Bulletin of

TEXAS TECHNOLOGICAL COLLEGE

The SCHOOL OF ENGINEERING

Announcements for 1962-1963

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GENERAL INFORMATION . . .

How To Use This Bulletin

The Bulletin of the School of Engineering should be used in conjunction with the most recent General Information Bulletin of Texas Technological College. Each student is held responsible for familiarizing himself with the content of both his **School bulletin** and the **General Information Bulletin.**

Detailed information is given in this bulletin on the School of Engineering. Reference is made also to general College regulations and many other topics, as admissions, advanced standing, general degree requirements, which are detailed in the General Information Bulletin but to which ready and frequent reference is needed by the engineering student.

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GLOSSARY AND SYMBOLS . . .

academic year. The period of time during which instruction is offered at the College. This is divided into the fall semester and the spring semester. Summer session is considered separately.

advanced standing. Credit toward a degree for work satisfactorily completed elsewhere.

bachelor's degree. The degree granted after successful completion of an approved undergraduate college program.

course. A unit of measure for instructional purposes. Most courses meet three times a week.

credit. A unit of credit, or semester hour, represents one prepared class period or hour a week for one academic semester.

curriculum (plural: curricula). A body of courses constituting a complete semester's or year's study, or a full four-year program, usually differing from one department to another.

elective. A course outside the specific courses prescribed for a given curriculum.

grade points. Quality points per credit hour awarded for performance in each course taken (A — 4, B — 3, C — 2, D — 1, F — 0, W — 0, WF — 0).

grade-point average. An average indicative of over-all performance; it is computed by dividing the sum of grade points earned by the number of credit hours taken.

graduate. As an objective, courses or degrees offered beyond the Bachelor of Science Degree.

laboratory fee. A special fee is required in certain laboratory courses.

major. A principal concentration of study in one field of learning.

prerequisite. A requirement that the student must fulfill before he is permitted to proceed with his program of study.

symbols, as (3:1:4), follow name and number of a course, as Chemistry 141 (4:3:3). The first digit, 4, refers to the credit hours of the course; the second digit, 3, refers to the number of lecture hours scheduled per week; and, the third digit, 3, refers to the number of laboratory hours scheduled per week.

transfer credit. Credit transferred to or from another college or university.

undergraduate. A course or person involved in the program leading to a bachelor's degree.

The SCHOOL OF ENGINEERING

John R. Bradford, Dean
Robert L. Newell, Assistant Dean

Advertising Art and Design
Architecture, Construction or Design
Chemical Engineering
Civil Engineering
Electrical Engineering
Engineering Physics
Industrial Engineering
Mechanical Engineering
Petroleum Engineering
Textile Engineering

The importance of engineering is stressed in the first section of the bill, passed by the Thirty-eighth Legislature, by authority of which the College was established. In it, it is pointed out that the commercial development of the State depends upon the thorough training given to students in the fields of engineering and manufacturing.

The aim of the School of Engineering is to impart a complete knowledge of the fundamentals of engineering, with specialization in one particular branch to that extent which experience indicates to be desirable. The course of study is planned with the view of giving the student basic training which he cannot obtain after graduation, leaving a great part of specialization to his later professional employment. Experience has shown that this type of training produces the most successful engineers.

Engineering has been defined as the "scientific utilization of the forces and materials of nature in the construction, production, and operation of works for the benefit of man." The fundamental training of the engineer includes a knowledge of pure science, as well as its application to the various specializations. As an aid to the development of a scientific attitude, the importance of the qualities of honesty, loyalty, thoroughness, and industry is emphasized; the desire for learning, and for a knowledge of the ethics of the profession is fostered.

