Chem. 620 or approval of instructor.

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. III

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

624. Physico-Organic Chemistry. (3-0). Credit 3. I

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.

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.

629. Chemistry of the Regular Elements. (3-0). Credit 3. I

Chemistry of the elements of subgroup A of the periodic table and the noble gases. Prerequisite: Chem. 641.

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

Introduction to methods of statistical mechanics based primarily on Bolzmann statistics. Approach to thermodynamics through partition function. Statistical concept of entrophy. 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.

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

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

637. Electroanalytical Chemistry. (3-0). Credit 3. I

Advanced survey of modern electroanalytical methods including potentiostatic, galvanostatic, sweep, and periodic techniques. Prerequisite: Chem. 620 or approval of instructor.

638. Chemical Instrumentation. (2-3). Credit 3. S

Introduction to electronic instrumentation of importance to the chemist in the generation, detection, amplification, modification, and presentation of chemical information. Typical modern instruments studied from design and operational standpoints after an introduction to electronics and electrical measurements. Prerequisite: Approval of instructor.

639. Instrumental Methods of Analysis. (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.

640. Transition Metal Chemistry. (3-0). Credit 3. II

Chemistry of the subgroup B elements of the periodic table including the lanthanides and actinides. Special emphasis on coordination compounds. Prerequisite: Chem. 641.

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

Introduction to chemical bonding; valance bond and molecular orbital theory, ionic bonding, the hydrogen bond, and introduction to ligand field theory. Prerequisite: Chem. 462.

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, alkaxyl, semi-micro saponification number. Prerequisite: Chem. 228.

646. Organic Chemistry. (3-0). Credit 3. I, II

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

647. Spectra of Organic Compounds. (3-0). Credit 3. I

Correlations of molecular structure with spectroscopic and other physical properties. Applications to modern problems in organic chemistry. Prerequisite: Chem. 646 or approval of instructor.

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

651. Advances in Physical Chemistry. (2-0). Credit 2. S

Recent advances in such areas as surface chemistry and catalysis, properties of high molecular weight polymers and their solutions, photochemistry and theories of liquids and solutions. Prerequisites: Chem. 324 or its equivalent; approval of instructor.

652. Advances in Analytical Chemistry. (2-0). Credit 2. S

Recent advances and special methods in field of analytical chemistry. Methods will be discussed in terms of their basic theory, particular advantages, limitations, and required instrumentation. Prerequisite: Chem. 620.

653. Advances in Organic Chemistry. (2-0). Credit 2. S

Special topics of current interest in organic chemistry, which are not normally covered in sufficient depth in other courses. Most subjects will be taken from recent or current chemical literature. Prerequisite: Chem. 646 or approval of instructor.

654. Advances in Inorganic Chemistry. (2-0). Credit 2. S

Discussion of topics such as boron hydrides, crystal field theory, inorganic reaction mechanisms, organometallic chemistry and nuclear chemistry. Prerequisite: Chem. 641.

655. Polymer Science I. (3-0). Credit 3. I

Synthesis of polymers by condensation, addition, and other types of polymerization. Solution methods of characterization. Solid state properties and their structural basis.

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

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

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

660. Nuclear Chemistry. (2-3). Credit 3. II
Fundamentals of radioactive decay, nuclear models, nuclear spectroscopy, nuclear reactions, fission, and other topics of current interest in nuclear chemical research. Laboratory work to emphasize modern nuclear chemical instrumentation. Prerequisite: Chem. 464 or approval of instructor.

662. Crystal Chemistry. (3-0). Credit 3. I
Introduction to chemistry of crystals, their properties and structures. Discussion of types of crystals with special emphasis upon the bonding present and its influence upon chemical and physical properties. Prerequisite: Approval of instructor.

663. X-Ray Absorption and Emission in Analysis. (3-0). Credit 3. I
Principles of x-ray emission and absorption for chemical analysis and control. Prerequisite: Approval of instructor.

681. Seminar. (1-0). Credit 1 each semester. I, II
Oral presentations and discussions of recent advances in chemistry.

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

F. J. BENSON, K. A. BREWER, S. J. BUCHANAN, J. H. BUHR, H. M. COYLE, W. B. DAVIS, D. R. DREW, W. A. DUNLAP, T. C. EDWARDS, C. R. FOSTER, H. L. FURR, B. M. GALLAWAY, R. H. GUNDERSON, R. W. HANN, JR., J. B. HERBICH, T. J. HIRSCH, R. M. HOLCOMB, D. L. IVEY, M. D. JONES, C. J. KEESE, A. H. LAYMAN, W. B. LEDBETTER, L. L. LOWERY, J. E. MARTINEZ, R. M. OLSON, J. A. ORR, C. PINNELL, R. O. REID, T. D. REYNOLDS, N. J. ROWAN, C. H. SAMSON, JR. (Head), R. E. SCHILLER, JR., F. H. SCRIVNER, M. SHELBY, R. M. SORENSEN, V. G. STOVER, L. J. THOMPSON, R. N. TRAXLER, R. D. TURPIN*, S. R. WRIGHT

A variety of courses is offered in civil engineering to permit a student to specialize in a given branch. The department is especially well equipped to offer, with support from other departments, programs in coastal and ocean engineering, construction engineering, environmental engineering, foundation engineering and soil mechanics, geodesy, photogrammetry and surveying, hydraulic engineering and fluid mechanics, materials engineering, public works engineering, structural engineering and structural mechanics, transportation engineering, urban management, and urban planning.

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.

*Graduate Advisor

603. Stream Quality. (3-0). Credit 3. I

Physical, chemical, radiological and biological properties of streams, impoundments, reservoirs and estuaries and the interrelationships of these properties; local, state, regional and federal water quality standards; legal aspects of water pollution control; quality criteria for beneficial uses of water; evaluation of critical problems. Prerequisite: Graduate standing in engineering or approval of instructor.

604. Introduction to Unit Operation Theory. (3-0). Credit 3. I

Introduction to the theory of various unit operations for water supply and waste water treatment; development of theoretical approaches to the design of various unit operations and criteria behind the development of the theoretical approach; fundamental principles of unit operations which are common to many systems; the evaluation of proto-type unit operations from laboratory data. Prerequisites: C.E. 402 or approval of instructor.

605. Experimental Analysis in Environmental Engineering. (1-6). Credit 3. I

Theory and practice of analytical methods used in the environmental engineering field. Wet chemistry techniques for organic and nonorganic determinations: Warburg and Gilson respirometers; infra-red, ultra-violet, and visible light spectrophotometry; gas chromatography; polarographic techniques for pH and dissolved gases and continuous field monitoring techniques. Prerequisite: Graduate classification in engineering or approval of instructor.

606. Design of Waste Water Treatment Systems. (1-6). Credit 3. II

Application of the theories of unit operations and unit processes to design waste water treatment systems for domestic and industrial wastes. Prerequisites: C.E. 603, 604.

607. Environmental Analysis for Urban Areas. (3-0). Credit 3. I, II

Analysis of urban problems including air pollution and environmental engineering problems affecting urban and suburban areas; evaluation of administrative and financing problems, legal problems, government assistance programs and aspects affecting development of overall environmental engineering plan for a city.

608. Environmental Design for Urban Areas. (1-6). Credit 3. I, II

Design of environmental engineering projects related to urban problems including air pollution and environmental problems affecting urban and suburban areas. Prerequisite: C.E. 607.

609. Simulation of Water Resources Systems for Numerical Analysis. (3-0). Credit 3. II, S

Digital methods for simulating runoff from river basins. Numerical evaluation of stream quality variations, flow augmentation requirements, waste assimilation capacities and optimum waste loadings. Evaluation of velocity and salinity patterns in streams, impoundments, and estuaries. Prerequisites: Aero. 320; C.E. 603 or equivalent.

610. Industrial Wastes. (2-3). Credit 3. II

Theory of industrial processes which create industrial wastes. Effect of industrial wastes on treatment processes. Process recovery units to prevent pollution and effluent waste treatment practices. Prerequisites: C.E. 603, 605, or equivalent.

611. Design of Potable and Industrial Water Systems. (1-6). Credit 3. II, S

Application of theories of unit operations and unit processes to design systems for treatment of water for domestic and industrial uses. Prerequisites: C.E. 603, 604, or equivalent.

612. Transportation in City Planning. (2-2). Credit 3. I

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.

613. Urban Engineering. (3-0). Credit 3. II

Service course for nonengineers on influence and relative importance of engineering aspects of urban development; engineering factors important in consideration and utilities, land allocation, waste disposal, drainage, public health, and recreation. Prerequisite: Approval of Department Head.

614. Stabilization of Soil-Aggregate Systems. (2-0). Credit 2. I, S

Theory of mechanical and chemical stabilization of soils and soil-aggregate systems. Prerequisite: Chem. 316.

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. (3-0). Credit 3. 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.

623. Properties of Concrete. (3-0). Credit 3. I

Physical and chemical properties of aggregate, cement, and concrete. Selected topics including chemistry of cement, synthetic aggregate and concrete. Failure analysis; bond, creep, elasticity, and volume changes in concrete; admixes; special concretes. Prerequisite: Graduate classification or approval of instructor.

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. (3-0). Credit 3. I

Precipitation, stream gauging 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. (3-0). Credit 3. I

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. Prerequisite: C.E. 338 or approval of instructor.

629. Hydraulics of Open Channels. (3-0). Credit 3. I, S

Advanced problems in uniform and nonuniform flow in open channels, hydraulic jump, control section, backwater profiles. Prerequisite: C.E. 338 or approval of instructor.

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. S

Stresses and strains at a point, torsion of noncircular cross sections, beams with combined axial and lateral loads, built-up columns, lateral buckling of beams, torsional buckling of centrally loaded columns, bending of thin plates and shells. Prerequisites: Aero. 306 or C.E. 306; Math. 308.

634. 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.

635. Soil Engineering. (3-3). Credit 4. II

General course in soil engineering for students not primarily interested in soil mechanics but who desire to obtain additional training beyond general undergraduate level. Basic subjects of consolidation and shear strength are discussed with applications to typical design problems. Prerequisite: C.E. 365.

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.

637. Pipeline Construction. (2-0). Credit 2. II

Study of cross-country pipeline construction. Although emphasis will be on construction methods and equipment, general information will be presented on design, automation, corrosion control, and shore installations for marine terminals. Prerequisite: C.E. 478 or approval of instructor.

638. Building Construction. (2-0). Credit 2. I

Take-off of quantities, compilation of estimate, pricing and checking of estimate, building construction equipment and methods. Prerequisites: C.E. 473, 478, or approval of instructor.

639. Highway Construction. (2-0). Credit 2. II

Methods of locating and procuring highway aggregates; design and operation of crushing, hot-asphalt, concrete, and grading equipment. Highway estimating and construction methods. Prerequisites: C.E. 365, 473, 478; Geol. 441, or approval of instructor.

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.

641. Construction Engineering Systems. (3-2). Credit 4. S

Fundamentals of systems engineering theory and methodology; application of systems theory to construction situations and problems; case history studies of complex construction problems and group action. Design and reporting of construction system projects. Prerequisites: C.E. 348, 404, 473, 478; or approval of instructor.

642. Construction Engineering Management. (3-0). Credit 3. I

Applied management aspects of construction. Construction company organization and management, project planning, critical path techniques, and computer methods. Prerequisites: C.E. 348, 404, 473, 478; or approval of instructor.

643. Plastic Analysis and Design in Steel. (3-0). 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.

644. Rock Mechanics. (2-0). Credit 2. I

Study of engineering behavior of rocks, stability of slopes, tunnels and protective structures, wave propagation in rock, and excavation methods. Prerequisite: Graduate classification in engineering or approval of instructor.

645. Scientific Methods in Urban Engineering and Management. (2-3). Credit 3. II
Mathematical models for managerial decision-making in the urban situation, emphasis on subjects such as mathematical programming and simulation and their application to a wide variety of organizational settings, techniques for solving optimization problems encountered in public works organizations. Prerequisites: Aero. 320 or equivalent; Math. 308.

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 explorations, 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.

652. Soil Dynamics. (3-0). Credit 3. II
Study of behavior of soils during high rates of loading. Introduction to wave propagation through soils, cratering by explosives, penetration of earth by projectiles, dynamic loads on foundations, and slope stability during earthquakes. Prerequisite: Graduate classification in engineering or approval of instructor.

653. Bituminous Materials. (2-3). Credit 3. I
Production, specifications, and tests of bituminous materials; design and evaluation of asphaltic concrete construction maintenance; inspection control of street, parking, and highway paving surfaces. Prerequisite: Graduate classification in engineering.

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 stress 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. (3-0). Credit 3. 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. Folded Plates and Shells. (3-0). Credit 3. 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.

660. Photogrammetry. (3-0). Credit 3. I
Photographic processes related to measuring, interior and exterior orientation of photographs, analysis of geometry and measurements relating photographic image and object, applications of photogrammetry to science and engineering. Prerequisites: Math. 121; graduate classification; approval of instructor.

661. Photo Interpretation. (3-0). Credit 3. II
Photographic processes related to interpretation; principles, methods, and techniques of photo interpretation; applications in agriculture, forestry, soils, engineering materials, geology, geomorphology, water resources, transportation, and urban planning. Prerequisites: Graduate classification; approval of instructor.

662. Engineering Applications of Map Projections. (3-0). Credit 3. I
Types and characteristics of maps and map projections; mathematical considerations of selected map projections, with emphasis on the Lambert conformal conic, Mercator, transverse Mercator, and polyconic projections; map production. Prerequisites: Math. 121; graduate classification; approval of instructor.

663. Geodetic Surveys. (3-0). Credit 3. II
Triangulation, trilateration, adjustment computations, first-order leveling, electronic distance measuring, field astronomy, size and shape of the earth. Prerequisites: Math. 121; graduate classification; approval of instructor.

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 multipurpose 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
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. 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.

673. Urban Transportation. (2-2). Credit 3. II
Planning urban transportation facilities; special emphasis on trip generation, trip distribution and traffic assignment on digital computers; transportation system planning and evaluation; consideration of all modes of transportation. Prerequisite: C.E. 612.

674. Flow Through Porous Media. (3-0). Credit 3. II
Theory of flow; applications to ground water movement: flow through semipervious strata; leaky aquifiers; hydrogeologic boundaries; natural and artificial recharge.

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

676. Ocean Engineering. (3-0). Credit 3. I
Engineering aspects of hurricane surge; stratified flow; properties of ocean water; deep-sea structures; deep-sea dredging; underwater habitat. Prerequisite: Approval of instructor.

677. Coastal Engineering II. (3-0). Credit 3. II
Applications of wave theories to engineering problems; tidal dynamics; sediment transportation along coast and in estuaries; dredging; coastal and estuarine models. Prerequisite: C.E. 675 or approval of instructor.

678. Hydromechanics. (3-0). Credit 3. II
Principles of ideal and real fluid flow; standard patterns of flow; conformal transformations; air entrainment; wave motion; flow through non-prismatic channels; rapidly varied unsteady flow. Prerequisite: C.E. 462 or equivalent.

679. Theory of Fluid Mechanics Models. (2-0). Credit 2. I, S
Dimensional analysis; model laws; mathematical techniques; applications to fluid mechanics and hydraulic models; fixed-bed; movable-bed, geometric, and distorted models. Prerequisite: Approval of instructor.

680. Civil Engineering Computer Systems. (2-3). Credit 3. II
Evaluation of role of computer hardware and software systems in civil engineering problem solving environment. Use of numerical analysis techniques and existing problem oriented computer languages, including the ICES System to solve civil engineering problems. Development of problem oriented languages for civil engineering analysis and design. Prerequisites: Aero. 320, I.En. 458, or Math. 417.

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.

(The Civil Engineering courses in applied mechanics such as elasticity, plasticity, continuum mechanics, etc., are listed under the section entitled Structural Mechanics.)

DEPARTMENT OF ECONOMICS

W. G. ADKINS, E. V. BOWDEN, A. F. CHALK, R. B. EKELUND*, C. E. FERGUSON, R. J. FREUND, E. FURUBOTN, W. P. GRAMM*, M. L. GREENHUT (Head), H. O. HARTLEY, R. R. HOCKING, T. E. HOLLAND, W. H. HUTT, I. O. LINGER, S. PEJOVICH, K. P. RAHBANY, J. N. K. RAO, T. SAVING, H. SIEBERT, R. G. THOMPSON, C. V. WOOTAN

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

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.

601. History of Economic Thought. (3-0). Credit 3. 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. (3-0). Credit 3. II
Primary emphasis given to the emergence of marginal utility theory and to the analytical system of Alfred Marshall. Prerequisite: Approval of Department Head.

*Graduate Advisor

606. Economics of Labor. (3-0). Credit 3. 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. (3-0). Credit 3. II
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. (3-0). Credit 3. I
Development of modern static national income analysis from general equilibrium system. Roles of fiscal and monetary policy in promoting economic stability are examined. Prerequisites: Econ. 323, 410.

612. Fiscal Theory and Policy. (3-0). Credit 3. II
Particular attention drawn to analysis of consumption, investment and government spending, and the influence on the above taxes. Although emphasis is on the total economy, attention is given the differential impact on the subsectors of the economy of changes in governmental expenditures and taxes. Prerequisite: Econ. 410.

613. International Economic Policies. (3-0). Credit 3. I
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 survey of development of competitive economic systems. Analysis of market system with particular reference to behavior of both individual and firm. Study of fluctuations in level of economic activity and macro analytical tools required for understanding causes of such fluctuations. Prerequisite: Graduate classification and 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 the following problem areas: public finance, international trade and finance, capital markets, labor markets, and social control of business. Prerequisite: Econ. 615.

619. Theory of the Firm in Economic Space. (3-0). Credit 3. I
Examination of impacts of distance on classical economic markets. Prerequisite: Econ. 323.

621. Regional Science I. (3-0). Credit 3. I
A survey of regional analysis including the construction of the economic landscape; agricultural, industrial and residential location analysis; regional delineation; factor mobility and commodity movements; interregional input-output models; and regional economic growth. Prerequisite: Ecmt. 660.

622. Regional Science II. (3-0). Credit 3. II
Additional study of regional analysis. Areas of study include regional income accounting, balance of payments, gravity models, industrial complex analysis, cost-benefit analysis, interregional programming, regional economic planning, interregional trade, and economic base analysis. Prerequisite: Econ. 621.

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

624. Regional Income Accounting. (3-0). Credit 3. I
Different types of regional accounting systems and their basic problems: income and product accounting, input-output accounting, flow of funds analysis, balance of payments, and the regional balance sheet. Regional and interregional input-output accounting, flow of funds analysis, and balance of payments, the regional balance sheet. Regional and interregional input-output analysis and application to policy problems. Prerequisites: Econ. 601 or equivalent.

625. Regional Resource Management. (3-0). Credit 3. II
Goals relevant for resource management. Conditions of optimal allocation of resources in a spatial setting. Necessity of regional resource management in a market economy. Analysis of resource base and its development. Activity analysis. Decision models and criteria for regional resource management. Problem areas. Role of planning. Prerequisite: Econ. 621, Ecmt. 660.

626. Regional Economic Planning. (3-0). Credit 3. II
Theory and policy of regional planning, beginning with consideration of general theory of regional economics, proceeding to analysis of investment planning, manpower planning, and government planning; ending with selected case studies. Prerequisites: Econ. 621 or equivalent or approval of Department Head.

627. Transport Systems Economics. (3-0). Credit 3. I
Study of economic structure of primary transport systems with emphasis on impact of transportation on regional development. Examines alternative methodologies for evaluating public policy with respect to investment in and management of transport sector. Prerequisite: Econ. 330 or 323; or approval of instructor.

628. Urban Economics. (3-0). Credit 3. II
Economic analysis of structure, functions, and problems of urban areas with particular emphasis on theory of urban, industrial, and residential location; land value surfaces; urban economic growth and stability; and such problem areas as urban poverty, renewal, traffic congestion, pollution, and urban public economy. Prerequisite: Approval of Department Head.

629. Price Theory. (3-0). Credit 3. I
Rigorous and analytical study, using mathematics and econometrics, of determination of prices and quantities of products, composition of national product, and allocation of resources. Students obtain detailed and comprehensive knowledge of literature so that they may act as teachers, researchers, and consultants. Prerequisite: Econ. 323.

630. Distribution Theory. (3-0). Credit 3. II
Rigorous and analytical study, using mathematics and econometrics, of determination of incomes of factors of production and composition of national income. Students obtain detailed and comprehensive knowledge of the literature. Study made also of general economic equilibrium and welfare economics. Prerequisite: Econ. 323.

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

632. Theories of Dynamic Economic Equilibria. (3-0). Credit 3. II
Study of basic concepts of intertemporal economic behavior. Consideration given to such topics as intertemporal utility maximization, intertemporal profit maximization, dynamic consumer demand theory, and theory of investment. Prerequisites: Econ. 629, Ecmt. 660.