Upon graduation, the student usually spends a period of time in subordinate positions, obtaining experience, and preparing himself for the more important work of the executive, designer, consulting engineer, teacher, researcher, or supervisor of manufacturing operations. In the past, from 60 to 70 per cent of the engineering graduates eventually held executive positions. Engineering training is recognized as desirable preparation for a commercial career. In-

deed, surveys of employment records disclose that men possessing an engineering education have found their way into nearly every type of vocation. A few which the engineering student may reasonably expect to enter upon graduation, or after a period of practical experience, were indicated in the beginning of the departmental descriptions. Attention is called to the fact that in a civilization such as ours, in which one is at all times in contact with the results of our modern industrial development, no type of education is more suitable than that leading to an engineering degree.

Requirements For Admission

Admission to the School of Engineering, undergraduate or graduate, is under the control of the Dean of Admissions, and all correspondence on this subject should be addressed to him. For information regarding general requirements for admission, the freshman testing program, the college calendar, details of registration, tuition costs, etc., consult the General Information Bulletin. Application forms for admission, as well as copies of school bulletins, may be obtained from the Dean of Admissions upon request. In addition to the general requirements for admission to the College, as given in the General Information Bulletin, students entering from high school should satisfy the specific requirements of the School of Engineering, as stated in the following section.

Entrance To The First Year

The School of Engineering wishes to cooperate with secondary schools, and with its individual applicants, by granting the widest possible latitude in the preparation of college candidates. Certain courses are essential, however, and may be looked upon as "requirements." These are:

English (4 units) or English (3 units) and Foreign Language (2 units)
Algebra (2 units)
Geometry (1 unit)
Trigonometry (½ unit)
Physics (1 unit)

Chemistry and advanced algebra, also, are recommended. Physics is not a requirement for majors in either advertising art and design, or the design option in architecture; and trigonometry is not required for advertising art and design.

Admission of applicants as freshmen in the School of Engineering is based upon the general requirements for admission to the College (consult the General Information Bulletin) and the specific requirements of the Engineering School. In order that applicants with good grades may enter the School of Engineering even though they may not have completed all of the specific high school subjects, special provisions have been made for their admission.

All students admitted with deficiencies will occupy conditional status, and will be classified as pre-engineers until the conditions of their admission have been satisfied. Admission to all sophomore work may be denied until such satisfaction has been achieved.

Degree requirements and the specific program of courses for each engineering field are tabulated in the departmental section of this bulletin. These requirements should be considered minimal, and satisfactory completion of each in the time and sequence outlined, can be accomplished only under the condition that students enter without deficiencies. Careful planning of the high school program will place a student in a position to complete degree requirements in the specified time. If he enters with deficiencies, as determined by the high school record, or as indicated by the results of the freshman placement tests, he must defer some of the regular course work; consequently, his ultimate graduation will be delayed. Applicants for admission to the School of Engineering who have entrance deficiencies are strongly urged to take advantage of the summer session immediately preceding the freshman year as one means of compensating for deficiencies. Courses available by correspondence, i.e., algebra, plane geometry, trigonometry, and English, present another method; the taking of advanced standing examinations offers a third. Students admitted with entrance deficiencies in the subjects just mentioned must begin removal of them during their first semester in residence. Whenever possible, however, it is advisable to compensate for deficiencies before entering college.

In addition to the high school record all entering freshmen are required to submit scores on the Scholastic Aptitude Test offered by the College Entrance Examination Board. Since this test, together with the high school record, is used for placement in mathematics, final permission to register in the School of Engineering will not be given until its result is available. It is recommended that it be taken before application for admission is made. Engineering students (not those planning to take architecture or advertising art and design) are required to take, also, the Advanced Achievement Test in Mathematics which is offered by the College Entrance Examination Board. This test is used to determine which students are qualified to begin their first year with analytics and calculus. Information concerning these examinations may be obtained from the College Entrance Examination Board, Box 592, Princeton, New Jersey. It is highly advisable to take these tests during the senior year in high school, for, while they will be given on the campus each September, a few days prior to the first day of registration for the fall semester, to wait until that time is likely to necessitate a delay in registration.

The College Entrance Board Achievement Test often reveals that freshmen entering engineering are not prepared to begin their college mathematics with analytics and calculus, even though they can meet entrance requirements. Engineering students not making a qualifying score on this placement examination will be required to complete Math. 133, College Algebra, and Math. 131, Trigonometry. The most satisfactory plan for the completion of these subjects, and the avoidance of delay, is that of attending the

summer school before the first long session. Students who are unable to begin in a summer school, but who need algebra and trigonometry, should schedule the following:

ALTERNATE FRESHMAN YEAR			SEMESTER	1st.	2nd.
Math.	131	Trigonometry		3	
Math.	133	Col. Alg.		3	
Eng.	131	Col. Rhet.		3	
Chem.	141	Gen. Chem.		4	
Grph.	131	Engr. Graphics		3	
P.E., Band, or Basic ROTC					
Math.	132	Anal. Geom.			3
Math.	231	Calculus I			3
Eng.	132	Col. Rhet.			3
Chem.	142	Gen. Chem.			4
Grph.	132	Engr. Graphics			3
P.E., Band, or Basic ROTC					
		Total credit hours		16*	16*
SUMMER SESSION			**TERM**	**1st.**	**2nd.**
Math.	232	Calculus II		3	
Math.	331	Calculus III			3

Admission To Advanced Undergraduate Program

All engineering programs possess, at the freshman and sophomore level, a common core curriculum. The work during the first two years emphasizes the basic physical sciences and mathematics. A thorough knowledge of these subjects must be acquired by the undergraduate engineering student before proceeding into the third and fourth years. For this reason, all students embarking upon the junior program must be **formally** certified as eligible for the advanced undergraduate program, and must be accepted by their major departments. In order to qualify for certification, a student must have completed the program for the first two years in its entirety, and have maintained a grade-point average of at least 1.00. Students failing to meet these requirements may not register for any of the third-year course offerings in their major departments until they so qualify. Exceptions to this regulation are the two courses: Ch.E. 330, Engineering Materials Science; and M.E. 3321, Engineering Thermodynamics. These comprise part of the core program, and are available to students at any time they have met prerequisites. It is the responsibility of each student to request certification. Request forms may be obtained at the office of the Dean of Engineering, and should be filed at least six weeks prior to registration for advanced undergraduate course work.

Transfer From Other Colleges

Admission to an advanced level may be obtained upon transfer from accredited universities, colleges, and junior colleges. Consult

*Exclusive of P.E., Band, or Basic ROTC

the General Information Bulletin for regulations regarding transfer procedures and requirements. Students transferring from other institutions, the programs of which differed from the regular engineering degree plans printed in this bulletin, are advised to begin during a summer session. By doing so, they may be able to compensate for admission deficiencies, or fulfill course prerequisites, thus avoiding delay in the completion of work toward a degree.

Undergraduate Degrees

The School of Engineering offers the following four-year curricula, each leading to the Degree of Bachelor of Science in the respective field: Chemical, Civil, Electrical, Mechanical, Industrial, Petroleum and Textile Engineering; and Engineering Physics. In the Department of Architecture, a five-year curriculum in Architecture and a four-year curriculum in Advertising Art and Design are offered, these leading to the degrees of Bachelor of Architecture, and Bachelor of Advertising Art and Design, respectively.

The courses listed in individual curricula are those prescribed for the various degrees, and the arrangement by freshman, sophomore, junior, and senior years, is the recommended sequence of courses, whether students begin them in the summer or during the long session. When a student registers for each semester, he should check course prerequisites carefully, and be certain to include in that semester's work the courses which are prerequisite to the ones prescribed for the following semester. Any substitution or deviation from those listed in the programs of study requires written approval from the Dean of the School of Engineering and the Head of the Department in which the student is majoring.

ROTC courses may be counted toward undergraduate degree requirements in the School of Engineering, as follows:

1. Four semesters of basic ROTC may be substituted for the four semesters of physical education which constitute part of the requirements of all undergraduate degrees offered by the College.

2. Subject to the approval of the head of the student's major department, advanced ROTC may be used to satisfy a maximum of 6 hours of non-technical electives of the degree program.