634. Economic Fluctuations. (3-0). Credit 3. II
Study of major theories of and factors affecting general economic relationships. Primary emphasis on empirical studies, including special analysis of economic fluctuations. Impact of fluctuations on inventories, capital spending, money stocks, governmental revenues and expenditures, and economic growth. Prerequisite: Econ. 611.

635. Monetary Theory and Policy. (3-0). Credit 3. I
Traditional as well as modern theories of money. Major emphasis on general equilibrium systems and role of money in determination of prices, interest rates, income, and employment. Factors influencing demand for money as well as its supply. Prerequisites: Econ. 311, 410.

636. Macroeconomics. (3-0). Credit 3. S
Attention given to selected problems arising from Keynesian and post-Keynesian income and employment theory. Theoretical and conceptual aspects of the analysis are stressed. Prerequisite: Econ. 611.

638. Capital and Interest Theory. (3-0). Credit 3. II

Investigation of pure theory of capital and interest, application of theory to problems of macroeconomic statics (i.e., employment, price level, and output of goods and services), monetary and fiscal policy, economic growth and development, and price theory. Mathematical economics and econometrics used to present and test theory. Prerequisites: Econ. 607, 611, 629, 630; or approval of Department Head.

639. Economic Analysis of Regulated Enterprise. (3-0). Credit 3. I

Explores scope of governmental regulation in economy of United States, its evolution and development. Particular emphasis given to application of tools of economic analysis to problems posed by regulated enterprise. Prerequisite: Econ. 424 or approval of Department Head.

640. Economics of Labor. (3-0). Credit 3. II

Critical evaluation of existing wage theories; application of these theories to employer wage and employment decisions; analysis of effect of changes in wages, productivity, and prices on level of economic activity; review of current methods for forecasting supply of and demand for labor; development of manpower policy to achieve full utilization of human resources. Prerequisite: Econ. 318.

641. Comparative Economic History. (3-0). Credit 3. I

Application of statistical inference and computer analysis to selected problems in comparative economic history. Prerequisites: Econ. 319, 320; or approval of Department Head.

642. Comparative Economic Systems. (3-0). Credit 3. II

Philosophical foundations of capitalism and socialism. Economic theory of different systems; selected case studies. Prerequisites: Econ. 323, 324, 410.

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.

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

ECONOMETRICS

Courses in econometrics (including mathematical economics) are administered by the Department of Economics and jointly sponsored by the Institute of Statistics.

660. Mathematical Economics. (3-0). Credit 3. I

Review of use of selected types of mathematical tools in economic theory. Prerequisites: Econ. 323; Math. 121 or 209.

661. Mathematical Economics. (3-0). Credit 3. II

Examination of fundamental properties of vectors and matrices, difference and differential equations, and their use in economic theory. Prerequisite: Ecmt. 660 or equivalent.

663. Econometrics. (3-0). Credit 3. I

Use of statistics in economic theory as device for testing hypotheses, formulation concepts, and economic forecasting. Prerequisites: Ecmt. 660; Stat. 608.

664. Intermediate Econometric Theory. (3-0). Credit 3. II

Principal statistical techniques in the analysis of economic phenomena including classical linear regression, extensions of linear regressions, linear regression with stochastic regressors, and estimation of simultaneous equation systems. Prerequisites: Ecmt. 663, Stat. 412, 611.

665. Econometric Theory and Programming. (3-0). Credit 3. II

A study of stochastic and non-stochastic model formulation, identification, methods of solution, and interpretation of results; applications of theory and methods to significant economic problems. Prerequisites: Ecmt. 664; Math. 652; or approval of Department Head.

666. Model Building in Econometrics. (3-0). Credit 3. I

Further intensive study of non-stochastic and stochastic model formulation. Identification, methods of solution and/or estimation, economic interpretations, and applications of theory and methods to economic problems. Tools of mathematical and variational programming and statistics used to present received theory and to solve newly formulated problems. Prerequisites: Ecmt. 664, 665.

667. Case Studies in Econometrics. (3-0). Credit 3. II

Primary emphasis given to extensions of dynamic theory and applications of theory and methods to significant dynamic economic problems. Prerequisites: Ecmt. 664, 665.

668. Production Functions. (3-0). Credit 3. II

Study of leading production models employed in economic theory. Consideration given to conceptual basis of production function and to particular expressions of the function as found in neoclassical, programming, stock-flow, learning, and dynamic production models. Special emphasis on problems of reconciling empircal production functions with models of pure theory. Prerequisites: Econ. 607, 611, 629; Ecmt. 664.

669. Microeconomics and Activity Analysis. (3-0). Credit 3. II

Evaluation of effectiveness of free enterprise system via decision theory, linear and nonlinear programming, and matrix algebra. Prerequisites: Econ. 619; Math. 121 or 209.

DEPARTMENT OF EDUCATION

D. G. BARKER*, J. C. CALHOUN, W. H. GRAVES, JR., R. L. HARRELL, P. R. HENSARLING, F. W. R. HUBERT (Acting Head), G. R. JOHNSON, E. JONES, S. A. KERLEY, C. E. McCANDLESS, T. J. MOFFETT, L. S. RICHARDSON, A. J. ROACH, T. M. STINNETT

Graduate courses in education 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, 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.

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

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

602. Educational Psychology. (3-0). Credit 3. II, S

Organization of knowledge to facilitate learning and relationship to curriculum or program construction. Psychological phenomena of the cognitive, effective, and psychomotor domains significant for complex educational and learning behavior subjected to symbolic analysis. Prerequisites: Educ. 439, 636; Psy. 634 or approval of Department Head.

604. Foundations of Corrective Reading Instruction. (3-0). Credit 3. I, S

Study of principles, procedures, and materials for teachers' use in classroom corrective reading programs; appraisal, diagnosis, and applied procedures for individual remediation in the small group setting. Prerequisites: Educ. 301, 351; Psy. 307.

605. Creative Application of Technology to Education. (2-3). Credit 3. I, II, S

Identification and solution of learning problems utilizing a learning systems approach; creative application of educational technology (programmed instruction, single-concept films, television, electronic carrels, etc.)

606. Administration of Elementary and Secondary Schools. (3-0). Credit 3. I, S

Study of the organization and administration of elementary and secondary schools. Administration and supervision of curriculum and instruction. Prerequisite: 12 hours of education or approval of Department Head.

*Graduate Advisor

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

Designed for teachers, supervisors, and administrators. Philosophy, organization, and administration of supervision of both elementary and secondary schools. Prerequisite: Educ. 639 or approval of Department Head.

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

Study of school funds on local, state, and federal level; budgeting, data processing; other systems of accounting, and reporting. Supply management as related to school efficiency. Maintenance of buildings, grounds, and equipment. Prerequisites: Educ. 606, 615 or approval of Department Head.

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

Constitutional provisions, statutory laws, court decisions, and regulations governing public schools, with special reference to Texas and federal relationships. Prerequisite: Educ. 606 or approval of Department Head.

613. The School Plant. (3-0). Credit 3. I, 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. Prerequisites: Educ. 606, 615 or approval of Department Head.

615. The School Superintendency. (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. Prerequisites: Educ. 606, 616, or approval of Department Head.

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

Analysis of personnel organization and administration in school systems. Relationship of position. Ethics, welfare, security, and professional improvement. Prerequisite: Twelve hours of education courses or approval of Department Head.

618. Teaching Elementary School Mathematics. (3-0). Credit 3. I, S

New approaches to teaching numeration are presented, emphasizing importance of place value and decimal system with consideration of systems of natural numbers. Prerequisite: Educ. 352 or approval of Department Head.

619. Teaching Basic Concepts of Mathematics. (3-0). Credit 3. II, S

Following review of number systems of elementary school mathematics, teaching use of number for quantifying geometric configuration is considered. Study of measurement with emphasis on nature of approximation precedes treatment of relation and function in cartesian frame of reference. Prerequisite: Educ. 618 or approval of Department Head.

620. Teaching Secondary School Algebra. (3-0). Credit 3. I, S

Techniques in teaching properties of real numbers and of order relations, factors, radicals, and polynomial expression. Emphasis on techniques of presenting concepts at various levels of complexity. Prerequisites: Six hours of calculus or certification in secondary school mathematics.

621. Teaching Secondary School Geometry. (3-0). Credit 3. II, S

Techniques in teaching point-set geometry are presented, including coordinates on a line, congruence, parallelism, similarity, and coordinates in planes and in space. Emphasis on techniques of presenting concepts at various levels of complexity. Prerequisites: Six hours of calculus or certification in secondary school mathematics.

629. Practicum in Counseling and Guidance. (2-3). Credit 3. I, II, S

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

631. Techniques of Counseling. (3-0). Credit 3. I, II, 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; Psy. 623, 634 or registration therein.

632. **Educational and Occupational Information. (3-0). Credit 3. I, 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. I, II, S**
Methods and practices in group guidance. Homeroom, classroom, and school clubs as opportunities for guidance. Prerequisite: Educ. 427 or 635.

635. **Administration of Special 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 program of pupil personnel services.

636. **Techniques of Research. (3-0). Credit 3. I, II, S**
Fundamental concepts and tools of research applied to psychological and educational problems. Rationale of research, analysis of problems, library skills, sampling, appraisal instruments, statistical description and inference, writing the research report, and representative research designs.

637. **Advanced Elementary School Methods. (3-0). Credit 3. I, II, S**
Study of teaching methods, devices, and techniques of learning-teaching situations on elementary school level. Prerequisites: 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: Twelve hours of Education or approval of Department Head.

639. **Processes in Educational Leadership. (3-0). Credit 3. I, II, 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. Techniques of curriculum change and innovation.

640. **School-Community Relations. (3-0). Credit 3. II, S**
Systems of interpretation of schools to community publics. Promotion of effective school-community relations through media of communication.

642. **Clinic Teaching in Reading. (1-6). Credit 3. II, S**
Recognition, diagnosis, remediation, and corrective procedures of reading-study problems; demonstration and laboratory analysis of physiological and psychological factors related to reading disabilities. Prerequisites: Educ. 351; Psy. 307, 624, or 634; or equivalent approved by Department Head.

643. **Current Issues in Elementary Education. (3-0). Credit 3. I, S**
Current educational issues affecting curriculum and organization of elementary school. Organizing instruction to meet individual differences, including gifted and disadvantaged student. Prerequisites: Twelve hours in advanced education or equivalent.

644. **Curriculum Development. (3-0). Credit 3. II, S**
Analysis of curriculum development. Bases of curriculum design. Study of problems of balance, scope, organization, sequence, selection, and articulation. Prerequisites: Educ. 426, 444, 636, 638; Psy. 623; or approval of Department Head.

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.

649. Reading Instruction in High School and College. (3-0). Credit 3. I, S

Basic principles of reading instruction; nature and scope of total reading program; methods, materials, and organization of the developmental, corrective, and speed reading programs in high school and college. Prerequisites: Educ. 301; teaching experience; or equivalent.

650. Psychology of Reading. (3-0). Credit 3. II, S

Psychological, linguistic, and physical factors related to reading performance; implications for content and teaching methods; appraisal of current materials and psychology-related reading for teachers, supervisors, and reading specialists. Prerequisites: Educ. 301; teaching experience; or equivalent.

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.

654. Teacher Education and Professional Standards. (3-0). Credit 3. II, S

Relationships between teacher education and professional standards and teaching as a profession. Topic consists of cluster of broad problems which teachers in public schools encounter repeatedly. Includes criteria of profession, theory professional standards, standards of practice, and orientation to current guidelines and legal sanctions.

655. Administration of Higher Education. (3-0). Credit 3. II, S

Survey of management principles in higher education. Functions in delegation, direction, operation, evaluation, and financial management applied to college and university administration. Prerequisite: Educ. 601 recommended but not required.

656. Practicum in Teaching. (2-3). Credit 3. I, II, S

Theoretical and practical study of teaching methods in elementary or secondary schools for graduate students with a minimum of prior training in education; production and teaching of substantive units under supervision in public schools. Prerequisite: Approval of Department Head.

657. Internship for the Teacher. (0-9). Credit 3. I, II, S

Designed to give prospective teachers on-the-job training under guidance of successful, experienced master teachers and under oversight of supervisory personnel from the University. Prerequisite: Educ. 656.

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

Problems pertinent to superintendent, principal, counselor, supervisor, and teacher. Recent developments and research in different areas. Prerequisites: Twelve 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.

DEPARTMENT OF ELECTRICAL ENGINEERING

S. L. CANTERBURY, R. K. CAVIN, J. S. DENISON, A. J. DRUCE, J. P. GERMAN*, A. J. GIAROLA, C. R. HADEN, G. D. HALLMARK*, L. M. HAUPT, JR., W. B. JONES, JR. (Head), J. S. LINDER*, A. D. PATTON, M. G. REKOFF, JR., V. T. RHYNE, S. RITER, J. W. ROUSE

The Department of Electrical Engineering offers programs leading to the Master's and Ph.D. degrees. These programs are designed to prepare students for careers in any of several fields of specialization including semiconductors, microelectronics, network theory, systems engineering, automatic control systems, electromagnetic fields, digital systems, communications, power systems and electronic computers. The facilities available to graduate students include well-equipped laboratories for work in all of these areas. Interdisciplinary programs can also be designed to meet special needs or interests in activation analysis, biomedical engineering, computer sciences, systems engineering and other areas.

601. Linear Network Analysis. (3-0). Credit 3. I, S
Fourier and Laplace transform methods of analysis applied to linear networks having periodic, transient, or random excitation.

602. Nonlinear Network Analysis. (3-0). Credit 3. 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, S
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. Prerequisite: E.E. 605.

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, 448, 457.

628. Linear System Theory. (3-0). Credit 3. II
Analysis of general dynamic systems using vector space concepts.

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. Prerequisite: E.E. 605 or approval of instructor.

633. Optimum and Adaptive Control Systems. (3-0). Credit 3. I
Study of analytic techniques used to design optimum control systems and of methods of mechanizing systems which adapt to their environment. Prerequisite: E.E. 605.

636. Network Synthesis. (3-0). Credit 3. 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.

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

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, 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. 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.

643. Electric Power System Reliability. (3-0). Credit 3. I
Design and application of mathematical models for estimating various measures of reliability in electric power systems. Prerequisite: E.E. 460 or approval of instructor.

644. 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. Prerequisite: E.E. 605.

645. Applications of Linear Graph Theory. (3-0). Credit 3. I
Engineering applications of linear graph theory to topics in which network topology is of importance, including network analysis and synthesis, switching circuits, signal flow graphs, and communication nets. Prerequisite: Approval of instructor.

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.

647. Information Theory and Coding. (3-0). Credit 3. II
Theorems of Shannon applied to transmission and coding of information. Markov processes, instantaneous codes; transmission over noiseless channels; error correcting codes and noisy channels without memory. Prerequisites: E.E. 456, 646 or equivalent background in probability theory.

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. Prerequisite: E.E. 451.

649. Plasma Waves. (3-0). Credit 3. I
Plasma equations in a cold, collisionless plasma. Wave motion with and without magnetic field. Different waves propagating in a plasma. Wave propagation behavior in different temperature regions. Wave guidance. Prerequisites: E.E. 451 or equivalent; Math. 407.

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. Prerequisites: E.E. 448, 457.

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

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

673. Fundamentals of Microelectronics. (3-0). Credit 3. I

Fundamental study of macroelectronic systems or integrated circuits, fabrication technologies, monolithic integrated circuits, hybrid integrated circuits, (thin films, thick films, monolithic chips). Prerequisite: E.E. 671 or equivalent.

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.

ENGINEERING

601. Engineering Concepts for Secondary School Teachers I. (1-3). Credit 2. S

Materials and solid mechanics; physical structure of solid materials; introduction to solid mechanics; dynamic effects on materials; creep; fatigue.

602. Engineering Concepts for Secondary School Teachers II. (1-3). Credit 2. S

System dynamics: an introduction to the concepts and methods of analyzing linear, continuous lumped parameter control and communication systems. Mathematical methods, modeling, stability, performance measures, graphical representations, and laboratory experiments.

603. Engineering Concepts for Secondary School Teachers III. (1-3). Credit 2. S

Energy: storage, conversion, and distribution. Conversion methods of natural energy resources into useful forms. Basic laws governing efficiency of conversion, characteristics of machinery used, measurement of performance. Development and use of laboratory equipment to demonstrate principles. Prerequisites: Algebra, trigonometry, chemistry, physics. Enrollment in Engr. 601, 602.

DEPARTMENT OF ENGINEERING GRAPHICS

S. M. CLELAND, A. E. CRONK (Head), J. H. EARLE*, J. G. McGUIRE

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

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

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

Pictorial systems — axonometrics, obliques, and perspectives. Shade and shadow theory. Study of industrial pictorial applications. Research and development of visual aids. Introduction to technical illustration. Prerequisites: E.G. 106, 127 or equivalent.

603. Advanced Machine Drawing. (1-6). Credit 3 II, S

Study of current industrial practices. Graphical applications to design, analysis, and communication. Working drawing practices. Machine components, jigs, fixtures, cams, linkages.

605†. Spherical Projections. (2-0). Credit 2. II, S

Graphical cartography and topographical representations. Application of spherical drawings to global projections and spherical structures. Graphical applications to mapping problems.

606*. Sterographic and Clinographic Projections. (2-0). Credit 2. I, S

Research and experimentation with sterographic (3-dimensional) photography and drawing as applied to industry and teaching. Development of audio-visual presentations and teaching aids. Graphical investigation of perspectives and related systems. Prerequisite: E.G. 106 or equivalent.

---

*Graduate Advisor

†Primarily for graduate students interested in education. Not available for major or minor work toward an engineering degree, except by permission of the Dean of the Graduate College.

607†. Descriptive Geometry for Teachers. (4-0). Credit 4. I, S

Research of early and current applications of descriptive geometry to technical problems. Research and study of new 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. II, S

Introduction to commercial methods and materials of technical illustration. Preparation of illustrations for reproduction. Report illustration, illustrations for publication. Time saving techniques and methods. Various media including airbrush renderings.

685†. Problems. Credit 1 to 4 each semester. 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, S. L. ARCHER, R. H. BALLINGER, R. W. BARZAK, G. H. CANNON, K. E. ELMQUIST, J. P. GUINN, JR., L. F. HAUER, H. E. HIERTH*, P. C. HUNTER, JR., H. P. KROITOR, C. D. LAVERTY, L. J. MARTIN (Head), E. E. STOKES, JR.

The graduate program in English offers courses leading to the degree of Master of Arts and Doctor of Philosophy.

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 thesis may be written on subjects in English literature, American literature, or the English language. 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.

A minimum of sixty-four credit hours beyond the M.A. degree in English, twenty-four of these hours being allowed for work on the dissertation, or ninety-four credit hours beyond the baccalaureate degree, twenty-four of these hours being allowed for work on the dissertation, is required for the Ph.D. degree in English. The dissertation may be written on subjects in English literature, American literature, or the English language.

To be admitted to these programs, students should have a baccalaureate degree. Students with degrees in fields other than English may be admitted provisionally and required to make up deficiencies. A candidate for the degree of Doctor of Philosophy will normally be expected to have a Master of Arts degree in English.

602. Sociolinguistics. (3-0). Credit 3. I

Study of interrelationships between sociology and linguistics, especially the particular qualities of a given group's speech that help lead to social and economic barriers against that group; the role of language as chief vehicle of communication in a given sociological situation. Prerequisite: Engl. 609 or approval of instructor.

603. Bibliography and Literary Research. (3-0). Credit 3. I, S

Introduction to basic techniques of research and scholarly procedure in English. Research reports.

605. Old English. (3-0). Credit 3. I, S

Introduction to Old English literature and language (phonology, morphology, syntax, lexicon, and dialectology) through extensive reading of the literature of the period. Research papers.

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

Literary and linguistic study of **Beowulf.** Prerequisites: Engl. 605, 610; or aproval of instructor.

608. General Linguistics. (3-0). Credit 3. I

Study of nature and structure of language; work in phonetics and phonemics, morphology, syntax, lexicography, and generative-transformational models. Prerequisites: Engl. 409 or approval of instructor.

---

*Graduate Advisor

†Primarily for graduate students interested in education. Not available for major or minor work toward an engineering degree, except by permission of the Dean of the Graduate College.

609. Middle English. (3-0). Credit 3. II, S
Introduction to Middle English literature and language (phonology, morphology, syntax, lexicon, and dialectology) through extensive reading of the literature of the period. Research papers.

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

612. Chaucer. (3-0). Credit 3. II, S
A literary and linguistic study of Chaucer's works. Bibliographical reports and research papers.

613. Studies in the Renaissance. (3-0). Credit 3. I
Drama of the English Renaissance, exclusive of Shakespeare. Research papers. Prerequisite: Graduate classification or approval of Department Head.

614. Studies in the Renaissance: Nondramatic Literature. (3-0). Credit 3. II, S
Major writers of nondramatic 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.

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: The Age of Pope. (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.

619. Studies in Shakespeare. (3-0). Credit 3. I, S
Readings in Shakespeare's plays with attention to requirements and needs of individual students; sources of plays; textual studies; parallel readings in Shakespearean criticism from eighteenth century to present. Research papers. Prerequisite: A course in Shakespeare.

621. Milton and His Contemporaries. (3-0). Credit 3. I, S
Poetry and prose of John Milton, with emphasis on **Paradise Lost.** Consideration of Milton's predecessors and contemporaries as they contribute to understanding the milieu of Milton. Research paper.

625. Teaching of English as a Foreign Language. (3-0). Credit 3. II
Study of relevant linguistics principles and audio-lingual methodology in terms of the teaching of (and writing the needed teaching materials for) English to non-native speakers of English; principles within the organization and administration of language programs in the U.S. and abroad. Prerequisites: Engl. 425 or equivalent, 662.

631. Studies in the Nineteenth Century: Romantic Poetry and Prose. (3-0). Credit 3. I, S
Intellectual influences — idealism, transcendentalism, sentimentalism, individualism, primitivism, and perfectibility — as they affected Burns, Blake, Wordsworth, Coleridge, Byron, Shelley, Keats, Lamb, Hazlitt, and De Quincy. Research papers.

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.

635. Studies in Victorian Poetry and Prose. (3-0). Credit 3. II, S
Studies in major Victorian writers of poetry and nonfiction prose, with concentration on two or three authors each time course is offered. Representative authors: Tennyson, Browning, Rossetti, Morris, Swinburne, Arnold, Carlyle, Ruskin, Mill, Newman, Pater, Shaw. Research papers.

641. Studies in the English Novel. (3-0). Credit 3. II, S
Study of major English novelists from 1740 to twentieth century. Analysis of eight to ten novels — style, characterization, plot, atmosphere, and social commentary — against their intellectual, historical, and social backgrounds. Research paper.

647. Studies in Modern British Drama. (3-0). Credit 3. II, S
Studies in dramatic literature of British Isles from 1880's to present, with some consideration of influence from the Continent. Representative dramatists: Wilde, Shaw, Pinero, Barrie, Galsworthy, Synge, O'Casey, Eliot, Fry, Osborne. Research papers.

649. Studies in the Twentieth Century: British Literature. (3-0). Credit 3. 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.

661. Analysis of Composition. (3-0). Credit 3. I, II, S
Principles of organization — sentence, paragraph, development of paper; rhetorical analysis of expository writing; diction; writing and assigning compositions; teaching techniques.

662. Analysis of the English Language. (3-0). Credit 3. I, II, S
Investigation of the phonological, morphological, syntactic, and lexical components of the English language; emphasis on transformational theory as well as traditional and structural grammar.

663. Analysis of Literature. (3-0). Credit 3. I, II, S
Characteristics of literature — meaning, imagery and symbolism, point of view, structure. Types of literature — poetry, plays, novel, short story. Literary criticism — principles of application.

666. Dialectology. (3-0). Credit 3. I
Study of the methods and principles of linguistic dialectology, including close work with published fascicles of the Linguistic Atlas of the U.S. and Canada and other data, as modified by dialectal implications from transformational theory. Prerequisites: Engl. 466, 609 and 662; or approval of instructor.

667. Linguistics and Literature. (3-0). Credit 3. II
Study of linguistic methods and principles applicable to understanding of literature, with a view to development of student's skills in making linguistic analyses of various kinds of literature. Prerequisites: Engl. 662 and 666; or approval of instructor.

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

673. Studies in American Literature: The Beginnings to 1820. (3-0). Credit 3. I, S

Colonial, Revolutionary, and Post-Revolutionary literature and the backgrounds; emphasis on various forms of early literature and individual writers. Research papers.

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: The Gilded Age. (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.

677. Studies in American Poetry. (3-0). Credit 3. I, S

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

683. Theory and Practice of Literary Criticism. (3-0). Credit 3. II, S

Analysis of more important theories of literary criticism for students of English and American literature with attention to functional emphasis in critical practice. Research papers.

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

Readings to supplement the student's knowledge of English or American literature or of the English language in areas not studied in other courses. Research papers. Prerequisites: Graduate classification; approval of Department Head.

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

Research for thesis. Prerequisites: Graduate classification; approval of Department Head.

DEPARTMENT OF ENTOMOLOGY

See also ANIMAL PARASITOLOGY

P. L. ADKISSON* (Head), D. L. BULL, H. R. BURKE, H. W. DOROUGH, O. H. GRAHAM, R. L. HANNA*, L. L. KEELEY, M. J. LUKEFAHR, M. A. PRICE, N. M. RANDOLPH, R. L. RIDGWAY, D. P. SANDERS, J. C. SCHAFFNER, J. P. VITE'

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 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.

---

*Graduate Advisor

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

Physiological processes of insects with emphasis on metabolism, nutrition, neuro-endocrinology, nerve action, cell structure, respiration, circulation, excretion and flight. Functional integration and regulatory processes of total organism are stressed. Prerequisite: Ento. 306 or equivalent.

617, 618. Medical and Veterinary 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

Signs, symptoms, treatments, chemistry, mode of action and biological fate of organic and inorganic insecticides. Insecticide selectivity, insecticide residues, insect resistance, use hazards and safety precautions are also considered. Prerequisite: Ento. 615.

620. Intermediary Metabolism and Endocrine Physiology of Insects. (2-6). Credit 4. II (Offered in 1969-70 and alternate years thereafter)

Current work in features of metabolism unique to insects. Emphasis placed on regulatory processes, especially role of hormones. Laboratory stresses theory and practice of modern biochemical techniques utilizing recent developments in separation, purification, and analysis of metabolic components. Prerequisites: Bi.Ch. 410 or equivalent; Ento. 615; or approval of instructor.

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.

DEPARTMENT OF FINANCE

J. E. PEARSON (Acting Head), M. L. PIOTROWSKI, R. M. STEVENSON*

Graduate courses in finance provide the financial and capital formation concepts for students with a professional concentration in accounting, organization and administration, computer science, or statistics. Students not in M.B.A. programs may take courses in finance if they meet the prerequisites.

The Department of Finance does not offer a separate graduate program leading to the M.B.A. degree.

630. Problems of Corporation Finance. (3-0). Credit 3. II, S

Financial problems of corporation analyzed, including current financing, refunding operations, dividend policies, and corporate reorganization. Prerequisite: Graduate classification; approval of graduate advisor.

652. Financial Management. (3-0). Credit 3. II

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

*Graduate Advisor for all M.B.A. candidates.

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

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.

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 appropriate departmental representative.

GENETICS

I. M. ATKINS, E. C. BASHAW, L. S. BIRD, H. T. BLACKHURST, H. H. BOWEN, R. D. BRIGHAM, M. S. BROWN, T. C. CARTWRIGHT, J. W. COLLIER, R. C. FANGUY, H. A. FITZHUGH, JR., P. A. FRYXELL, C. E. GATES, E. C. GILMORE, F. W. GOULD, G. E. HART, E. C. HOLT, N. M. KIEFFER, M. L. KINMAN, R. J. KOHEL, W. F. KRUEGER, H. O. KUNKEL, T. E. McAFEE, G. A. NILES, B. A. PERRY, K. B. PORTER, J. H. QUISENBERRY, T. R. RICHMOND, I. V. SARKISSIAN, K. F. SCHERTZ, J. M. SHELTON, J. D. SMITH, J. W. STANSEL, D. F. WESELI, F. D. WILSON

Genetics, the science of heredity and variation, occupies a central position in biology. Many of the recent significant research developments in the life sciences have occurred in this dynamic discipline. Multiple opportunities exist for the further development of genetic theory and for the application of genetic principles to improve animal and plant species.

Graduate study in the various areas of genetics is supervised by the interdepartmental Genetics Faculty, whose training, teaching and research are directly related to genetics. Supporting coursework is available in such specialized fields as biochemistry, biophysics, computer science, cytology, pathology, physiology and statistics.

Research areas which may be pursued include cytogenetics, immunogenetics, molecular genetics, population genetics and physiological genetics as well as forest genetics, animal breeding and plant breeding.

Graduate programs in genetics leading to the Master of Science and the Doctor of Philosophy degrees may be administered in the departments of Animal Science, Biochemistry and Biophysics, Biology, Plant Sciences, Poultry Science, Range Science, and Soil and Crop Sciences. Graduate assistantships and fellowships are available in each department. Applications to the Graduate College should specify the department in which the student expects to do his research.

For course descriptions of the following, see the respective departmental listings.

ANIMAL SCIENCE

616. **Animal Genetics. (3-3). Credit 4. II 1970, 1971, 1973; S 1969, 1972**

628. **Animal Breeding. (2-0). Credit 2. I 1969, 1971, 1973**

PLANT SCIENCES

(Genetics)

603. **Genetics. (3-0). Credit 3. I**

604. **Genetics Laboratory. (0-3). Credit 1. I**

612. **Plant Genetics. (3-3). Credit 4. II**

620. **Cytogenetics. (3-3). Credit 4. II**

623. **Special Topics in Genetics. Credit 1 to 3. I**

624. **Statistical Genetics. (2-0). Credit 2. I**

625. Speciation. (2-0). Credit 2. II

631. Biochemical Genetics. (2-0). Credit 2. I

633. Forest Genetics. (2-0). Credit 2. I

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

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

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

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

POULTRY SCIENCE

613. Breeding and Genetics of Poultry. (3-3). Credit 4. II

RANGE SCIENCE

610. Range Grasses and Grasslands. (2-3). Credit 3. II

SOIL AND CROP SCIENCES

641. Plant Breeding. (3-0). Credit 3. II

DEPARTMENT OF GEOGRAPHY

G. F. CARTER*, E. F. COOK, E. DORAN (Head), J. SONNENFELD

Graduate work in geography is offered at both the Master's and Doctoral levels. The Department of Geography has wide interests in the area of interaction between man and the land, and students are encouraged to work in physical, biological, and social sciences. Staff interests include cultural, historical, behavioral, resource, plant geographical, and geomorphic studies. Graduate students are expected to be heavily involved in research work throughout their programs.

601. Economic Geography. (4-0). Credit 4. I

An analysis of geographical theories explaining the growth, development and diversity of economic landscapes.

606. Agricultural Origins and Dispersals. (3-0). Credit 3. II

Origin and spread of agriculture over the world. Single versus multiple origins. The several complexes: Near East, Far East, Africa, America. Prerequisite: Approval of Department Head.

607. Physical Geography of Early Man in America. (3-0). Credit 3. I

Applications of physical earth science to the problem of the antiquity of man in America: paleoclimates and paleosols, eustatic sealevel changes and coastal terraces, plus local field problems.

610. Geography of Early Transportation. (3-0). Credit 3. I

Significance of boat types to cultural geography. Distribution and characteristics of great traditions: Western, Chinese, and Oceanic. Ambiguous traditions and their possible meanings. Prerequisite: Approval of Department Head.

620. Man and Nature. (3-0). Credit 3. I

Evolving views of man and nature; constraints on man's use of nature; natural hazards and environmental degradation; alternative consequences approach to resource decisions. Prerequisite: Approval of Department Head.

624. Plant Geography. (3-0). Credit 3. II

Plant cover of the world — its composition, local productivity, and distribution. Differences and similarities between various floras and vegetations of the world. Prerequisite: Approval of Department Head.

630. Behavioral Geography. (2-3). Credit 3. II

Synthesis of concepts derived from behavioral sciences which relate to man-environment interaction. Emphasis on determinants of variability in individual or group relationship with non-human environment, including class research in environmental perception, behavioral, and personality. Prerequisite: Approval of Department Head.

*Graduate Advisor

641. Exploration and Discovery I. (3-0). Credit 3. I

Expansion of geographic knowledge of lands, oceans, and peoples of world from prehistoric times to the fall of the Roman Empire. Prerequisite: Approval of Department Head.

642. Exploration and Discovery II. (3-0). Credit 3. II

Expansion of geographic knowledge of lands, oceans, and peoples of world, from the Dark Ages to present. Prerequisite: Approval of Department Head.

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

Special topics to meet small group requirements. Problems in various aspects of geography. Prerequisite: Approval of Department Head.

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

Original research in various areas of geography. Research for thesis or dissertation.

DEPARTMENT OF GEOLOGY

R. R. BERG (Head), J. E. CASE, E. F. COOK, D. K. DAVIES*, M. FRIEDMAN, J. W. HANDIN, K. J. KOENIG, T. J. PARKER, M. C. SCHROEDER*, C. L. SEWARD, JR., F. E. SMITH, R. J. STANTON, T. T. TIEH

Graduate work in geology and in geological engineering is offered at both the Master's and Doctorate levels. Programs are designed to provide the student with an understanding of the fundamentals of geology and of related disciplines. Research investigations comprise a significant part of each program.

Opportunities for research at both the M.S. and Ph.D. levels are available in ground-water investigations, sedimentation, clay mineralogy, micropaleontology, stratigraphy, structural geology, tectonophysics, petrology, field geology, and engineering 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.

603. Rocks and Minerals. (2-3). Credit 3. S

Study of rocks and minerals and megascopic determination by means of their physical properties. Origins of mineral, rocks, and mineral deposits. For secondary school teachers. Prerequisites: Geol. 600; graduate classification; approval of Department Head.

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

Comparative structural geology including the description and classification of local and regional structures and the application of selected mechanical principles to the development of structural features.

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.

*Graduate Advisor

620. Geology of Ground Water. (3-0). Credit 3. I
Principles of occurence 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.

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, 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.

650. Paleoecology. (3-0). Credit 3. II
Study of interrelationships of organisms and environment in the fossil record. Analysis of methods and criteria available for interpreting ancient environments. Critical review of classic studies and current research in paleoecology.

659. Volcanic Geology. (3-0). Credit 3. I
Geology of volcanic rocks, with emphasis on petrology of layered volcanic rocks and their stratigraphic and structural utility. Relations of volcanism to tectonism and to ore deposition. Prerequisites: Geol. 303, 312.

660. Igneous and Metamorphic Petrology. (2-3). Credit 3. II
Origin and evolution of igneous and metamorphic rocks; characteristics and variations of common rock types. Prerequisite: Geol. 304.

662. Sedimentary Petrology. (2-6). Credit 4. II

The provenance, mode of transportation, and environment of deposition of sediments as indicated by petrographic studies; introduction to collection and statistical evaluation of petrological data. Prerequisite: Geol. 303 or approval of Department Head.

663. Mineralogy. (2-6). Credit 4. I

Laboratory methods for mineral separation and identification by optical and X-ray techniques; detailed study of more important rock-forming and ore minerals. Prerequisite: Geol. 303.

665. Structural Petrology. (2-3). Credit 3. I, II

Fabrics of deformed rocks studied on all scales of observation—from single crystal to mountain range. Their tectonic significance evaluated by means of dynamic and kinematic interpretations. Laboratory assignments on descriptive techniques include petrographic microscope universal-stage methods, field procedures, and data analysis. Prerequisites: Geol. 303; approval of instructor.

667. Structural Geology II. (3-0). Credit 3. I, II

Application of theoretical and experimental results to problems in natural rock deformations. Study of structural styles and mechanisms of deformation. Evaluation, through mechanical principles, of theories of tectonism. For students who specialize in tectonophysics or its applications. Lecture and selected readings. Prerequisites: Graduate classification; Geop. 611; or approval of instructor.

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

Reports and discussions of current research and selected topics from geologic literature. Prerequisite: Graduate classification.

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.

DEPARTMENT OF GEOPHYSICS

J. E. CASE, D. A. FAHLQUIST, A. F. GANGI*, J. W. HANDIN, G. M. SOWERS, T. W. SPENCER (Head), R. R. UNTERBURGER

The degrees of Master of Science and Doctor of Philosophy are offered in geophysics.

Geophysics includes all areas of scientific inquiry which deal with the physical state of the planets, with the dynamic physical processes which act on and within the planets, and with their evolution. Geophysics is not restricted to the study of a particular environment. The deep interior, crust, atmosphere, oceans, and space all lie within the province of the geophysicist. To work effectively in so broad an area requires considerable depth and breadth of understanding of physical principles and considerable proficiency in mathematics. Thorough undergraduate training in geology, mathematics, or physics is regarded as a necessary prerequisite for advanced study.

Current research areas of members of the department include theoretical, model, and observational seismology; marine geophysics; gravity and magnetic fields; naturally occurring and artificially induced electric current systems; and tectonophysics.

The Center for Tectonophysics provides unique opportunities for research in the following areas: design and analysis of scaled photomechanical studies of structural processes; deformation of rock specimens under conditions which simulate the physical and chemical environment at depth in the earth's crust; use of specialized X-ray diffraction and microscopic techniques to study experimentally and naturally deformed rocks; interpretation of geologic structures in terms of the results of laboratory studies.

*Graduate Advisor

Special facilities include an IBM 360/65 computer system; a Standard World-Wide Seismic Station equipped with a laser interferometer for recording very low frequency earth motions; the research ship ALAMINOS for marine studies; an analog computer and two-dimensional seismic models for study of elastic wave propagation in layered media, and a complete 24-trace Seismic recording and processing system for field studies.

*Graduate Advisor

611. Geomechanics. (3-0). Credit 3. I

Development and application of physical mechanics to rock deformation. Review of rigid body dynamics emphasizing equilibrium and energy concepts. Strain and stress analysis of deformable bodies. Solution of problems in elasticity and viscoelasticity. Brief consideration of elastic stability, plasticity, and rupture concentrating on topics pertinent to structural geology. Prerequisites: Math. 307; Phys. 218, 228.

615. Experimental Rock Deformation. (2-3). Credit 3. II

Laboratory testing of mechanical properties of rocks at high pressure and temperature; photomechanical modeling; strain gage techniques. Theory of testing, apparatus design, data interpretation and extrapolation with emphasis on interaction of theoretical, experimental, petrofabric, and field studies of rock deformation as applied to problems in structural geology, seismology, and engineering. Prerequisite: Geop. 611.

630. Geophysical Applications of Solid State Theory. (3-0). Credit 3. II

Basic physics, chemistry, and mathematics of lasers, radar, optical pumping, nuclear magnetic resonance, and holography discussed with referance to present and future applications in earth sciences. Prerequisite: Approval of instructor.

651. Theoretical Seismology. (3-0). Credit 3. I

Wave propagation in unbounded and bounded media. Body waves and surface waves. Characteristic equation for surface waves on a layered half space. Dispersion. Phase and group velocity. Methods of stationary phase and steepest descent. Geometrical ray theory derived from wave theory in the high frequency limit. Reciprocity. Normal modes of vibration of the earth. Effect of curvature, gravity, and attenuation on waves in the earth. Prerequisites: Geop. 436; Math. 601, 602.

653. Analysis of Gravity and Magnetic Fields. (3-0). Credit 3. I

An advanced lecture-seminar course in the application of potential theory to the analysis of the earth's gravity and magnetic fields and to the solution of geologic problems. Critical study and evaluation of techniques for the interpretation of gravity and magnetic data. Prerequisites: Geop. 475; registration in Math. 601.

655. Electrical and Radioactivity Methods. (2-0). Credit 2. II

Design of field procedures, instruments, and data interpretation techniques utilized in electric and electromagnetic methods of exploration. Prerequisite: Phys. 416.

657. Earthquake Seismology. (2-0). Credit 2. II

Observed effects and possible causes of earthquakes. Epicenter location. Use of travel-time data to infer velocity and density within the earth. Source mechanism studies. Information derived from aftershock sequences. Seismograph theory. Prerequisites: Geop. 436, 611; Math. 601, 602.

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

Discussion of subjects of current importance. Prerequisite: Graduate classification.

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

Designed 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

Research toward thesis or dissertation.

DEPARTMENT OF HEALTH AND PHYSICAL EDUCATION

J. M. CHEVRETTE, C. B. CORBIN, L. J. DOWELL*, C. W. LANDISS* (Head), E. MAMALIGA, D. J. MERKI

Graduate study in health and physical education is offered leading to the Master of Education and Master of Science degrees. A student taking advanced graduate work leading to a Doctor of Philosophy degree in Education may major in health and physical education.

Graduate courses in health and physical education have been designed to assist in the advanced preparation of master teachers in health and physical education at the school and college level; to prepare physical education administrators; and to prepare candidates as recreation and health 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.

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

685. Problems. Credit 1 to 4 each semester. I, II, S
Directed study of selected problems in health education.

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

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. (3-0). Credit 3. II, 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. I, 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.

627. Kinesiology. (3-0). Credit 3. I
Investigation and analysis of science of human motion. Relationship between structure and function in accordance with general mechanical laws and interrelated factors. Prerequisite: P.E. 427.