General college regulations allow a maximum of 18 semester hours of work on an undergraduate degree to be accomplished by correspondence. In the School of Engineering, not more than 9 of the total 18 credit hours may be in the fields of engineering, science, and mathematics. In all cases, credit for correspondence work is subject to the approval of the Dean of Engineering.

Application For Degree

A candidate for a degree must register in the School of Engineering, and should apply for a degree in the manner indicated below:

(a) A student who expects to receive a degree during the next school year must file an "Application for Degree" with the office of the Dean of Engineering during the **spring semester** of the **junior year.** He will receive a list of the courses, and be apprised of the number of grade points which he lacks, prior to his fall registration as a senior student if his application was made at the proper time.

(b) In making application for a degree, the student must indicate the year's bulletin under which he wishes to be checked, as he must meet the requirements, in their entirety, of a specific year's bulletin. This must be a year during which he was registered as a student in the School of Engineering, with the restriction that all requirements for an undergraduate degree must be completed within seven years of the date of the bulletin chosen.

(c) A graduating senior must file with the Placement Office a complete personnel record, and two 2" x 3" glossy photographic prints, for record and identification. This must be done at least three months prior to graduation.

(d) A $5 graduation fee is required.

(e) To receive a degree, a student must either attend commencement exercises or obtain the approval of the Dean of Engineering for the reception of a degree **in absentia.** Each student receiving a degree **in absentia** will be charged an additional fee of $1.50.

Regulations governing general requirements for graduation will be found in the General Information Bulletin. The final responsibility for meeting all requirements for a degree rests with the student.

Second Bachelor's Degree

A student who has completed the requirements for a bachelor's degree may receive a second upon completion of the curriculum prescribed for it. To qualify for a second degree awarded by the School of Engineering, a minimum of 30 additional hours over and above the number completed for the first degree is required. By the proper selection of courses a student may complete the requirements for the degree of Bachelor of Science in Engineering, and that of Bachelor of Arts in the School of Arts and Sciences, in five years.

Cooperative Programs With Other Colleges

The School of Engineering now has a cooperative program of study with Baylor, Hardin-Simmons, North Texas State, and Trinity Universities; Abilene Christian and McMurry Colleges. Under this program, the student attends one of the aforementioned schools

for three years and Texas Technological College for two years and one summer. This program of study leads to the awarding of a degree by each institution.

Advanced Degrees In Engineering

The graduate program in the School of Engineering provides course work and research leading to the Degrees of Master of Science in Chemical, Civil, Electrical, Industrial, and Mechanical Engineering. Major course work in the respective field, combined with minor course work in related ones, provides broad and intensive study in important branches of the profession.

Admission to the Graduate School is based upon an above-average undergraduate record and satisfactory standing on the Graduate Record Examinations. The regulations and requirements of the Graduate School are given in the Graduate Bulletin.

Scholarships And Awards

Each year several undergraduate scholarships, specifically allocated to outstanding students in the School of Engineering, are awarded. Applications for sophomore, junior, and senior awards are accepted from January 2 to March 10, and announcement of recipients is made in May. Application for freshman scholarships may be made between June and September; however, selection of recipients is not made until receipt of fall mid-semester reports. For a complete listing of scholarships and awards, refer to the Bulletin on Fellowships, Scholarships, and Awards which is available from the Registrar upon request.

Annually, also, a limited number of scholarships are given to outstanding students who plan to enter graduate study. Areas in which these awards are available vary from year to year. Inquiries concerning graduate scholarships should be directed to the Dean of Engineering.

Graduate Assistance

To aid the graduate student financially, and to provide him with a valuable apprenticeship in college teaching and research, the School of Engineering has a number of graduate teaching fellowships and research assistantships available. Interested persons should write to the department head concerned for further details.