628. Therapeutics. (3-0). Credit 3. II
Theories and techniques of muscle re-education and application of exercise to orthopedic, medical, post-surgical, and neurological disorders. Administration and direction of therapeutic and adapted physical activity programs. Prerequisite: P.E. 427.

630. Mechanical Analysis of Motor Activity. (3-0). Credit 3. II, S
Analysis of human movement with emphasis on sports skills by application of principles of mechanics, kinesiology, and cinematographical analysis. Prerequisites: P.E. 627; approval of instructor.

*Graduate Advisor

633. Principles of Exercise and Physical Fitness. (2-2). Credit 3. I, S
Analysis of nature of physical fitness, basic principles of exercise and physical fitness, analysis of methods of developing and evaluating physical fitness. Prerequisites: Biol. 219, 220.

636. Advanced Tests and Measurements. (2-2). Credit 3. 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 4 each semester. I, II, S
Directed study of selected problems of health, physical education, and recreation not related to thesis.

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

DEPARTMENT OF HISTORY

A. D. ASHCRAFT, J. T. DAWSON, C. H. HALL, H. H. LANG, T. L. MILLER, H. M. MONROE, JR., J. M. NANCE* (Head), L. C. TAYLOR, JR., B. M. UNTERBERGER

Graduate study of history is offered leading to the degree of Master of Arts. The graduate program in history is designed to give added preparation to students for teaching, government services, and for continuing graduate study in either history or political science leading to a doctorate. 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.

Students will find acceptable minors in economics, education, English, mathematics, science, or other social sciences including political science. The minor must be some field outside of the major field of study.

Prerequisites: For a major in 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 six advanced hours) in the minor field of study. See page 46 of this catalogue.

603. The United States: Revolutionary Era, 1750-1789. (3-0). Credit 3. I, S
Structure of American Society; British policy, the revolutionary movement; independence; Confederation period; social, political, and economic changes; diplomatic affairs. Prerequisite: Approval of Department Head.

604. The United States: Early National Era, 1789-1829. (3-0). Credit 3. II, S
Organization of the new government; the Federalist system; Jeffersonian democracy; the War of 1812; the New Nationalism, political, social and economic problems; territorial expansion. Prerequisite: Approval of Department Head.

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, economic, social, and cultural influences of frontier. Prerequisites: Approval of Department Head.

611. American Leaders. (3-0). Credit 3. II, S
Personalities and contributions of 36 American leaders from Samuel Adams to Dwight Eisenhower. Prerequisite: Approval of Department Head.

*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: Approval of Department Head.

613. Twentieth Century United States Diplomacy. (3-0). Credit 3. II, S
United States foreign policies from end of Spanish-American War to present, including scope, principles, practices, objectives, dangers, and lessons learned. Prerequisite: Approval of Department Head.

615. Growth of Spanish Institutions in America, 1492-1857. (3-0). Credit 3. 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: Approval of Department Head.

616. United States-Latin American Relations. (3-0). Credit 3. II, S
Formation and development of United States policy towards Latin America with principal emphasis upon major countries in North, South, and Central America; Pan-Americanism, Good Neighbor Policy, and recent trends. Prerequisite: Approval of Department Head.

621. The United States, 1877-1914. (3-0). Credit 3. I, S
Economic, social, political history of the U. S., 1877-1914, emphasizing growth of industrialism, disappearance of the frontier, labor and farm organizations, the growth of American imperialism, and constitutional development. Prerequisite: Approval of Department Head.

622. The United States, 1914 to the Present. (3-0). Credit 3. II, S
The United States during World War I; the "Roaring Twenties," the depression; the New Deal, World War II, and the Cold War. Prerequisite: Approval of Department Head.

623. United States in World Perspective Since 1933. (3-0). Credit 3. S
Examination of changes in United States by its transition towards internationalism since 1933. Particular emphasis upon agriculture, labor, industrialization and urbanization, science and technology, and foreign policy. Prerequisite: Approval of Department Head.

675. Central and Eastern Europe Since 1930. (3-0). Credit 3. S
Comprehensive analysis of conditions in central and eastern Europe in the 1930's, in World War II, the Communist takeover, status today; analyses of ideologies of Communism and of western democracies; possible solutions to problems of central and eastern Europe. Prerequisite: Approval of Department Head.

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. Prerequisites: Eighteen hours of history and approval of Department Head.

691. Research. Credit 1 or more each semester. I, II, S
Thesis research. Credit given only upon acceptance of completed thesis. Prerequisites: Twelve hours of advanced history.

DEPARTMENT OF INDUSTRIAL EDUCATION

H. D. BEARDEN, C. A. BERTRAND, J. L. BOONE, JR.* D. R. CLARK, E. R. GLAZENER* (Head), L. V. HAWKINS*, R. J. VERNON

It is the responsibility of the Industrial Education Department to develop master teachers, researchers, and effective leaders in such human relationship vocations as teaching of industrial arts and vocational industrial education, technical 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. To become a master teacher in industrial arts, a student may earn a Professional Teaching Certificate for the state of Texas through this department.

*Graduate Advisor

The classrooms, laboratories, 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 subject material which is closely related to industrial education. The laboratories embody the newest type of equipment, machine arrangements, 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 preparing safety reports.

606. Organization of Industrial Arts Department. (2-0). Credit 2. I, II, S

Problems in determining type and size of industrial arts program 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 the field of drawing. Designing and organizing of problems and teaching devices.

613. Audio-Visual Communication. (2-2). Credit 3. I, II, S

Study of communications with special emphasis upon senses of hearing and seeing in teaching-learning process. Emphasis given to preparation and utilization of audio-visual tools available for helping to develop abstract concepts. Prerequisite: Graduate classification.

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 nonteaching class and laboratory routine, and keeping records.

627. Teacher Training for Local Supervisors of Trade and Industrial Classes. (2-0). Credit 2. I, II, 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. I, II, 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 various types of metal.

635. Industrial Design and Development. (3-0). Credit 3. I, II, 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 Master's candidate 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*, J. P. CO VAN, D. D. DREW, R. W. ELLIOTT*, W. L. MEIER* R. J. McNICHOLS, P. E. PULLEY*, V. T. RHYNE, G. D. SELF*, R. L. STREET*, A. W. WORTHAM (Head), H. P. YULE

The graduate program of this department presently has five major areas of specialization which include: computer science, operations research, industrial planning and control, industrial operations, and environmental and human factors. The degrees available through the Industrial Engineering Department include the Master of Industrial Engineering and the Master of Computing Sciences (no thesis), the Master of Science degree in both industrial engineering and computing sciences (thesis required), the Doctor of Philosophy in industrial engineering, and the Doctor of Philosophy in interdisciplinary engineering with the major coursework and research being performed in this department. The graduate courses listed in these areas indicate the depth of each field of study available to the student.

In addition to the course work, there are a number of areas of research that are related to the major options. The computer science major, as well as other graduate researchers, will frequently use the excellent facilities provided by the Data Processing Center during the course of his research program. The operations research major will be oriented toward the systems approach in application and development of math models and optimization techniques. The industrial planning and control researcher will be directed toward the classical industrial engineering methods and the modern area of environmental effects upon man-machine interactions.

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
Discussion of background literature in human relations as it applies to industry. Control conditions which influence productivity and motivate the worker. Principles of leadership and misunderstandings between management and labor; incentives, i.e. direct systems, seasonal bonus, quality incentives, and profit-sharing systems. Prerequisites: I.En. 404, 412.

604. Advanced Time and Motion Studies. (1-6). Credit 3. II
Advanced methods in time and motion study, balancing operations, learning curves, work sampling, memomotion and chronocyclegraph studies, fatigue effects, determination and application of elemental times, Master Standard Data system, and 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: I.En. 403.

612. Design by Reliability. (3-3). Credit 4. II
Combines principles of design specification and reliability. Emphasis upon reliability aspect of design as related to mechanical systems which will include analysis of design specifications, safety factors, probability of failure, wear, fatigue, and computation of reliability. Prerequisites: I.En. 614, 617, 619.

613. Process Control and Optimization. (3-0). Credit 3. I
Covers advanced topics used in industrial quality control and experimentation. Theory developed for special control charts, sequential sampling plans, optimization techniques, and experimental designs. Prerequisites: I.En. 414, 614.

614. Advanced Quality Control. (3-3). Credit 4. I, S
Advanced methods applied to quality control and industrial experimentation. Covers aspects of physical application of significance tests; process control theory, techniques, and applications; analysis of process variables; and industrial experimentation. Prerequisites: I.En. 414 or approval of Department Head.

*Graduate Advisor

615. Production and Inventory Control. (3-3). Credit 4. II, S

Recent developments in techniques 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 or equivalent.

616. Advanced Industrial Analysis. (3-0). Credit 3. II

Designed for combining engineering principles with applied statistics in order to provide student with mechanics for analysis of industrial experimentation. Emphasis placed upon applications of principles of I.En. 414, 613, 614 and the planning required for proper use of those techniques. Prerequisites: I.En. 414, 613, 614.

617. Maintainability Engineering I. (3-0). Credit 3. I, II

Designed to make engineering applications of techniques developed in I.En. 414, 415, 420, and 614 to problems in analysis of systems maintainability. Will involve model development and analysis in addition to industrial problems in maintainability areas. Prerequisites: I.En. 414, 415, 420, and 614 or equivalent.

618. Maintainability Engineering II. (3-0). Credit 3. II

Designed to extend basic principles developed in I.En. 617 and to provide more of basic theory necessary for design and analysis of engineering systems relative to maintainability problems. Prerequisite: I.En. 617 or equivalent.

619. Analysis and Prediction. (3-3). Credit 4. I, S

Designed to provide student with model building technology in area of maintainability. Includes data collection and analysis, development of parameters empirically, time dependent models, and generalized simulation. Prerequisites: I.En. 614. 620.

620. Principles of Operation Analysis. (4-0). Credit 4. I, II, S

Provides specific capabilities in operations research techniques so that extensions and modifications can be made for practical applications. Mathematical models for optimizing decisions using probability methods, linear and quadratic programming, dynamic programming, game theory, and queuing theory. Prerequisite: I.En. 420 or equivalent.

622. Applied Linear Programming. (3-0). Credit 3. I

Designed to provide student with understanding of mathematics associated with linear programming and proficiency in recognition, definition, and solution of all types of applied linear programming problems by manual and computerized methods. Application of this methodology in operations research and industrial engineering problems. Prerequisites: I.En. 420, 620.

623. Nonlinear and Dynamic Programming. (3-0). Credit 3. II

Designed to provide student with an understanding of mathematics involved and a proficiency in recognition, definition, and solution of quadratic, dynamic, and other nonlinear programming problems by manual and computerized methods. Emphasis on application of methods to problems in operations research and industrial engineering. Prerequisite: I.En. 622.

624. Applied Distribution and Queuing Theory. (3-0). Credit 3. I

Detailed study of queuing theory applications and its associated emphasis on industrial, traffic, and service problems. Consideration given to methods of using statistical distributions most often required in solution of queuing problems in industrial engineering and operations research. Prerequisites: I.En. 420, 620; Stat. 601 or equivalent.

625. Applications of Simulation Technology. (3-0). Credit 3. II

Designed to provide student with appropriate methods and illustrative applications necessary for the highest level of sophistication in models using simulation techniques. Prerequisite: I.En. 624 or 626 or equivalent.

626. Model Building and Applications of Operations Research. (3-0). Credit 3. I, S

Application of techniques developed in I.En. 420 and 620 in a systems analysis context. Provides student with proper perspective of operations research within total system framework and its use in formulation, support and construction of mathematical models. Prerequisites: I.En. 420, 620.

627. Engineering Analysis for Decision Making. (3-0). Credit 3. II
Designed to provide student with principles and application of techniques in analysis of decision processes involving engineering systems under uncertainty. Introduces student to areas of utility and information theory as related to quantification of information for decision making. Prerequisites: I.En. 414, 420, 620, 622, 628.

628. Applied Game Theory. (3-0). Credit 3. I
Provides student with understanding of mathematics associated with game theory and proficiency in recognition, definition, and solution of all types of applied game theory problems. Covers application of this methodology in operations research, military operations research, and industrial engineering problems. Prerequisites: I.En. 420, 620.

630. Theory of Human Factors Engineering. (3-0). Credit 3. I, II
Provides student basic understanding of how human body and environmental factors affect human performance. Includes broad coverage of work organization and integration of human element in work design. Prerequisite: Graduate classification in industrial engineering or approval of Department Head.

632. Human Factors in Systems Design. (3-0). Credit 3. II
Applications of human factors to design and evaluation of man-machine systems. Prerequisite: I.En. 630.

641. Computer Languages. (2-6). Credit 4. I, II, S
Logical operations of a large-scale digital computer through its basic machine language and associated assembly languages. Includes theory of design and implementation of assembly language. Prerequisite: I.En. 458.

642. Computer Methods in Applied Sciences. (2-6). Credit 4. I
Thorough treatment of numerical solution of initial value problems in ordinary differential equations, solution of linear systems by direct and iterative methods, matrix inversion, the evaluation of determinants, and the calculation of eigenvalues and eigenvectors of matrices. Application to boundary value problems in ordinary differential equations. Introduction to numerical solution of partial differential equations. Selected algorithms will be programmed for solution on computers. Prerequisites: I.En. 458, Math. 417.

643. Logic of Information Processing. (2-6). Credit 4. I, II, S
Study of application of digital computers to problems other than those defined by a series of explicit mathematical equations. Emphasis on programming of data processing problems. Prerequisite: I.En. 458.

644. Information Processing Systems. (2-3). Credit 3. I
Study of data processing systems including construction and maintenance of file structures for on-line systems, storage allocation and collection, and design and use of generalized data management systems. Prerequisite: I.En. 643.

645. Data Processing Management. (3-0). Credit 3. II, 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. Prerequisites: I.En. 458, 641.

646. Computer Methods in Applied Sciences. (3-3). Credit 4. II
Extension of I.En. 642 to encompass more complex systems. Includes recently developed calculation techniques; applications to transient and steady-state analysis. Emphasis on coordinate systems, matrix operator and tracer methods, imposition of boundary conditions, special boundary configuration and stability considerations. Prerequisite: I.En. 642.

647. Compiler Theory. (3-3). Credit 4. II
Definitions of formal grammars: arithmetic expressions and precedence grammars, context-free and finite-state grammars. Algorithms for syntactic analysis: recognizers, backtracking, operator precedence techniques. Semantics of grammatical constructs: reductive grammars, Floyd productions, simple syntactical compilation. Relationships between formal languages and automata. Prerequisite: I.En. 641.

648. Computer Software Systems. (3-0). Credit 3. I, II

Review of batch process systems programs, their components, operating characteristics, user services and their limitations. Implementation techniques for parallel processing of input/output and interrupt handling. Prerequisite: I.En. 641.

649. Time-Sharing Computer Systems. (3-0). Credit 3. I

Comprehensive survey of time-sharing computational techniques with emphasis on software for time-shared computer operations. Time-sharing hardware, processors, and monitors; multiprocessing concepts; data flow; central processors; multiplexing devices; general software concepts; data management; performance analysis. Prerequisites: I.En. 641, 643.

650. Real-Time Simulation and Function Generation. (3-3). Credit 4. I

Analog, hybrid and related digital techniques for solution of differential equations. Analog simulation languages, scaling methods, operational characteristics of analog components, digital differential analyzers, analog-to-digital and digital-to-analog conversion, modeling methods, digital simulation of continuous systems. Prerequisites: I.En. 641, 642.

651. Tool Design. (3-3). Credit 4. II

Design of automatic machine tools: tracer and director control of tool paths; numerical control, automatic feeding, holding, indexing and ejection of work pieces; tool replacement analysis. Automatic inspection and sorting, assembly, and packaging. Prerequisite: I.En. 453.

652. Computer Languages for Simulation. (2-3). Credit 3. I

Techniques of using a computer for simulation. Study of general purpose system simulator SIMSCRIPT, and other languages. Prerequisite: I.En. 641.

653. Information Storage and Retrieval. (2-2). Credit 3. II

Study of application of electronic devices to problem of storing and retrieving engineering information. Prerequisite: I.En. 643.

660. Design and Control of Engineering Management Systems. (3-0). Credit 3. I

Survey of analytical methods for optimal design, operation, and control of engineering management systems. Techniques in analysis of complex engineering systems. Methodology for determining optimal operating criteria. Prerequisites: I.En. 414, 415, 420.

661. Network-Based Planning and Scheduling Systems. (3-0). Credit 3. I, S

Advances and theoretical developments in network-based scheduling systems. Specific topics include analytical study of network statistics, development of mathematical basis for time compression, consideration of decision point theory, generalized activity networks, probabilistic networks, and analysis of engineering cost control systems. Prerequisites: I.En. 614, 620.

662. Planning Technology. (3-0). Credit 3. I

Recent advances in analytical planning theory. Techniques for determining manpower requirements, allocation of resources, and project selection while satisfying overall planning objectives in an optimal manner. Methods for formulating planning objectives in quantitative terms; solution procedures. Prerequisite: I.En. 660.

663. Engineering Management Control Systems. (3-0). Credit 3. II

Methods for controlling engineering management systems. Topics from areas of control system theory, production and inventory control, and quality control are combined to develop systematic approach to optimal control of engineering management systems. Prerequisite: I.En. 660.

664. Principles of Scheduling. (3-0). Credit 3. II

Advanced prediction techniques useful in forecasting and scheduling problems associated with industrial engineering analyses. Topics discussed include time series analysis, probabilistic models, smoothing techniques, and error analysis. Prerequisite: I.En. 660.

681. Seminar. (1-0). Credit 1. II, S
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; content and credit dependent upon needs of individual student.

Interdisciplinary Engineering

601. Systems Engineering. (3-0). Credit 3. I
Study of processes and patterns of systems engineering, a discipline concerned with planning, organization, and management of programs for developing large, highly complex systems.

610. System Characterization. (3-0). Credit 3. I
Study of concepts and techniques of characterizing systems and subsystems to facilitate their analysis and design. Prerequisite: Itd.E. 601.

611. System Reticulation. (3-0). Credit 3. II
Study of techniques used in decomposing system concepts into identifiable structural components and of task allocation between man and system. Prerequisite: Itd.E. 610.

612. Multilevel System Theory. (3-0). Credit 3. II
Study of multilevel concept and how it is applied in design of complex technological systems. Prerequisite: Itd.E. 601.

620. Preliminary System Design. (3-3). Credit 4. II
Study of procedures, methods, and factors influencing preliminary design of complex technological systems. Prerequisite: Itd.E. 601.

621. Detailed System Design. (3-3). Credit 4. S
Study of methods for abstractly analyzing, synthesizing, and evaluating complex systems. Prerequisite: Itd.E. 620.

622. Computer-Aided Design. (3-0). Credit 3. S
Study of theoretical and practical aspects of specialized computing systems used to assist engineers in design of complex technological systems.

650. Materials Science. (3-0). Credit 3. II
Detailed study of structure and properties of solid materials. Prerequisites: Graduate classification; approval of instructor.

651. Thermodynamics of Materials. (3-0). Credit 3. I
Application of thermodynamics to materials and materials processes. Solid state reactions emphasized with particular attention to metallurgical processes. Atomistic approach to properties of materials included where beneficial. Prerequisite: Approval of instructor.

652. Physical Metallurgy. (3-0). Credit 3. II
Properties of metals and alloys described by application of simple physical laws. Dislocation theory, thermodynamics, statistical mechanics, vacancies and deformation twinning used to explain mechanical and physical behavior of metals. Prerequisite: Approval of instructor.

653. Materials in Design. (3-0). Credit 3. I
Utilization of fundamental knowledge of solid state and available materials data in selection of materials for engineering applications. Advanced techniques described and applied to numerous examples. Prerequisite: Itd.E. 650.

654. Principles of Composite Materials. (3-0). Credit 3. II
Atomic, molecular, micro/macrostructure studied with respect to physical and mechanical properties of composite materials. Includes plastic, metallic, and ceramic matrices reinforced with continuous and discontinuous fibers, whiskers, and particulates. Mechanical and chemical interactions, failure modes, interface, fabrication techniques, and structural design concepts. Prerequisite: Approval of instructor.

681. Seminar. (1-0). 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 nor twice in Ph.D. program.

685. Problems. Credit 1 to 4. I, II, S
Research problems of limited scope designed primarily to develop research technique.

691. Research. Credit 1 or more. I, II, S
Research for thesis or dissertation.

DEPARTMENT OF MANAGEMENT

L. R. BURGESS, R. L. ELKINS, P. B. GOODE, W. C. HOUSE, J. E. PEARSON (Dean), C. A. PHILLIPS, G. H. RICE (Head), J. L. SANDSTEDT

The department does not offer a graduate program in management, but does offer the professional management courses for students with a professional concentration in accounting, organization and administration, computer science, or statistics. Students not in M.B.A. programs may take professional courses in management if they meet the prerequisites with preprofessional work.

Although a degree program in management is not offered, the Organization and Administration Program contains a number of professional management courses.

609. Management Seminar. (3-0). Credit 3. I, S
Study of organization theory and its application to business systems. Prerequisites: Graduate classification; approval of instructor; Mgmt. 655 or equivalent.

610. Business and Society. (3-0). Credit 3. II
Covers the roles of the businessman and his major instrument of organization, the corporation, particularly as they relate to social and political environment. Prerequisite: Mgmt. 655 or equivalent.

623. Wage and Salary Administration. (3-0). Credit 3. II
Trends in wages, salaries and fringe benefits. Prerequisite: Mgmt. 422 or equivalent.

624. Seminar in Human Resources. (3-0). Credit 3. I
Seminar in human resources, emphasis on individual student research projects.

625. Management Training in Industry. (3-0). Credit 3. I
Examination of theoretical foundations for and implementation of manager development efforts in American industrial organizations. Prerequisite: Mgmt. 422 or equivalent.

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.

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 regulations of competition, business and labor. Prerequisites: Mgmt. 643 or equivalent; 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; Mgmt. 655 or equivalent.

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

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 on thesis.

DEPARTMENT OF MARKETING

J. U. McNEAL (Head), H. G. THOMPSON

Graduate courses in marketing provide distribution, logistics and product development concepts for students with a professional concentration in accounting, organization and administration, computer science, or statistics. Students not in M.B.A. programs may take courses in marketing if they meet the prerequisites.

The Department of Marketing does not offer a separate graduate program leading to the M.B.A. degree.

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: Mgmt. 211.

649. Survey of Marketing. (3-0). Credit 3. I, II, S
Analysis of marketing functions and institutions. Marketing mix related to consumer, trade, and industrial products. Emphasis on terminology and essential concepts. Prerequisites: Graduate classification; 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.

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

685. Problems. Credit 1 to 3 each semester. I, II, S
Directed study of 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 MATHEMATICS

J. D. BRYANT*, J. T. HURT*, J. T. KENT, E. C. KLIPPLE*, H. A. LUTHER* (Head), W. S. McCULLEY, J. J. MALONE, JR*., B. C. MOORE, N. W. NAUGLE

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 mathmatics; second, it attempts to furnish proper mathematical preparation for graduate students majoring in other departments.

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
Measureable 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 nonlinear 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, S
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 succesive 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 I. (3-0). Credit 3. I
Vector spaces, linear transformation, fundamental properties of matrices including canonical forms. Prerequisite: Math. 409 or 415 or equivalent.

616. Vector Spaces and Matrices II. (3-0). Credit 3. II
Metrization and consequent matrix properties. Prerequisite: Math. 615.

617. Theory of Functions of a Complex Variable I. (3-0). Credit 3. I, S
Conformal mapping, the Schwartz-Christoffel theorem, infinite products, entire functions, meromorphic functions, the gamma function. Prerequisite: Math. 407.

*Graduate Advisor

618. Theory of Functions of a Complex Variable II. (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.

625. Matrix Algebra and Tensor Calculus. (4-0). Credit 4. I, II

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

Quadratic residues; the Legendre, Jacobi, and Kronecker symbols; quadratic reciprocity; residue characters; character sums; sums of squares; diophantine equations. Prerequisite: Approval of instructor.

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.

634. Group Representations. (3-0). Credit 3. II

Equations invariant with respect to the rotation and Lorentz groups. Representation theory of inhomogeneous Lorentz groups. Lie algebras of simple groups and their representations. Composition and decomposition of representations of Lie algebras. Tensor analysis of simple Lie groups. Prerequisite: Math. 633.

636. Topology. (3-0). Credit 3. II

Axiomatic treatment of topological spaces. The meterization problem. Applications to arcs and curves. Prerequisite: Math. 607.

637. Advanced Topics in Topology. (3-0). Credit 3. I, II, S

Topics in topology not provided for in other courses. Prerequisite: Math. 636 or approval of instructor.

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 the theory of functions. Prerequisite: Math. 608.

651. Optimization I. (3-0). Credit 3. I

Study of fundamentals of mathematical analysis underlying theory of constrained optimizations for a finite number of variables, necessary and sufficient conditions for constrained extrema of equality constraint problems, sufficient conditions for fulfillment of constraint qualification, computational methods for concave programming problems and applications. Prerequisites: Math. 410, 416, or approval of Department Head.

652. Optimization II. (3-0). Credit 3. II

Study of necessary conditions of calculus of variations, elementary theory of games, formulation of basic control problem, Hestenes' necessary conditions for optimal control, transformations, methods of computation, and applications. Prerequisite: Math. 651.

653. Algebra I. (3-0). Credit 3. I, II, S
Survey of groups, rings, ideals. Prerequisite: Math. 415 or approval of instructor.

654. Algebra II. (3-0). Credit 3. I, II, S
Survey of modules, field extensions, Galois theory. Prerequisite: Math. 653 or approval of instructor.

660. Advanced Topics in Algebra. (3-0). Credit 3. I, II, S
Topics in algebra not provided for in other courses. Prerequisite: Math. 653, or approval of instructor.

661. Calculus of Finite Differences. (3-0). Credit 3. I, II
Use of differences and summations as involved in differentiation and integration. Prerequisite: Math. 308.

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 the curriculum. Prerequisite: Math. 601.

691. Research. Credit 1 or more each semester. I, II, S
Research for thesis or dissertation.

DEPARTMENT OF MECHANICAL ENGINEERING

J. H. CADDESS, E. S. HOLDREDGE*, C. F. KETTLEBOROUGH, T. J. KOZIK*, R. E. MARTIN, T. A. NOYES, J. V. PERRY, JR., C. M. SIMMANG* (Head), H. J. SWEET, J. G. H. THOMPSON, H. R. THORNTON, W. I. TRUETTNER, P. D. WEINER, R. M. WINGREN*, H. S. WOLKO

The graduate program in mechanical engineering is designed to prepare a student to work in the more technical phases of this field. The courses are planned not only to give certain factual information but to emphasize fundamentals and methods, to clarify principles, to indicate their applicability in a growing field, to develop a rational analysis from basic fundamentals, and to develop skill in the formulation of solutions to engineering problems. Instrumentation and research techniques are emphasized.

The student is allowed to choose his courses so as to specialize in the fields of heat power, mechanical design, applied mechanics, and materials. Laboratory facilities are available for graduate study and research in materials and metallurgy, stress analysis including photoelasticity, 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 Science 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
Advanced problems in design, forces and stresses in piping systems subjected to thermal expansion, combined stresses and theories of failure, bearing design, curved beams and flat plates.

603. Power Plants. (4-0). Credit 4. II
Design of central and isolated power plants with special attention to over-all economic operation. Fossil fuel and nuclear plants analyzed. Prerequisite: M.E. 417.

*Graduate Advisor

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 the more involved problems in engineering practice. Topics involving equilibrium, Gibb's function, nonideal gases, and various equations of state are covered. 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 nonlinear 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

Review of stress and strain at a point. Relations and procedures of specific significance in photoelasticity are emphasized. Review of optics and double refraction and an explanation of the optical phenomena in the polariscope. Meaning of fringe patterns, isoclinics and stress trajectories and methods of obtaining them. Methods of calculating principle stresses from photoelastic data. Use of electric strain gages and stresscoat.

621. Fluid Mechanics. (4-0). Credit 4. I

Study of dynamics of two-dimensional incompressible and compressible fluids. Viscous flow in laminar and turbulent layers, the Navier-Stokes equations, boundary layer theory and applications to turbomachinery are stressed.

623. Two-Phase Flow. (3-0). Credit 3. I

Current status of two-phase flow technology. Covers basic one-dimensional treatment of two-phase flow; detailed analysis of flow of suspended particles, bubbles, and mists; analysis of slug and annular flows; measurement techniques; system stability. Prerequisite: Undergraduate course in fluid mechanics.

626. Lubrication Theory. (3-0). Credit 3. II

Development of Reynolds equation from Navier-Stokes equation for study of hydrodynamic lubrication theory as basis for bearing design. Application to simple thrust and journal bearings and pads of various geometries. Study of hydrostatic lubrication, floating ring bearing, compressible fluid (gas) lubrication, grease lubrication, dynamically loaded bearings, half speed whirl and stability. Prerequisites: Math. 308; M.E. 344 or equivalent.

627. Heat Transfer-Conduction. (3-0). Credit 3. I

Mathematical theory of steady-state and transient heat conduction. Solution of the governing differential equations by analytical, graphical, and analogical methods; applications to various geometric configurations. Prerequisites: Math. 601 or registration therein; M.E. 461.

628. Heat Transfer-Convection. (3-0). Credit 3. II

Mathematical theory of convection energy transport, combined mass and heat transfer. Solution of the governing equation by analytical, numerical, and analogical methods. Applications to the design of heat-transfer apparatus are included. Prerequisite: M.E. 627.

629. Heat Transfer-Radiation. (2-0). Credit 2. I

Mathematical theory of thermal radiation with applications. Ideal and nonideal radiating surfaces, heat transfer in enclosures, solar radiation. Analytical, numerical, and analogical methods stressed in problem solving. Prerequisite: M.E. 627 or registration therein.

631. Jet Propulsion. (4-0). Credit 4. II

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.

632. Field Computations in Engineering. (3-0). Credit 3.

Application of matrix methods to problems associated with flow of fluids, heat and stress. Emphasis on application to physical problems. Prerequisites: Math. 601; graduate classification.

634. Two-Phase Heat Transfer. (3-0). Credit 3. II

Presents current state of the art. Summary of current research efforts in heat transfer situations involving liquid-to-vapor or vapor-to-liquid phase changes. Prerequisite: M.E. 461 or equivalent.

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 cast iron, and their influence upon the design of machine elements. Prerequisites: M.E. 340, 409 or its equivalent.

641. Metallurgy and Nonmetallic Materials. (3-0). Credit 3. I

Rational scientific-technological basis of metals and nonmetallic materials in stages of manufacturing. Influence of manufacturing stages upon structure of metals, nonmetals, and their properties. Mechanisms of change at the atomic, micro/macro-structural level. Prerequisite: M.E. 340.

642. Metallurgy and Nonmetallic Materials Laboratory. (0-6). Credit 2. I

Methods for studying structure of metals and nonmetals at the atomic, micro/macro-structural levels, application of these methods to investigations of behavior of metals and nonmetals under different conditions; participation in research projects on topic of current interest in metals/materials area. Prerequisite: M.E. 641 or registration therein.

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.

(The Mechanical Engineering courses in applied mechanics such as elasticity, plasticity, continuum mechanics etc., are listed under the section entitled Structural Mechanics.)

DEPARTMENT OF METEOROLOGY

B. ACKERMAN, K. C. BRUNDIDGE*, H. R. BYERS, R. A. CLARK, W. H. CLAYTON, P. DAS, D. DJURIC, G. A. FRANCESCHINI, J. F. GRIFFITHS, W. K. HENRY, C. L. HUEBNER, JR., A. KASAHARA, V. E. MOYER (Head), R. C. RUNNELLS, J. R. SCOGGINS, A. H. THOMPSON

DEGREES

Degrees of Master of Science and Doctor of Philosophy are offered in meteorology in addition to the Bachelor of Science degree.

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 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 in the College of Geosciences for working at sea and several coastal and offshore locations.

600. Survey of Meteorology. (3-0). Credit 3. II, S

Survey course in meteorology designed for teachers of secondary school science. Prerequisite: Approval of Department Head.

615. Instrument Theory and Design. (3-0). Credit 3. I

Study of modern methods of instrumentation as related to meteorology and allied geophysical fields; their basic concepts, design, use, and inherent errors. Prerequisite: Bachelor of Science degree in science or engineering.

616. Meteorological Instrumentation. (3-0). Credit 3. II

Study of advanced methods of measurement in geoscience with emphasis on meteorological parameters. Prerequisite: Met. 615 or equivalent.

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 1969-70 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.

640. Atmospheric Radiation. (3-0). Credit 3. I

Consideration of radiative transfer in a stratified atmosphere, with emphasis on gaseous absorption and emission; use of charts and tables for computing fluxes; applications to remote sensing by aircraft, balloon, and satellite. Prerequisite: Met. 445.

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.

656. Tropical Meteorology. (3-0). Credit 3. II
Theory and structure of meteorological phenomena of tropical latitudes, easterly waves and tropical cyclones, the tropics and the general circulation, trade wind regime, convective phenomena. Persons desiring practice in analysis techniques should enroll for one or more hours of Met. 685. Prerequisite: Met. 453 or approval of instructor. (Offered in 1970-71 and in alternate years thereafter.)

657. Mesometeorology. (3-0). Credit 3. II
Theory and structure of mesoscale weather systems and their relation to larger and smaller scale systems. Persons desiring practice in analysis techniques should enroll for one or more hours of Met. 685. Prerequisite: Met. 453 or approval of instructor. (Offered in 1969-70 and in alternate years thereafter.)

658. Synoptic Meteorology. (3-0). Credit 3. I
Examination of structure of macroscale atmospheric disturbances. Procedures for forecasting their development. Persons desiring practice in analysis techniques should enroll for one or more hours of Met. 685. Prerequisite: Met. 453 or approval of instructor.

664. Atmospheric Turbulence. (3-0). Credit 3. I
Theory of atmospheric turbulence; production and dissipation of eddy energy; eddy energy equation; similarity theory; structure of turbulence. Prerequisites: Math. 308; Met. 445.

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. (Offered in 1970-71 and in alternate years thereafter.)

666. Agricultural Meteorology. (3-0). Credit 3. II
Application of physical concepts of meteorology to problems arising in agriculture, with detailed study of meso-micro-climates. Prerequisite: Met. 465 or approval of instructor.

674. Radar Meteorology. (3-0). Credit 3. II
Theoretical considerations of principles of electromagnetic propagation, radar applications in cloud physics research. Prerequisites: Math. 601; Met. 475. (Offered in 1970-71 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. I, II, S
Presented by students and based upon their research work and upon surveys of the literature.

685. Problems. Credit 1 or more 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.

DEPARTMENT OF MODERN LANGUAGES

E. C. BREITENKAMP, J. A. DABBS* (Head), J. M. SKRIVANEK

CZECH

627. Introduction to Scientific Czech. (3-0). Credit 3. S
Intensive course to prepare graduate students to read scientific material; language structure; technical vocabulary and translation.

*Graduate Advisor

628. **Readings in Scientific Czech. (3-0). Credit 3. S**
Continuation of Czech. 627. Reading and translation of selected texts relating to various sciences. Designed to develop technical vocabulary and facility in reading scientific Czech. Prerequisites: Czech 627 with grade of B, or equivalent; approval of Department Head.

FRENCH

601. **Introduction to Scientific French. (3-0). Credit 3. I, S**
Intensive course to prepare graduate students to read scientific material. Technical vocabulary and translation.

602. **Readings in Scientific French. (3-0). Credit 3. II, S**
Continuation of Fren. 601. Reading and translation of material relating to various sciences. Designed to develop technical vocabulary and facility in reading scientific French. Prerequisite: Fren. 601 or approval of Department Head.

GERMAN

603. **Introduction to Scientific German. (3-0). Credit 3. I, S**
Intensive course to prepare graduate students to read scientific material. Technical vocabulary and translation.

604. **Readings in Scientific German. (3-0). Credit 3. II, S**
Continuation of Germ. 603. Translation of material relating to various sciences. Designed to develop technical vocabulary and facility in reading scientific German. Prerequisite: Germ. 603 or approval of Department Head.

RUSSIAN

609. **Introduction to Scientific Russian. (3-0). Credit 3. I, S**
Intensive course top prepare graduate students to read scientific material. Technical vocabulary and translation.

610. **Readings in Scientific Russian. (3-0). Credit 3. II, S**
Continuation of Russ. 609. Selected material relating to various sciences. Designed to develop technical vocabulary and facility in reading scientific Russian. Prerequisite: Russ. 609 or approval of Department Head. Intended for Ph.D. candidates.

DEPARTMENT OF NUCLEAR ENGINEERING

R. G. COCHRAN* (Head), E. J. DOWDY, D. M. GIBSON, JR., W. H. KOHLER, H. R. LERIBAUX, R. D. NEFF, J. D. RANDALL, J. B. SMATHERS, R. S. WICK*

The rapid growth in the relatively new field of nuclear engineering has created a great demand for trained nuclear engineers. The nuclear engineer is concerned with the release, control and utilization of energy from nuclear sources. Nuclear engineering is based on the principles of nuclear physics which govern radioactivity, fission and fusion, the production of heat and radiation in those processes, and the interaction of radiation with matter. The function of the nuclear engineer is to apply these principles for the benefit of mankind. Consequently, the nuclear engineer will be involved in many of the most challenging technological problems of tomorrow, such as providing adequate low cost energy for our vast urban and industrial complexes, desalting the water of the oceans, designing the propulsion and power systems for man's exploration and exploitation of space and sea.

The Nuclear Engineering Department 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 baccalaureate degree.

The facilities available for instructional and research purposes include a radiation measurements laboratory, a sub-critical reactor laboratory, an IBM-7094, IBM 360-65

*Graduate Advisor

and an analog computer, a reactor simulator, a radiochemistry laboratory, a low power nuclear reactor, a 14 Mev Cockroft-Walton pulsed accelerator, and a large research reactor located at the Texas A&M Nuclear Science Center. A 75 Mev cyclotron has been recently completed for research in nuclear physics and engineering.

PROFESSIONAL EDUCATIONAL PROGRAM IN HEALTH PHYSICS.

This program is offered as a specialized area of study by the Nuclear Engineering Department 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 coursework in the Department of Nuclear Engineering and other cooperating departments of the University. His summer is then spent in a government laboratory or at Texas A&M University for three months of on-the-job training. 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.

Graduate studies in health physics may also be undertaken in the Department of Biochemistry and Biophysics (See page 72).

601. Nuclear Reactor Analysis. (3-0). Credit 3. 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.

603. Fast Reactor Analysis. (3-0). Credit 3. I

Fast neutron interactions, neutron spectra, criticality calculations, reactivity effects: void effects, Doppler effects, expansion effects. Kinetics and dynamics, comparison with thermal reactors, engineering safeguards. Breeding ratio, doubling time, fuel cycle economics. Comparison of coolants: Na, steam, gas. Discussion of existing fast reactor experiments. Prerequisite: Approval of instructor.

605. Nuclear Measurements Laboratory. (2-3). Credit 3. I

Basic techniques of nuclear measurements discussed and practiced. Behavior of neutrons in multiplying and nonmultiplying 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.

607. Thermonuclear Engineering. (3-0). Credit 3. I

Fusion reactions, orbit theory in magnetic and electric fields, Coulomb interactions, formulation of Boltzmann equation, magnetohydrodynamics, plasma waves. Prerequisite: Math. 601.

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. Prerequisite: N.E. 607.

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.

613. Principles of Radiological Safety. (3-0). Credit 3. I
Rigorous mathematical and physical approach to various aspects of radiological safety. Derivation of equations involving radiation absorption, radiation dosimetry, and calculations of radiation dose due to internal emitters. Mathematical models developed for determination of maximum permissible body burdens and concentrations in air and water. Prerequisite: Math. 308.

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
Design 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. 601 or registration therein; 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. 601 or registration therein; 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.

629. Numerical Methods in Reactor Analysis. (3-0). Credit 3. S
Solution of variable dimensions multigroup P_n calculations. In addition, Monte Carlo techniques, reactor kinetics, fuel cycle and reactor life study approximations will be presented. Prerequisite: Approval of instructor.

630. Analysis of Isotopic Enrichment. (3-0). Credit 3. II
Development of general cascade equations for isotopic enrichment; analysis of the ideal cascade, squared off cascade, close separation cascade approximations. Discussion of various processes used to achieve enrichment and application. Prerequisite: N.E. 404.

631. Reactor Fuel Reprocessing. (3-0). Credit 3. I

Engineering analysis of characteristics of fission products in irradiated reactor fuel, properties of reactor fuel materials; various methods used to reprocess spent fuels. Prerequisite: N.E. 404.

679. Practical Applications of Radiological Safety I. (1-6). Credit 3. S

Intensive and comprehensive lecture and practical training in radiological safety operations. Includes radioactive license application, review, and compliance. Major emphasis on actual performance of radiation safety duties at isotope laboratories, counting laboratories, nuclear reactors, and high energy accelerators. Prerequisites: N.E. 612, 613.

680. Practical Applications of Radiological Safety II. (1-6). Credit 3. S

Continuation of N.E. 679 with student reaching point where he can design and conduct radiation surveillance operations on his own with no immediate supervision. Prerequisite: N.E. 679.