Expenses and Fees

A complete listing of all expenses normally incurred by students during registration may be found in the General Information Bulletin. Special charges are made in certain courses to cover the

cost of expendable items and services required. Amounts of these charges follow the course descriptions. A laboratory fee of $2 each is charged for all courses in which the combined credit of lecture and laboratory is from 1 to 3 semester hours. For courses in which the semester credit is 4 semester hours or more, the laboratory fee is $4 per semester.

Textile Research Laboratories

Through the facilities of the Textile Research Laboratories, a program of fundamental and applied research on the utilization of textile fibers in the manufacture of yarn and fabric is carried out. For a number of years the Cotton Research Committee of Texas has sponsored research designed to bring about expanded markets for, and broader use of, Texas cotton in textile manufacturing operations. Services of Textile Research Laboratories are available for conducting research which is both privately and publicly sponsored. A pilot scale spinning research facility is available for evaluation of the mill scale performance characteristics of cottons exhibiting any combination of fiber properties. The fiber research laboratory is equipped for developing data and information required for effectively merchandising cotton fibers and organizing manufacturing processes which will permit these cottons to be used in the most effectual manner possible.

The Textile Research Laboratories and the Textile Engineering Department are housed in a new building specifically designed as a textile research laboratory. Equipment and other facilities are used also for laboratory instruction in textile engineering.

Modern research equipment is made available for teaching purposes through the cooperative program. Laboratory staff members offer student instruction in their specialized areas of study and research.

ARCHITECTURE CURRICULUM

Bachelor of Architecture

Construction Option

FRESHMAN YEAR			SEMESTER 1st.	2nd.
Arch.	121	Freehand Drawing I	2	
Arch.	151	Prin. of Des., Grade I	5	
Math.	132	Anal. Geom.	3	
Math.	231	Calculus I	3	
Eng.	131	Col. Rhet.	3	
P.E., Band or Basic ROTC				
Arch.	122	Freehand Drawing II		2
Arch.	152	Prin. of Des., Grade I		5
Math.	232	Calculus II		3
Elective				3
Eng.	132	Col. Rhet.		3
P.E., Band or Basic ROTC				
		Total credit hours	16*	16*

SOPHOMORE YEAR			SEMESTER 1st.	2nd.
Arch.	231	Arch. Des. Grade II	3	
Arch.	323	Hist. of Mod. Arch.	2	
Arch.	226	Mat. & Meth. of Const.	2	
Math.	331	Calculus III	3	
Phys.	143	Prin. of Phys. I	4	
Eng.	231	Mast. of Lit.	3	
P.E., Band, or Basic ROTC				
Arch.	232	Arch. Des. Grade II		3
Arch.	221	Hist. of Ancient Arch.		2
Arch.	227	Mat. & Meth. of Const.		2
Phys.	241	Prin. of Phys. II		4
Al. A.	210	Intro. to the Arts		1
C. E.	233	Statics		3
P.E., Band or Basic ROTC				
		Total credit hours	17*	15*

JUNIOR YEAR			SEMESTER 1st.	2nd.
Arch.	351	Arch. Des., Grade III	5	
Arch.	222	Hist. of Med. Arch.	2	
Arch	335	Mech. Equip. of Bldgs.	3	
C. E.	330	Structures I	3	
C. E.	333	Strength of Mat.	3	
Arch.	352	Arch. Des., Grade III		5
Arch.	432	Hist. of Renaissance Arch.		3
Arch.	336	Mech. Equip. of Bldgs.		3
C. E.	334	Structures II		3
Spch.	338	Bus. & Prof. Speech		3
		Total credit hours	16	17

FOURTH YEAR			SEMESTER 1st.	2nd.
Arch.	451	Arch. Des., Grade IV	5	
Arch.	333	Arch. Working Drawing	3	
C. E.	431	Reinf. Concrete	3	
E. E.	3351	Illumination	3	
C. E.	231	Plane Surveying	3	
Arch.	436	City Planning		3
Arch.	452	Arch. Des., Grade IV		5
Arch.	334	Arch. Working Drawing		3
C. E.	432	Reinf. Concrete		3
Elective				3
		Total credit hours	17	17