681. Seminar. (1-0). Credit 1. 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

L. D. BERNER, JR., A. H. BOUMA, W. R. BRYANT, L. R. A. CAPURRO, J. W. CARUTHERS, W. H. CLAYTON, J. D. COCHRANE, R. DARNELL, S. Z. EL-SAYED, R. A. GEYER (Head), T. ICHIYE, L. M. JEFFREY, K. V. KRISHNAMURTY, W. D. NOWLIN, JR., W. E. PEQUEGNAT, S. M. RAY, R. O. REID*, R. REZAK, W. M. SACKETT, W. B. WILSON

DEGREES

Degrees of Master of Science and Doctor of Philosophy are offered in oceanography.

OCEANOGRAPHY

Oceanography is the study of the oceans and their boundaries. 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, certain aspects of weather forecasting, 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 are offered in oceanography. These are the biological, chemical, geological, physical, and air-sea interactions. 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.

All students are expected to have had mathematics through integral calculus, at least one year of physics and chemistry, and at least one survey course in biology and geology in addition to the usual amount of coursework in their major field of science.

*Graduate Advisor

To qualify for an advanced degree in oceanography, the student must learn how to apply for 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. He is expected to develop an interest in the other marine sciences.

FACILITIES AND PARTICIPATION IN RESEARCH

Graduate students often take an active part in one or more of the research contracts sponsored in the Department of Oceanography by industry and by state and federal agencies. In addition to campus facilities, others are available in the College of Geosciences for working at sea and at several coastal and offshore locations.

603. Sea Laboratory Techniques. (0-3). Credit 1. I

Practice in techniques used regularly aboard ship and in collecting field data, cruise planning and execution, processing and analysis of data. Prerequisite: Ocn. 608.

608. Physical Oceanography. (3-2). Credit 4. I

Observations, physical properties of sea water. Property distributions, heat budget, oceanic waters, kinematics, gravity, pressure, hydrostatics, stability, Coriolis force. Wave motions, horizontal flow, geostrophy, wind drift, circulation. Prerequisites: Math. 122 or 210; Phys. 219, 229.

609. Physical Oceanography. (3-0). Credit 3. II

Advanced treatment of topics introduced in Ocn. 608, including vorticity, turbulent transfer, wind-driven and thermohaline circulation. Prerequisite: Ocn. 608.

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; Met. 435 or Ocn. 609.

612. Elements of Ocean Wave Theory. (3-0). Credit 3. I

Theories of simple harmonic surface waves, capillary waves, and internal waves. Wave energy, propagation, modification in shallow water. Superposition, waves of finite height. Prerequisites: Math. 601; Ocn. 609; or approval of instructor.

613. Engineering Aspects of Oceanography. (3-0). Credit 3. II

Engineering applications of ocean wave theories, including long waves, wave spectra, wave generation and practical wave prediction, wave modification, wave forces. Prerequisite: Ocn. 612 or approval of instructor. (Offered in 1969-70 and in alternate years thereafter.)

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, 612. (Offered in 1970-71 and in alternate years thereafter.)

615. Long Waves and Tides. (3-3). Credit 4. II

Free and forced surges, seiches, effect of variable depth, WKB and Rayleigh-Ritz methods. Method of characteristics, bores, Kelvin and Stokes waves, oceanic tides, cooscillating tides, storm tides. Prerequisites: Math. 602; Ocn. 612. (Offered in 1970-71 and in alternate years thereafter.)

616. Theory of Ocean Waves. (3-0). Credit 3. II

Wave height statistics, wave spectra and their determination. Pierson-Neumann wave forecasting theory, effects of viscosity on surface, gravity waves, wave generation by wind, nonlinear interaction. Prerequisite: Ocn. 612. (Offered in 1969-70 and in alternate years thereafter.)

617. Theories of Ocean Circulation. (3-0). Credit 3. I

Theories of wind-driven circulation, Sverdrup solution, frictional and inertial boundary domains, energy and vorticity considerations, role of stratification and bathymetry, theories of thermohaline circulation, model experiments. Prerequisite: Ocn. 611. (Offered in 1969-70 and in alternate years thereafter.)

620. Biological Oceanography. (3-0). Credit 3. I

Critical analysis of contribution of biological science to our understanding of sea. Discernible interrelationships between organisms and physicochemical parameters emphasized. Prerequisite: General prerequisites for oceanography.

622. Analysis of Benthic Communities. (2-3). Credit 3. II

Comprehensive study of marine benthos with principal emphasis upon Gulf of Mexico and Caribbean Sea. Prerequisite: Ocn. 620 or equivalent.

623. Marine Zooplankton. (2-3). Credit 3. I

Detailed examination of selected aspects of biological oceanography with particular reference to the zooplankton of the Gulf of Mexico and Caribbean. Prerequisite: Ocn. 620 or equivalent.

624. Marine Phytoplankton. (2-3). Credit 3. II

Detailed studies of phytoplankton with emphasis on physical and chemical factors which affect plankton production. Study of phytoplankton-zooplankton relationship, sampling problems. Prerequisite: Ocn. 620 or equivalent.

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. (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.

633. Carbonate Sediments I. (1-3). Credit 2. I (Alternate years)

Detailed examination of skeletal microstructures of carbonate producing organisms and recognition of these organisms through particle identification in carbonate sediments. Prerequisite: Undergraduate major in geology or approval of instructor.

634. Carbonate Sediments II. (2-3). Credit 3. II (Alternate years)

Composition, classification, and distribution of carbonate sediments; processes of carbonate sedimentation and diagenesis. Laboratory work includes study of both recent and ancient carbonates. Prerequisite: Undergraduate major in geology or approval of instructor.

635. Techniques in Geological Oceanography. (3-2). Credit 4. I (Offered in alternate years.)

Review of shipboard and laboratory techniques used in geological oceanography: sampling, peels, impregnation, thin sectioning, imbedding, radiography, straining, geotechnical properties, photography, microscopy, photomicrography, granulometry, profiling, cruise preparation. Two field trips. Prerequisite: Approval of instructor.

638. Simulation Techniques. (2-6). Credit 4. I

Simulation research applications utilizing large general purpose electronic analog computer. Problem material from many disciplines but primary emphasis on hydrodynamic model design and solution procedures of ocean-atmosphere interaction. Prerequisites: Math. 308; approval of instructor.

639. Lithophycology. (2-3). Credit 3. II (Alternate years)

Morphology, taxonomy, and ecology of calcareous algae and stromatolites with emphasis on their role as builders of limestones. Laboratory work includes identification of both recent and fossil species. Prerequisite: Undergraduate major in geology or approval of instructor.

640. Chemical Oceanography. (3-0). Credit 3. I

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. II

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. II

Analytical methods for biological, chemical, and geological investigations. Methods concern salinity, alkalinity, nutrients, organic production, photosynthesis, sediment particle size, trace elements. Prerequisites: Ocn. 608, 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. (3-0). Credit 3. 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. 609.

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: Ocn. 611; Stat. 601. (Offered in 1969-70 and in alternate years thereafter.)

653. Synoptic Physical Oceanography. (2-2). Credit 3. I

Methods, climatology of the air-sea boundary, evolution of oceanic waters quasi-permanent and varying upper oceanic currents, vertical motions, spreading of waters, abyssal circulation, planetary heat distribution, observational design. Prerequisite: Ocn. 609. (Offered in 1970-71 and in alternate years thereafter.)

681. Seminar I. (1-0). Credit 1. I

Presented by students and based upon their research work and upon surveys of literature.

682. Seminar II. (1-0). Credit 1. II

Seminar intended for Ph.D. candidates. Searching discussions of recent topics in the field, participation by students and staff. Prerequisite: Two years of graduate oceanography work.

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, J. S. OSOBA*, J. R. PEDIGO, 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.

*Graduate Advisor

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

R. P. BECKA, M. M. DAVENPORT (Head)

601. Major Philosophical Issues. (3-0). Credit 3. I, II, S
Designed to introduce graduate students to major issues of philosophical thought.

641. Mathematical Logic. (3-0). Credit 3. I
Formal development of first order logic together with extensive metamathematical investigation of this theory.

*Graduate Advisor

DEPARTMENT OF PHYSICS

T. W. ADAIR, J. D. BRONSON, J. B. COON*, N. M. DULLER, JR., P. J. GREEN, J. S. HAM, J. C. HIEBERT, J. C. HILL, G. W. KATTAWAR, R. A. KENEFICK, R. L. KOZUB, J. KUBIS, J. KUBLER, H. R. LERIBAUX, C. W. LEWIS, F. A. McDONALD, J. A. McINTYRE, L. C. NORTHCLIFFE, J. NUTTALL, W. A. PEARCE, G. N. PLASS (Head), C. F. SQUIRE, R. K. UMERJEE, D. F. WEEKES, B. H. WILDENTHAL, D. H. YOUNGBLOOD

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 or academic research 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 areas of members of the department include theory of elementary particle interactions, quantum field theory, theoretical nuclear physics, nuclear structure, low temperature physics, transport properties of solids, molecular structure, radiative transfer, atmospheric physics, and cosmic ray physics. Special research facilities include a nuclear reactor presently operating at 100 kilowatts, an 88-inch cyclotron, and an IBM digital computer.

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. II, S

Postulational development. Hamiltonian formalism, canonical transformations, representation and expansion theory, perturbation theory. Prerequisite: Phys. 412, Math. 309 or 601.

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. Prerequisites: Phys. 408; Math. 309 or 601.

611. Electromagnetic Theory. (4-0). Credit 4. II

Continuation of Phys. 603. Boundary value problems of vector wave equation, effect of matter on waves, anisotropic dielectrics, dispersive media. Prerequisite: Phys. 603.

617. Physics of the Solid State. (3-0). Credit 3. I, S

Crystalline structure, lattice vibrations, dielectric phenomena, luminescence, magnetism, free electron and band theories, semi-conductors. Prerequisites: Phys. 412, 607.

624. Quantum Mechanics. (4-0). Credit 4. I

Continuation of Phys. 606. Scattering theory, angular momentum theory, matrix mechanics, application to atomic and nuclear systems, semi-classical radiation theory. Prerequisite: Phys. 606.

625. Nuclear Physics. (3-0). Credit 3. I

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. I

Perfect and imperfect crystal lattices, interaction of electromagnetic radiation with nonconducting crystals, metallic cohesion, transport phenomena, semiconductors. Prerequisite: Phys. 617. (Offered in 1970-71 and in alternate years thereafter.)

632. Molecular Structure. (4-0). Credit 4. II
Applications of group theory, electronic structure of molecules, molecular vibrations, the rigid rotator, ultraviolet and infrared spectra. Prerequisite: Approval of instructor. (Offered in 1970-71 and in alternate years thereafter.)
*Graduate Advisor

634. Relavistic Quantum Field Theory. (3-0). Credit 3. I
Perturbation theory and renormalization techniques, dispersion relations, Mandelstam representation. Prerequisite: Phys. 606. (Offered in 1969-70 and in alternate years thereafter.)

635. Scattering Theory. (3-0). Credit 3. I
Scattering of particles by noncentral fields, polarized particles, scattering of pions and nucleons by nucleons, the optical model, the deuteron stripping reaction. Prerequisite: Phys. 606. (Offered in 1970-71 and in alternate years thereafter.)

636. The Many-Body Problem. (3-0). Credit 3. II
Nuclear matter, liquid He^3, the Bose gas, the electron gas, superconductivity. Prerequisite: Phys. 606. (Offered in 1969-70 and in alternate years thereafter.)

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. I
Many-body kinetic theory of plasmas, plasma fluctuations, propagation of electromagnetic waves through plasmas, magnetohydrodynamics, plasma stability and confinement. Prerequisites: Phys. 603, 607, 624.

640. Theory of Liquids. (2-0). Credit 2. I
Discussion of statistical mechanics of simple liquids for equilibrium and non-equilibrium phenomena. Shows how every property may be calculated from first principles. Predictions of theory compared to experimental results. Emphasis on physical content rather than mathematics. Prerequisite: Phys. 607.

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. (Offered in 1969-70 and in alternate years thereafter.)

645. Nuclear Theory. (3-0). Credit 3. II
Topics of current interest, e.g., multiple theory of electromagnetic interaction, shell model, and collective model of nucleus. Prerequisites: Phys. 606, 625. (Offered in 1969-70 and in alternate years thereafter.)

648. Cosmic Rays. (3-0). Credit 3. II
Phenomenology and theory of contemporary cosmic ray physics with emphasis on subjects of current research interest. Prerequisites: Phys. 603, 606; approval of instructor. (Offered in 1970-71 and in alternate years thereafter.)

654. Low Temperature Physics. (3-0). Credit 3. II
Continuation of Phys. 644. Topics from current literature involving latest theories and experiments on superfluids, thermal properties of solids, and electromagnetic effects on matter at very low temperatures. Prerequisite: Phys. 644. (Offered in 1969-70 and in alternate years thereafter.)

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. APPLEGATE, J. G. ATKINS, J. R. BAUR, C. R. BENEDICT, L. S. BIRD, G. A. DONOVAN, D. R. ERGLE, R. A. FREDERIKSEN, C. E. GATES, F. J. GOUGH, W. C. HALL, R. S. HALLIWELL, A. L. HARRISON, G. E. HART, H. E. JOHAM*, N. M. KIEFFER, S. D. LYDA, R. E. MEYER, C. S. MILLER, P. W. MORGAN, R. D. POWELL, D. W. ROSBERG* (Head), H. W. SCHROEDER, J. D. SMITH*, L. R. SMITH, E. R. SWANSON, W. H. THAMES, JR., R. W. TOLER, E. F. VAN ARSDEL, G. M. WATKINS*

GENETICS SECTION

Programs in the various areas of genetics are supervised by members of the Genetics Faculty. For a listing of all genetics courses and of the interdepartmental Genetics Faculty, please refer to the Catalogue listing under Genetics, page 104.

The principal objective of the genetics section is to train graduate students in basic genetics. Research is an essential part of the work leading to graduate degrees. Faculty supervision and facilities are available to support work related to biochemical genetics, cytogenetics, forest genetics, microbial genetics, molecular genetics, population genetics and physiological genetics.

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. 602.

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 specialty 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 genetic parameters, statistical aspects of quantitative inheritance. Prerequisites: Gen. 603; Stat. 602.

625. Speciation. (2-0). Credit 2. II

Study of genetic and environmental forces which operate in species formation together with critical examination and comparison of more important current explanations of speciation. Prerequisite: Gen. 603 or approval of instructor. (Offered in 1970-71 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; chemical nature of agents of heredity. Prerequisites: Bi.Ch. 410 or 603; Gen. 301.

*Graduate Advisor

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 1970-71 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 1970-71 and in alternate years thereafter.)

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

Reports and discussions of topics of current importance in genetics. Reports to be prepared and presented by graduate students enrolled in course.

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

Individual problems or research not pertaining to thesis or dissertation.

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

Prerequisite: Gen. 603.

See Animal Science 616, 628; Poultry Science 613; Statistics 602 for descriptions of related courses.

PLANT PATHOLOGY SECTION

Plant pathology is the science of plant diseases, their nature, causal agents and interrelated phenomena. The major objectives concern the scientific training of professional phytopathologists, as well as majors and minors in the plant sciences. Emphasis is placed on the fundamental and practical concepts associated with pathology and the conceptual schemes of fungal, bacterial, viral, helminthological, mycoplasmal and physiogenic diseases. In addition, superior facilities are available for research in most all phases including physiology of parasitism, host parasite relationships, genetics of host resistance, genetics of pathogen variation and variability, ecology of soil-borne pathogens, etiology and epidemiology of plant diseases, nematology, virology, phytotherapeutics and clinical phytopathology.

616. Methods in Plant Pathology. (2-6). Credit 4. I

Familiarization with standard principles, techniques, and equipment used in investigation of plant disease and plant pathogens. Prerequisite: Pl.Pa. 301 or equivalent.

617. Parasitism in Plant Disease. (3-3). Credit 4. I

Critical review of literature on parasitism, mechanisms of host defense, and host-parasite interactions. Theoretical aspects of parasitism stressed. Prerequisite: Pl.Pa. 301.

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: Pl.Pa. 301 or equivalent. (Offered in 1969-70 and in alternate years thereafter.)

619. Forest Pathology. (3-3). Credit 4. II

Life histories of representative tree diseases. Concept of parasitism, physiological relationships, epidemiology and control of forest tree diseases. Prerequisite: Pl.Pa. 301 or approval of instructor.

620. Plant Viruses. (2-3). Credit 3. II

Study of nature and properties of plant viruses and plant virus diseases. Prerequisite: Pl.Pa. 301 or equivalent. (Offered in 1969-70 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: Pl.Pa. 621 or equivalent. (Offered in 1969-70 and in alternate years thereafter.)

623. Diseases of Field Crops. (2-3). Credit 3. II
Intensive study of both fundamental and practical aspects of more important and representative diseases of field crops. Plant disease problems peculiar to extensive cultivation methods will be stressed. Prerequisite: Pl.Pa. 301.

624. Diseases of Fruit, Vegetables and Ornamentals. (2-3). Credit 3. I
Study of various disease inciting agents responsible for fruit, vegetable, and ornamental diseases. Emphasis upon fungal identification, host-parasite physiology pathogen dissemination and control of the pathogen. (Offered in 1970-71 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 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: Pl.Pa. 301 or equivalent.

691. Research. Credit 1 or more each semester. I, II, S
Original investigations in support of thesis or dissertation.

PLANT PHYSIOLOGY SECTION

The primary objective of this section is to train students in basic plant physiology. Facilities for research and coursework include modern, well-equipped laboratories and greenhouses. Because of the availability of specialized equipment and excellent faculty, students are able to conduct research in phytohormones and bioregulating systems, mineral nutrition, physiology of disease resistance, defoliation and desiccation air pollution, systemic chemicals, plant nucleic acids and environmental physiology. Excellent support in the basic sciences and biochemistry make it possible to give the plant physiology student the breadth of training necessary for his profession.

601. Physiological Plant Chemistry. (3-0). Credit 3. II
Advanced course dealing with chemical constitution of plants and interrelationship of various types of plant constituents. Topics included are bioenergetics, photosynthesis, proteins, enzymes, carbohydrates, lipids, and nucleic acids. Prerequisites: Chem. 228; Pl.Ph. 314.

605. Plant Metabolism. (3-0). Credit 3. I
Metabolic pathways of major classes of plant compounds, respiration and photosynthesis as metabolic processes and bioenergetics. Prerequisites: Chem. 228; Pl.Ph. 314.

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: Pl.Ph. 314. (Offered in 1969-70 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: Pl.Ph. 314.

610. Environmental Physiology. (2-0). Credit 2. I
A quantitative study of the biological and agricultural effects of elements of the environment including pollutants. Prerequisite: Approval of instructor.

611. Plant Nutrition. (3-0). Credit 3. I
Inorganic nutrition of plants, including solute absorption, accumulation and translocation, growth in artifical media, physiological roles of various elements and biochemical problems associated with salt absorption. Prerequisite: Pl.Ph. 314.

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: Pl.Ph. 314.

613. Plant Growth and Development. (3-0). Credit 3. II
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: Pl.Ph. 314.

681. Seminar. (1-0). Credit 1 each semester. I, II
Reports and discussions of topics of current interest in plant physiology including reviews of literature on selected subjects.

685. Problems. Credit 1 to 4 each semester. I, II, S
Individual problems or research not pertaining to thesis or dissertation. Prerequisite: Pl.Ph. 314.

691. Research. Credit 1 or more each semester. I, II, S
Original investigations in support of thesis or dissertation.

DEPARTMENT OF POLITICAL SCIENCE

W. E. BENTON, W. C. GIBBONS* (Head), K. H. RO

Graduate study in political science is offered leading to the degree of Master of Arts. The graduate program in political science is designed to give added preparation to students for teaching, government service, and for continuing graduate study in either history or political science leading to a doctorate. 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 economics, education, English, mathematics, science. or other social sciences, including history. The minor must be some field outside of the major field of study.

Prerequisites: For a major in political science 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 six advanced hours) in the minor field of study. See page 46 of this catalogue.

608. The American Presidency. (3-0). Credit 3. II, S
The office of President of the United States; its place in the constitutional and political system. Emphasis on modern experience and current problems of the office. Prerequisites: Six hours of advanced Political Science; approval of Department Head.

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 political science or equivalent.

613. Communist China in World Politics. (3-0). Credit 3. I, II, S
Analysis of formulation, substance and conduct of Communist Chinese foreign policy. Special attention given forces shaping Communist China's behavior in area of international politics.

623. Ancient and Medieval Political Theories. (3-0). Credit 3. I, S
An exposition and critical analysis of major political philosophers and schools of political thought from Plato to Machiavelli. Prerequisites: Six hours of advanced political science.

624. Theories of International Politics. (3-0). Credit 3. I, II, S
Nature and tasks, limits and goals, of interstate theory. Examines ends-means relationship, mechanisms of systematic adjustment, international legality and morality, national interest question, level of analysis problem, and role of description, explanation and prediction. Includes Machiavelli, Rousseau, Ranke, traditionalist theory, systems approaches, decision-making theory, quantitative techniques, and historical sociology. Prerequisite: Approval of Department Head.

*Graduate Advisor

631. Comparative Political Systems. (3-0). Credit 3. I, II, S
Comparative study of political systems using a developmental approach with emphasis on national integration, securing loyalty and commitment of citizenry and developing citizen participation, distribution of economic benefits, system maintenance and adaptation to change.

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 political science.

635. International Relations of Latin America. (3-0). Credit 3. II, S
Descriptive analysis of political and economic relations of Latin American countries within and without the western hemisphere, with emphasis upon defense, communism, trade and economic problems, foreign policies of major countries, major disputes, role of OAS. Prerequisite: Pol.S. 331 or 335 or six hours of Latin American history.

640. Government and the American Economy. (3-0). Credit 3. II, S
Relationships of government to economic system, political and economic background of government regulation, past and present trends in government policy. Government as protector of public interest and promoter of particular interest, control, organization, and procedure of regulatory agencies, development of administrative law and judicial interpretations. Prerequisites: Econ. 204; Pol.S. 206.

641. Politics and Administration. (3-0). Credit 3. I, S
The influence of partisan and pressure group activities in the formation and execution of public policy. Case studies of decision making and administrative techniques. Prerequsites: Six hours of advanced political science; approval of Department Head.

642. Scope, Theory, and Techniques of Political Analysis. (3-0). Credit 3. I, S
Consideration of evolution and present status of political science as a discipline and as a profession, including different theoretical approaches, relation of political science to philosophy, traditional and behavioral orientations; elements of systematic analysis, concepts and procedures of scientific investigation, research techniques, and bibliographical survey. Prerequisites: Twelve hours of advanced political science.

685. Problems. Credit 1 to 4 each semester. I, II, S
Individual instruction in selected fields of political science. Will stress reports and wide reading in field selected. Prerequisites: Eighteen hours of political science 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 political science.

DEPARTMENT OF POULTRY SCIENCE

R. L. ATKINSON, J. R. COUCH, C. R. CREGER, R. C. FANGUY, T. M. FERGUSON, F. A. GARDENER, J. R. HOWES, W. F. KRUEGER, D. B. MELLOR, 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.

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

*Graduate Advisor

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 Biophysics, Biology, and the Genetics Section of the Department of Plant Sciences, the department is in a position to offer graduate work leading to the Master of Science and Doctor of Philosophy degrees in the fields of poultry genetics and breeding, poultry nutrition and feeding, avian physiology, incubation, brooding and rearing, production and management, 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. Environmental and Developmental Relationships. (3-2). 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, methods of maintaining quality, effects of storage conditions and of time on egg and meat quality. Production factors affecting 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 or 232; P.S. 411.

*Graduate Advisor

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 PSYCHOLOGY

A. J. CASEY, J. M. ELLIOTT, L. H. HOPE, W. R. SMITH (Head), W. A. VARVEL*

603. Motivation and Cognitive Processes. (3-0). Credit 3. I
Selected topics in areas of motivation and higher mental processes, including symbolic processes in perceptual organization; consideration of learning and remembering, reasoning, and creativity.

604. Personality and Social Behavior. (3-0). Credit 3. II
Study of cultural determinants of personality and complex social behavior with emphasis upon personality theories, role of society in formation and control of individual behavior, and experimental studies of psychotherapeutic approaches.

607. Experimental Psychology. (2-3). Credit 3. I
Problems and techniques of investigating psychophysical, sensory, perceptual, and psychophysiological processes. Prerequisites: Psy. 408 or equivalent; graduate classification.

610. Industrial Psychology. (3-0). Credit 3. II
Comprehensive study of current research and literature in industrial psychology with emphasis on personnel selection, training of skilled and managerial personnel, men-machine systems, employee motivation and morale.

612. Behavior Modification. (3-0). Credit 3. I
Principles of behavior theory and techniques of application to pathological and deviant behaviors. Prerequisite: Psy. 406 or approval of Department Head.

623. Standardized Tests and Measurements. (3-0). Credit 3. I, II, S
Principles of psychological testing. Uses and critical evaluation of tests of achievement, intelligence, aptitude, and personality.

624. Individual Testing. (2-3). Credit 3. I, II, S
Practicum in administration and interpretation of Stanford-Binet and Wechsler-Bellevue intelligence tests. Introduction to individual tests of personality. Prerequisite: Psy. 623 or registration therein.

634. Principles of Human Development. (3-0). Credit 3. I, II, 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.

681. Seminar. (1-0). Credit 1. I, II
Group study and discussion of current periodical literature not covered by formal course work. Psychology as a profession, ethical responsibilities.

685. Problems. Credit 1 to 4 each semester. I, II, S
Directed individual study of selected problem in psychology or special topics to fit small group requirements. Prerequisite: Approval of Department Head.

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

DEPARTMENT OF RANGE SCIENCE

J. R. BAUR, R. W. BOVEY, J. D. DODD, E. J. DYKSTERHUIS, F. W. GOULD, C. L. LEINWEBER* (Head), W. G. McCULLY, R. G. MERRIFIELD, D. M. MOEHRING, L. B. MERRILL, R. R. RHODES

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.

*Graduate Advisor

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 substations 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 preparations in botany, agronomy, and animal science, as well as in the fundamentals of economics, chemistry, and mathematics.

FORESTRY SECTION

Graduate study in forestry is offered in forest ecology, forest soils, silviculture, wood chemistry, and wood technology. Related forestry programs in entomology, genetics and pathology are offered in other departments. Training in these fields is oriented toward preparing a student for teaching and research positions.

Students are given the opportunity to actively participate in research covering any one of several fields of specialization, utilizing facilities located on the campus as well as at field centers in the forested region of East Texas.

Graduate programs are developed by the student under the guidance of a graduate committee. The nature of these programs is largely governed by the interests and needs of the individual student.

601. Forest Ecology. (3-0). Credit 3. I

Detailed study of forest communities and successions, interrelationships of various life forms of forest stands. Occasional field trips. Prerequisite: For. 302.

602. Advanced Silviculture. (3-0). Credit 3. II

Study of advanced silvicultural methods, techniques and problems including current and recent research and technical literature. Occasional field trips. Prerequisites: For. 302, 305.

603. Forest Management. (3-0). Credit 3. I

Economic theories and principles applied to production of forests and forest products. Occasional field trips. Prerequisites: For. 403, 404.

604. Forest Management. (3-0). Credit 3. II

Management of timberlands for economic returns, including study of technical literature related to methods and techniques of forest management. Occasional field trips. Prerequisites: For. 403, 404.

605. Forest Practices. (4-0). Credit 4. I, II

Principles of forest development as related to silvicultural practices and systems. Techniques of measurement and management for regulation and administration of forest properties. Review of current systems of forest product marketing. Prerequisite: Graduate classification in agriculture or allied subjects.

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

For graduate students and staff members in forestry. Presentation and discussion of current scientific work in forestry and closely related subjects.

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

Designed for investigations not included in student's research for thesis or dissertation. Problems to be selected in some aspect of forestry.

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

Research in an approved aspect of forestry for thesis or dissertation credit.

RANGE SCIENCE SECTION

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 substations 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 range science must have adequate preparation in botany, agronomy, and animal science, as well as in the fundamentals of economics, chemistry, and mathematics.

601. Range Resource Use. (3-0). Credit 3. II, S
Inventory and management of range resources of North America with emphasis on Texas and the Southwest. Trends in range classification, practices, and economics. Field work arranged on individual basis. Prerequisite: Graduate classification in agriculture or related subject matter areas.

602. Ecology and Land Uses. (3-0). Credit 3. I
Ecological foundations for sustained use of natural resources. Climate, edaphic, biotic, and cultural factors in land resource allocation. Iand and cover viewed with respect to population dynamics, succession and climax, gradients and gradation, equilibria and imbalance. Prerequisite: Graduate classification in agriculture or in allied subjects.

605. Range Research Methods. (3-0). Credit 3. I
Study of research methods in range management and related subjects. Review of scientific investigation in field and analysis of results. Prerequisite: Graduate majors and minors in range science.

606. Range Economics. (3-0). Credit 3. 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 or equivalent.

609. Plant and Range Ecology. (3-0). Credit 3. II
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; or approval of Department Head.

611. Control of Noxious Range Plants. (3-0). Credit 3. I
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.

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 majors in range science.

DEPARTMENT OF RECREATION AND PARKS

R. L. BURY, C. A. GUNN*, L. M. REID* (Head), F. W. SUGGITT, C. S. VAN DOREN

The Department of Recreation and Parks offers a course of study leading to the Master of Science and Doctor of Philosophy degrees in Recreation and Resources Development with emphasis in the fields of recreation administration, park planning, recreational travel or tourism, economics of public and commercial enterprises, and area resource development. Graduate study in recreation and parks is by nature highly interdisciplinary and the departmental graduate faculty is comprised of outstanding scholars with a depth and breadth of experience in research and varied fields of service which benefits the student with a theoretical and applied approach to the profession. Close cooperative relations exist with a large number of disciplines including sociology, regional and urban planning, economics, range science and forestry, which affords unexcelled opportunities for a student to build a diversified program in the areas of his choice.

Graduate course offerings in the Department of Recreation and Parks are designed to provide scientific solutions to current and possible future problems encountered by administrators, educators and practitioners through the most recent valid and reliable techniques and methods of research and evaluation. Emphasis is placed upon the fundamental and practical concepts associated with the planning and administration of recreation and park areas and systems. This includes studies in comprehensive recreation resource planning, quality and carrying capacity, user preferences and demand, agency administration, and alternative methods for meeting leisure needs.

Courses selected within the department and in supporting fields are designed to serve the individual needs of persons interested in teaching, extension, research or administration of recreation developments. These courses stress the study of spatial relationships between humans and the natural environment in various recreational settings in which the primary concern is managerial response to man's critical need of open space, urbanization and utilization of leisure through recreational pursuits.

*Graduate Advisor

603. Recreational Organization and Policy. (3-0). Credit 3. I

Study of executive leadership in park departments and recreation agencies with particular emphasis on administration of recreation resources to meet human needs, decision making, and the structuring of organizational goals. Prerequisite: R.P. 403 or approval of Department Head.

607. Recreation and Park Design. (2-3). Credit 3. II

Problem solutions dealing with contemporary and creative treatment of site development with emphasis on functional, aesthetic, and economic considerations. Prerequisite: R.P. 402 or equivalent.

611. Recreation Systems Planning. (2-3). Credit 3. I

Study of basic concepts and methods necessary for identification and rational allocation of resources for recreation. Employs projections, attendance, and preference studies as tools of demand analysis. Includes study of demographic, mobility, and socio-economic factors as guide to recreation planning. Prerequisite: Stat. 602 or equivalent.

681. Seminar. (1-0). Credit 1. I

Preparation and discussion by students of special reports, topics, and research data in recreation and parks. Presentation of subjects of professional significance by staff members and invited speakers.

*Graduate Advisor

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

Designed for investigations not included in student's research for thesis or dissertation. Problems selected in administration or management, recreation, or planning.

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

Research in recreation and parks for thesis or dissertation.

DEPARTMENT OF SOIL AND CROP SCIENCES

W. B. ANDERSON, I. M. ATKINS, E. C. BASHAW, H. T. BLACKHURST*, M. E. BLOODWORTH (Head), H. H. BOWEN, R. D. BRIGHAM, M. S. BROWN, E. BURNETT, E. E. BURNS, L. E. CLARK, J. W. COLLIER, E. D. COOK, J. P. CRAIGMILES, A. F. DeWERTH*, J. B. DIXON, E. F. EASTIN, M. H. FERGUSON, P. A. FRYXELL, C. J. GERARD, E. C. GILMORE, G. L. GODFREY, H. E. HAMPTON, E. C. HOLT, M. L. KINMAN, R. J. KOHEL, G. W. KUNZE, J. E. LARSEN, P. J. LYERLY, T. E. McAFEE, G. G. McBEE, M. E. McDANIEL, N. P. MAXWELL, M. G. MERKLE, O. G. MERKLE, M. H. MILFORD*, J. F. MILLS, G. A. NILES, D. R. PATERSON, B. A. PERRY, K. B. PORTER, R. C. POTTS, T. R. RICHMOND, L. W. ROONEY, J. R. RUNKLES, K. F. SCHERTZ, J. W. STANSEL, R. D. STATEN, J. B. STOREY, A. R. SWOBODA, E. L. WHITELY, A. F. WIESE, F. D. WILSON

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 Biophysics 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.

603. Cytological and Histological Principles in Plant Breeding. (2-3). Credit 3. II

Modern concepts and recent developments for advanced students in plant and soil sciences and related fields employing microscopic evaluation. Specimen preparation, stain technology, theory and use of microscopes, micromanipulators, microtomes, the microtome cryostat, use of equipment in modern cytological research. Prerequisites: Graduate classification; Biol. 422 or approval of instructor.

605. Pedology. (3-0). Credit 3. I

Advanced study of development, morphology, constitution, and classification of soils. Prerequisites: Agro. 301, 411, or approval of instructor.

607. Field Study of Texas Soils. (4-6). Credit 6. S

Field and laboratory course relating physical and chemical properties, description, classification, and management of major kinds of soils in Texas to agricultural and to urban and other nonagricultural uses. Tours and lectures held at research and other facilities throughout State. Prerequisites: Agro. 605 or approval of instructor; approval of Department Head. (Offered in 1970 and alternate years thereafter.)

---

*Graduate Advisor

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 1970-71 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 1969-70 and in alternate years thereafter.)

620. Saline and Sodic Soils. (2-3). Credit 3. S
Intensive and advanced study concerning fundamentals in diagnosis, nature, and management of saline and sodic soils, especially as they relate to physiochemical properties of soils and agronomic phases of irrigation agriculture. Water quality, as related to growth and development of crop plants, is also studied. Prerequisites: Agro. 445, 618; or approval of instructor.

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; Chem. 324. (Offered in 1970-71 and in alternate years thereafter.)

625. Colloidal Chemistry of Soils and Clays. (3-3). Credit 4. II
Advanced study of colloidal surface properties of soils and clays. Effect of chemical and physical properties of colloids on adsorption of ions, organic molecules, gases and water. Laboratory emphasizes techniques for studying physio-chemical properties of colloids. Prerequisites: Agro. 624, 626; Chem. 324.

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 1969-70 and in alternate years thereafter.)

627. Soil Fertility Relationships. (3-0). Credit 3. II
Advanced study of behavior of nutrient elements in soils and plants. Emphasis placed on nitrogen, phosphorus and potassium. Prerequisites: Agro. 422; PlPh. 314. (Offered in 1970-71 and in alternate years thereafter.)

630. Cereal Grains for Human Food. (3-3). Credit 4. II
Includes discussion of fundamental concepts of dry milling, wet milling, oil extraction, baking, malting, brewing, storage, sanitation, and quality evaluation and control interrelated with physical and biochemical properties of cereals and their products. Laboratory includes use of instruments and techniques to evaluate cereal quality. Prerequisite: Approval of instructor.

631. Chemical and Physical Characteristics of Cereals. (3-0). Credit 3. I
Properties of cereals and cereal products as affected by growth, storage, and physical, chemical, and biological factors. Discussion of dough structure and rheology and enrichment of cereal products. Prerequisite: Bi.Ch. 410.

641. Plant Breeding. (3-0). Credit 3. II
Study of theoretical and practical aspects of plant breeding, including genetic basis. Application of breeding methods and interdisciplinary considerations in breeding problems. Prerequisites: Gen. 603; Stat. 602.

650. Chemical Weed Control. (2-3). Credit 3. I
Detailed study of families of herbicides. Emphasis given to relationship of molecular structure to herbicidal activity, mode of action, pathways of degradation, and herbicidal interactions. Prerequisite: Agro. 450 or approval of instructor.

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 Genetics 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 Foilage Plants. (2-2). Credit 3. II
Intensive study of rare and exotic plants of tropical and subtropical regions of world. Identification, adaptation, cultural requirements, propagation, and economic importance. Specific problems in taxonomy, physiology, and anatomy of these plants.

615. Greenhouse Problems Diagnosis. (2-0). Credit 2. II
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.

616. Plant Reproduction. (2-2). Credit 3. II, S
Basic scientific principles underlying highly technical practices involved in reproduction of plants by sexual and asexual methods. Current developments in anatomical, morphological, and physiological factors involved in plant regeneration. Prerequisite: Flor. 424 or approval of instructor.

617. Landscape Horticulture. (2-3). Credit 3. I, S
Relations of plants to landscape environments. Study of basic underlying scientific principles involved in improvement and maintenance of physical landscape environments in urban, suburban, and rural areas. Selection, culture, and maintenance of plants in the landscape; changing demands created by modern living. Prerequisite: Flor. 609 or approval of instructor.

685. Problems. Credit 1 to 4 each semester. I, II, S
Individual problems or research not pertaining to thesis or dissertation. Prerequisite: Approval of instructor.

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 additional departments. Supporting work may be required in several of the related fields such as chemistry, botany, plant pathology, plant physiology, entomology, soils, genetics, nutrition, and agricultural engineering. The specific objective of the individual student will guide his committee in the choice of courses from the departments mentioned above and others in special cases.

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 1969-70 and in alternate years thereafter.)

602. Factors Influencing Fruit Production. (3-3). Credit 4. II
Influencing 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 1970-71 and in alternate years thereafter.)

603. Structure of Vegetable Plants. (3-3). Credit 4. I
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.

614. Vegetable Propagation. (2-3). Credit 3. II
Fundamental principles and practices of vegetable reproduction, factors affecting seed development. Handling, storage, and processing of vegetable seeds; the seed industry; breeding and trial grounds; seed certification, storage, and longevity. Prerequisite: Hort. 322 or approval of instructor.

615. Origin and Distribution of Horticultural Plants. (2-3). Credit 3. II
Study of origin, distribution, identification, classification, and description of horticultural crops. Importance of genetic knowledge to continued improvement of horticultural crops. Prerequisite: Agro. 304 and/or approval of instructor.

644. Food Quality. (2-3). Credit 3. II
Advanced studies on physical, chemical, and biological properties of foods. Fundamental attributes of flavor, color, odor, texture. Esthetic, ethnic, and nutritional requirements. Role of additives. Regulatory standards and quality control regimes. Current techniques in food investigations.

681. Seminar. (1-0). Credit 1. I, II
Student and staff participation in review of literature and reporting on current developments in research on production and processing of horticultural crops. Required of all graduate students in horticulture.

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

R. J. FREUND*, C. E. GATES, H. O. HARTLEY (Director), R. R. HOCKING, J. N. K. RAO, W. B. SMITH

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.

*Graduate Advisor

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.

601. Statistical Analysis. (3-2). Credit 4. I, II, S
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.

602. 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 nonparametric methods. Prerequisite: Stat. 406 or equivalent.

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 602. (Offered in 1970-71 and in alternate years thereafter.)

604. Special Problems in Statistical Computations and Analysis. (3-0). Credit 3. II
Computer algorithms for programming with emphasis on statistical analysis, efficient uses of existing statistical computer programs, generation of random numbers and statistical variables, programming of simulation studies, selected topics in statistical analysis not covered in Stat. 601 or 602. Prerequisites: I.En. 201; Stat. 608 or 619.

606. Design of Experiments. (2-3). Credit 3. I
Fundamental concepts in designing experiments, justification of linear models, randomization, principle of blocking, use of concomitant observations, construction and analysis of basic designs. Principles of confounding, fractional replication, composite designs, incomplete block designs. Prerequisite: Stat. 619 or approval of instructor.

607. Sampling. (3-0). Credit 3. I
Planning, execution, and analysis of sampling from finite populations; simple, stratified, multistage, and systematic sampling; ratio estimates. Prerequisite: Stat. 601 or 602.

608. Least Squares and Regression Analysis. (3-0). Credit 3. I, 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 602.

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 602. (Offered in 1969-70 and in alternate years thereafter.)

611. Theory of Statistics. (3-3). Credit 4. II
The concept of probability, probability distribution, moment generating functions and limit theorems; 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 nonstationary stochastic processes, autoregressive processes and correlogram analysis, harmonic-periodogram and spectral analysis. Markoff and diffusion processes. Prerequisites: Math. 409, 601; Stat. 611. (Offered in 1969-70 and in alternate years thereafter.)

616. Multivariate Analysis. (3-0). Credit 3. II
Multivariate normal distributions and multivariate generalizations of classical test criteria, Hotelling's T^2, discriminant analysis and elements of factor and canonical analysis. Prerequisites: Math. 409; Stat. 601 or 602, 611.

617. Theory of Sampling. (3-0). Credit 3. I
General randomization theory of multistage sampling of finite populations, sampling with and without replacement and with equal and unequal probabilities, ratio and regression estimates in multiphase sampling, analytic studies and multiframe problems. Prerequisites: Stat. 607, 611.

618. Advanced Experimental Design. (3-0). Credit 3. II
Randomization theory of experimental design. General analysis of experimental design models. Role of Galois fields and their related definite geometries in the general p^n factorial representation, confounding and fractional replication. Construction and analysis of balanced and partially balanced incomplete block designs. Designs for special situations. Prerequisites: Stat. 606, 611, 612. (Offered in 1969-70 and in alternate years thereafter.)

619. Analysis of Variance. (2-3). Credit 3. I, II
Analysis of variance in experimental statistics; single and multiple classifications, factorials. Analysis of designed experiments including randomized blocks, Latin squares, split plots and simple confounded designs, multiple comparisons and orthogonal contrasts, analysis of covariance, analysis of non-orthogonal data. Prerequisite: Stat. 601 or 602.

621. Advanced Topics in Statistical Theory. (3-0). Credit 3. S
Topics in statistical theory not provided for in other courses and readings of current research topics in statistical theory published in leading statistical journals. Prerequisites: Stat. 606, 608, 613.

622. Advanced Topics in Statistical Methodology. (3-0). Credit 3. S
Topics in statistical methodology not provided for in other courses and readings of current topics in statistical methododogy published in leading statistical journals. Prerequisites: Stat. 606, 608, 612.

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 including exponential, log normal, gamma, and Weibull. Parameters studied include mean time to failure, failure rate, variances, and standard deviations, confidence limits, and tests hypotheses. Prerequisites: I.En. 614; Stat. 601; or approval of instructor.

626. Statistical Methods of Process Control and Optimization. (3-0). Credit 3. II
Statistical theory and methods of modern stochastic control systems including those based on autoregressive Markoff and related dynamic models, adaptive optimization and control, evolutionary processes, response surface analysis including steepest ascent methods and associated statistical estimation theory. Prerequisites: I.En. 614; Stat. 601; or approval of instructor. (Offered in 1970-71 and in alternate years thereafter.)

628. The Theory of Mathematical Programming. (3-0). Credit 3. II
Mathematical theory of linear and nonlinear programming including extensions to parametric, integer, and stochastic situations. Provides student with theory necessary to develop and apply the methodology of mathematical programming. Prerequisites: Math. 609; Stat. 412 or equivalent.

632. Statistical Decision Theory. (3-0). Credit 3. I
Decision rules, Bayes and minimax solutions, use of linear programming as a computational tool, sequences of decisions over time, sequential analysis. Prerequisites: Math. 609; Stat. 613. (Offered in 1969-70 and in alternate years thereafter.)

633. Statistical Information Theory. (3-0). Credit 3. I
Elementary exposition of information theory; link between Shannon's, Wiener's, and Fisher's concepts of information. Concept of "entropy" and statistical applications, statistical error correction by least squares procedures. Some theorems on groups and finite fields, error correcting codes. Prerequisites: Math. 416; Stat. 613; or approval of instructor. (Offered in 1970-71 and in alternate years thereafter.)

634. Response Surface Design and Analysis. (3-0). Credit 3. II
Definition of response surface, and relation to multiple regression, optimum finding procedures, steepest ascent, PARTAN, modified Gauss-Newton methods, designs for response surface estimation, optimization of response surface designs for various criteria, the Box-Draper theory, discrimination among mechanistic models. Prerequisites: Stat. 606, 608. (Offered in 1969-70 and in alternate years thereafter.)

635. Applications of Stochastic Processes to the Natural Sciences. (3-0). Credit 3. I
Basic concepts, Markov chains, branching processes, Markov processes in continuous time, homogeneous and non-homogeneous processes, multi-dimensional processes, queuing processes, epidemic processes, competition and predation, diffusion and non-Markovian processes. Prerequisites: Stat. 611 or 615; approval of instructor. (Offered in 1970-71 and in alternate years thereafter.)

636. Methods in Multivariate Analysis. (3-0). Credit 3. II
Multivariate extensions of the chi-square and t-test, discrimination and classification procedures. Applications to diagnostic problems in biological, medical, anthropological, and social research. Multivariate analysis of variance, factor-principal component-analysis canonical correlations. Prerequisites: Stat. 412 or equivalent, Stat. 619. (Offered in 1970-71 and in alternate years thereafter.)

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.

See Econometrics 660, 661, 663, 664 for descriptions of related courses.

STRUCTURAL MECHANICS

601. Theory of Elasticity. (4-0). Credit 4. I
Study of analysis of stress and strain in two and three dimensions, equilibrium and compatability 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, builtup 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
Unified study of continuous media using vectors and tensors.

605. Flow and Fracture of Solids. (4-0). Credit 4. II
Study of flow theories and fracture mechanisms of crystalline solids. Elasticity, materials science applications to engineering. Dislocation theory, fracture, creep, and fatigue.

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. I
Unified treatment of two and three dimensional structures 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 Lame's surface parameters. Membrane analysis, bending analysis, and shallow shell theory. Prerequisite: S.M. 603.

611. Plasticity. (3-0). Credit 3. II
Theory of perfectly plastic yield and flow of two and three-dimensional bodies. General theory of shear lines, velocity fields, and limiting lines are developed for problems of incipient, steady, and pseudo plastic flow. Prerequisite: Math. 601 or registration therein.

612. Energy Methods. (3-0). Credit 3. I
Study of principle of virtual work, Rayleigh-Ritz method, Reissner's Variational Theorem. Applications to linear and nonlinear problems in mechanics. Prerequisite: Math. 601 or registration therein.

613. Foundations of Solid Mechanics. (3-0). Credit 3. II
Fundamental description of displacement, stress and strain mechanisms in deformable solids. Major effort directed toward microscopic theory; comparison of macroscopic analysis. Prerequisite: Math. 601.

614. Rheology. (3-0). Credit 3. I
Study of basic dynamics and kinematics of viscous and viscoelastic fluids. Newtonian, non-Newtonian, and viscoelastic fluids are considered. Fundamentals of tensor analysis are included and are utilized in generalizing rheological equations of state. Prerequisite: Math. 601.

DEPARTMENT OF URBAN AND REGIONAL PLANNING

J. R. GARDNER, W. W. HARPER, J. J. McGRAW*, E. J. ROMIENIEC, R. F. WHITE

The objective of the graduate program in the Department of Urban and Regional Planning is to provide the Profession of Planning and the State of Texas with competent professions in the fields of urban and regional planning. In the process of making available to the student the appropriate facilities, programs and qualified faculty the Department becomes a center for the advancement and dissemination of knowledge in the art and science of planning.

Candidates for the degree of Master of Urban Planning are accepted, and encouraged to apply, from a broad range of disciplines and undergraduate programs. The work and attitude of the professional planner is interdisciplinary in nature; a close, effective relationship thus exists between students and faculty in planning with supporting programs in the social sciences, humanities, the arts, engineering sciences and architecture.

601. Introduction to Urban Planning. (3-9). Credit 6. I, S

General course dealing with cities as centers of civilization. Social, economic, and physical problems and opportunities of cities will be explored. Importance of general interdisciplinary approach will be stressed. Prerequisite: Approval of Chairman of School.

602. General Urban Development and Function. (3-9). Credit 6. II, S

Students will prepare general comprehensive plan for urban area within visiting distance of College Station. After adequate research, data collection, analysis and synthesis, plans and programs will be developed for the planning area on group and individual basis. Prerequisite: Approval of Chairman of School.

603. Regional and Area Planning. (3-9). Credit 6. I, S

General course of planning and its application to metropolitan and urban regions. Field trips and plans for Texas and the Southwest will be prepared. Areas other than those indicated may be studied provided adequate data is available. Prerequisite: Plan. 601, 602.

604. Urban and Regional Planning. (3-9). Credit 6. II, S

Continuation in depth of application of planning principles to student programs and projects distilled from previous work in Plan. 603. Prerequisite: Plan. 603.

611. Environmental Studies. (3-0). Credit 3. I, S

Interdisciplinary course offered to graduate students which introduces them to broad approach and view to man's environment. Program of analysis and design on individual and group basis of a study area. Prerequisite: Approval of Chairman of School.

613. Planning Methods and Techniques. (2-0). Credit 2. I, II, S

Lectures and discussions dealing with existing and potential methods of research, data collection, and analysis. Seminars coordinating planning process with public policy and plan implementation will be emphasized. Prerequisite: Approval of Chairman of School.

654. Planning Administration and Management. (1-0). Credit 1. II, S

Discussions by the faculty and others concerned with the activities of professional practice. Prerequisite: Approval of Chairman of School.

656. Housing and Community Facilities. (2-0). Credit 2. II, S

Discussions of housing, its development, planning, marketing, designing, financing, and production. Student program dealing with urban renewal, neighborhood structure, and community facilities will be presented. Prerequisite: Approval of Chairman of School.

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

Individual and group problems dealing with application of planning theory and practice. Opportunities will be presented the student to select foreign and domestic planning programs of special interest. Prerequisite: Plan. 603.

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

Research and dissertation. Prerequisite: Approval of Chairman of School.

---

*Graduate Advisor

DEPARTMENT OF VETERINARY ANATOMY

L. W. GIBBS, R. G. GREELEY*, A. G. KEMLER*, J. H. MILLIFF*, R. J. SIS (Head)

601. Anatomy. (1-9). Credit 4 each semester. I, II
Topographical dissection of domestic animals. Prerequisite: V.A. 302.

602. 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, G. M. GOWING, D. L. PIERMATTEI, J. C. RAMGE

603. Surgery. Credit 1 to 8 each semester. I, II
Special surgery of large or small animals. Prerequisite: D.V.M. degree.

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 and diagnostic aids discussed and demonstrated. Prerequisite: D.V.M. degree.

621. Reproductive Diseases of Female Domestic Animals. Credit 1 to 4. I, II, S
Advanced study of diagnosis, treatment, and control of diseases primarily affecting reproduction in female domestic animal. Prerequisite: D.V.M. degree.

622. Andrology. Credit 1 to 4. 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: D.V.M. degree

630. Small Animal Diagnostics. (0-3). Credit 1., (0-6). Credit 2., or (0-9). Credit 3. I, II, S
Advanced training in arts and science of diagnosis. Clinical and theoretical diagnostic models utilized for application of procedures which can be expected to yield accurate diagnoses. The logic of diagnosis is emphasized through rational application of facts disclosed by examination techniques and critically selected laboratory procedures. Prerequisite: D.V.M. degree.

*Graduate Advisor

685. Problems. Credit 1 to 8 each semester. I, II
Original investigations of problems in field of surgery, therapeutics, or radiology. Prerequisite: D.V.M. degree.

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

DEPARTMENT OF VETERINARY MICROBIOLOGY

J. E. GRIMES, L. C. GRUMBLES* (Head), C. F. HALL, F. C. HECK, R. J. HIDALGO, P. F. JUNGERMAN, K. L. KUTTLER, D. H. LEWIS, C. W. LIVINGSTON, JR., S. McCONNELL, R. W. MOORE, R. A. TODOROVIC

643. Pathogenic Bacteriology. (3-4). Credit 4. II
Study of pathogenic microorganisms, their cultural and biological characteristics and pathogenicity. Prerequisite: Minimum of eight hours of undergraduate microbiology.

646. Avian Virus Diseases. (4-0). Credit 4. I
Study of viral diseases of poultry including methods of isolation and identification of causative agents. Practice consists of conducting postmortem examinations and special diagnostic procedures on birds received daily for necropsy. Prerequisite: D.V.M. degree or equivalent.

647. Virology. (4-0). Credit 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: V.Mi. 438 or equivalent.

648. Medical 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: Minimum of eight hours of undergraduate microbiology.

649. Immunology. (3-3). Credit 4. I
Comprehensive study of antigens and antiserums including their immunochemical applications and relationships. The in vitro antigen-antibody reactions related to diagnostic serology and the in vivo antibody reactions related to applied immunology. Prerequisites: V.Mi. 335, 438, or equivalent.

650. Experimental Microbiology. (3-3). Credit 4. I
Familiarization, development and integration of techniques into experimental design of microbiologic investigation. Included are virus and protein purification, immunofluorescence, agar diffusion, immunoelectrophoresis, germ free animal techniques, microflora analysis and specialized serologic tests. Prerequisites: Bi.Ch. 410 or equivalent; eight hours of microbiology.

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: D.V.M. degree; approval of Department Head.

691. Research. Credit 1 or more. I, II, S
Research for thesis or dissertation.

*Graduate Advisor

DEPARTMENT OF VETERINARY PARASITOLOGY

R. R. BELL* (Head), T. J. GALVIN

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.

DEPARTMENT OF VETERINARY PATHOLOGY

W. W. BAY, C. H. BRIDGES* (Head), R. A. DENNIS, C. A. GLEISER, F. D. MAURER, K. R. PIERCE, W. K. READ, R. M. ROBINSON, R. W. STORTS

640. Mechanisms of Disease. (3-0). Credit 3. S
Concepts of pathogenesis of disease in animals. Prerequisite: D.V.M. degree or equivalent.

641. Systemic Pathology. (4-4). Credit 6. I
Study of disease manifestations in special organs and tissues and interrelations of pathological processes in individual and functionally related organs. Prerequisite: D.V.M. degree or equivalent.

642. Nutritional and Metabolic Diseases. (3-3). Credit 4. II
Study of spontaneous and experimental diseases caused either by deficiencies, excesses, or imbalances of specific nutrients, or by regulatory disturbances of metabolism in laboratory or domestic animals. Prerequisites: D.V.M. degree and Bi.Ch. 604; or V.A. 302 and Bi.Ch. 604 with approval of instructor.

643. Applied Pathology. Credit 1 or more. 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: D.V.M. degree 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: D.V.M. degree or equivalent.

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 of special laboratory techniques necessary to demonstrate such lesions. Prerequisite: D.V.M. degree or equivalent.

653. Diseases of Laboratory Animals. (2-2). Credit 3. II
Study of pathology and pathogenesis of spontaneous infectious, parasitic, metabolic, and neoplastic diseases of laboratory animals. Prerequisites: V.Mi. 438; V.Par. 484; V.Pat. 444; V.P.P. 427; or equivalents.

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.

*Graduate Advisor

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. Prerequisites: Approval of Department Head.

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

Advanced special problems concerned with pathogenesis and pathology of disease. Prerequisites: 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 M.S. or Ph.D. degree.

DEPARTMENT OF VETERINARY PHYSIOLOGY AND PHARMACOLOGY

D. R. CLARK, R. H. DAVIS, J. W. DOLLAHITE, G. L. HUEBNER, D. HIGHTOWER, J. D. McCRADY* (Head), M. SZABUNIEWICZ

601, 602. 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.

603. Endocrinology. (3-3). Credit 4. I

Study of physiology, biochemistry, and pharmacology of the endocrines. Laboratory emphasizes a number of classical experiments with clinical application. Prerequisites: Basic courses in morphology, physiology, and organic chemistry.

605, 606. 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. 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. 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.

613. Cardiovascular and Respiratory Physiology. (3-3). Credit 4. II

Detailed study of cardiovascular and respiratory physiology using highly specialized techniques and equipment. Prerequisite: V.P.P. 602 or 611 or equivalent.

614. Gastrointestinal and Ruminant Physiology. (3-3). Credit 4. I

Detailed physiologic study of digestion in monogastric and ruminating domestic animals. Prerequisite: V.P.P. 611 or equivalent.

615. Physiology of the Kidney and Body Fluids. (2-0). Credit 2. S

Detailed study of kidney and body fluids. Prerequisite: V.P.P. 611 or equivalent.

616. Neurophysiology. (2-0). Credit 2. S

Detailed study of physiology or nervous system. Prerequisite: V.P.P. 602 or 611 or equivalent.

625. Physiological Measurements. (3-3). Credit 4. II

Study of modern methods of measurement and recording of physiological phenomena in the living body as related to diagnosis, research, and teaching. Prerequisite: E.E. 463 or equivalent.

631. Instrumentation in Toxicological Analysis. (2-6). Credit 4. II

Introduction to analytical methods in toxicology with particular reference to procedures using modern laboratory instruments. Prerequisites: Chem. 316, 319; V.P.P. 611 or equivalent.

*Graduate Advisor

632. Metabolic and Detoxication Mechanisms. (3-0). Credit 3. I

Study of fate of foreign compounds with particular reference to their inhibitory and antagonistic action toward normal metabolic processes of the animal body. Prerequisites: Bi.Ch. 603; approval of instructor and Department Head.

633. Industrial Toxicology. (3-0). Credit 3. I

Study of industrial agents that are toxic with emphasis on industrial and occupational involvement. Prerequisite: Approval of instructor and Department Head.

634. Environmental Toxicology. (3-0). Credit 3. II

Study of hazards encountered from poisons contaminating environment. Prerequisite: Approval of instructor and Department Head.

635. Laboratory for Industrial and Environmental Toxicology. (0-6). Credit 2. II

Study of experimental design and techniques used in industrial and environmental toxicology in different species of animals. Prerequisite: Approval of instructor and Department Head.

636. Regulatory Toxicology. (4-0). Credit 4. S

Study of laws, rules, and regulations applicable to toxic materials; drugs, pesticides, chemical, air, water, and food pollutants. Course will include development of understanding of regulations; problems and techniques involved in evaluation of hazards; inspection, seizure, and prosecution. Prerequisite: Approval of instructor and Department Head.

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

Review and discussion of current scientific work in physiology and related subjects. Prerequisite: Approval of Department Head.

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

Problems in physiology, pharmacology, or toxicology. Prerequisite: D.V.M. degree or appropriate specialized training.

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

Original investigations in veterinary physiology, pharmacology, or toxicology to be submitted by writing of thesis or dissertation as partial fulfillment for M.S. or Ph.D. degree. Prerequisite: Approval of Department Head.

DEPARTMENT OF VETERINARY PUBLIC HEALTH

H. W. CASEY, A. I. FLOWERS* (Head), F. C. HECK, P. A. LINERODE, L. H. RUSSELL, JR.*, F. ULVEDAL

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.

618. Food Toxicology. (3-0). Credit 3. I

Study of the toxicity of various foods and food components, particularly food additives, chemical and microbial contaminants, genetically determined toxic foods. Principles and problems in evaluating safety of foods. Investigation of food associated disease incidents will be considered. Prerequisites: Approval of instructor and Department Head.

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

Problems course in veterinary public health. Prerequisite: D.V.M. degree or approval of Department Head.

*Graduate Advisor

DEPARTMENT OF WILDLIFE SCIENCE

E. D. ABLES*, D. V. ALDRICH, K. A. ARNOLD, R. J. BALDAUF, D. C. CARTER*, D. R. CLARK, W. B. DAVIS, J. R. DIXON*, J. M. INGLIS*, H. D. IRBY, R. K. STRAWN* (Acting Head), J. G. TEER*

600. Field and Laboratory Methods. (1-6). Credit 3. II
Designed to give secondary school teachers experience in field studies, organizing field notes, collecting and preserving vertebrate animals for teaching purposes. Emphasis on methods for maintaining live animals for classroom studies and for identifying animals collected. Training in preparing skeletons, corrosion models, cleared specimens, and in plastic embedding. Prerequisite: Eighteen hours of biological sciences.

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.

603. Vertebrate Ecology. (1-6). Credit 3. II
Ecology of the individual, population, and ecosystem, with consideration given to the epistemology of major ecological concepts. Emphasis given to theory evolved in the study of vertebrates.

604. Radioecology. (2-3). Credit 3. II
Intended to familiarize students with ecological significance of radionuclides in nature with special emphasis on use of nuclides in studying bio-geochemical exchange between ecological compartments and ecological fate of elements. Consideration given to special uses of radionuclides by ecologists. Not a rigorous course in radioisotope techniques. Prerequisites: Biol. 654; W.S. 603 or equivalent.

605. Systematic Ichthyology. (2-3). Credit 3. II
Lectures and discussions of literature, fish taxonomy, classifications, and theories of teleostean phylogeny, zoogeography of fishes, and extensive field studies. Prerequisite: W.S. 311 or 312.

606. Systematic Herpetology. (2-3). Credit 3. II
Studies of distribution, evolution, speciation, and new systematics of amphibians and reptiles, including extensive field studies of local problem groups and philosophy and role of herpetology as a science. Prerequisite: W.S. 315.

607. Systematic Ornithology. (2-3). Credit 3. I
A study of the living birds of the world, including diversity, radiation, adaptation, distribution and past history. Considers contrasts both between the taxa and between the continental avifaunas. Prerequisite: W.S. 402 or equivalent.

609. Wildlife Research Methods. (3-0). Credit 3. I
Study of research methods applied to wildlife management.

610. Systematic Mammalogy. (2-3). Credit 3. II
Study of kinds, diversity, radiation, adaptation, and distribution of recent mammals of world, with special emphasis on adaptive diversity within taxa and adaptive similarities between taxa and between continental faunas. Prerequisite: W.S. 401 or equivalent.

681. Seminar. (1-0). Credit 1 each semester. I, II
Important current developments in wildlife field with special reference to literature.

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.

*Graduate Advisor

INDEX

412/7
1525