FIFTH YEAR			SEMESTER 1st.	2nd.
Arch.	420	Prof. Practice	2	
Arch.	435	Adv. Arch. Work. Drawings	3	
C. E.	433	Struct. Design I	3	
C. E.	324	Str. of Mat. Lab.	2	
Hist.	231	Hist. U.S. to 1865	3	
Govt.	233	Amer. Govt., Org.	3	
Elective				3
C. E.	4311	Struct. Design II		3
C. E.	325	Cem. & Conc. Lab.		2
C. E.	3312	Soil Engr. I		3
Hist.	232	Hist. U.S. Since 1865		3
Govt.	234	Amer. Govt., Func.		3
C. E.	311	Soil Engr. Lab.		1
		Total credit hours	16	18

Minimum hours required for graduation — 165 and P.E., Band or Basic ROTC

*Exclusive of P.E., Band or Basic ROTC

ARCHITECTURE CURRICULUM

Bachelor of Architecture

Design Option

FRESHMAN YEAR			SEMESTER 1st.	2nd.
Arch.	121	Freehand Drawing I	2	
Arch.	151	Prin. of Des., Grade I	5	
Phys.	141	Gen. Physics	4	
Math.	133	Col. Alg.	3	
Eng.	131	Col. Rhet.	3	
P.E., Band or Basic ROTC				
Arch.	122	Freehand Drawing II		2
Arch	152	Prin. of Des., Grade I		5
Math.	131	Trigonometry		3
Phys.	142	Gen. Physics		4
Eng.	132	Col. Rhet.		3
P.E., Band or Basic ROTC				
		Total credit hours	17*	17*

SOPHOMORE YEAR			SEMESTER 1st.	2nd.
Arch.	231	Arch. Des., Grade II	3	
Arch.	323	Hist. of Modern Arch.	2	
Arch.	224	Freehand Drawing III	2	
Arch.	226	Mat. & Meth. of Const.	2	
Foreign Language			4	
Hist.	231	Hist. U.S. to 1865	3	
P.E., Band or Basic ROTC				
Arch.	232	Arch. Des., Grade II		3
Arch.	221	Hist. of Ancient Arch.		2
Arch.	225	Beginning Watercolor		2
Arch.	227	Mat. & Meth. of Const.		2
Foreign Language				4
Hist.	232	Hist. U.S. Since 1865		3
Al. A.	210	Intro. to the Arts		1
P.E., Band or Basic ROTC				
		Total credit hours	16*	17*

JUNIOR YEAR			SEMESTER 1st.	2nd.
Arch.	351	Arch. Des., Grade III	5	
Arch.	326	Anat. & Life Drawing	2	
Arch.	222	Hist. of Med. Arch.	2	
C. E.	337	Struc. Mech.	3	
Eng.	231	Mast. of Lit. or Foreign Language	3	
Arch.	335	Mech. Equip. of Bldgs.	3	
Arch.	352	Arch. Des., Grade III		5
Arch.	432	Hist. of Renaissance Arch.		3
C. E.	338	Struc. Mech.		3
Elective or For. Lang.				3
Arch.	336	Mech. Equip. of Bldgs.		3
		Total credit hours	18	17

FOURTH YEAR			SEMESTER 1st.	2nd.
Arch.	451	Arch. Des., Grade IV	5	
Arch.	333	Arch. Working Drawings	3	
C. E.	435	Simple Th. Reinf. Conc.	3	
Arch.	420	Prof. Prac.	2	
Arch.	327	Life Drawing I	2	
Elective			3	
Arch.	452	Arch. Des., Grade IV		5
Arch.	436	City Planning		3
Arch.	334	Arch. Working Drawings		3
Elective				3
Spch.	338	Bus. & Prof. Speech		3
		Total credit hours	18	17

FIFTH YEAR			SEMESTER 1st.	2nd.
Arch.	463	Arch. Des. & City Planning Grade V	6	
Arch.	4316	Arch. Sculpture	3	
Arch.	435	Adv. Arch. Working Drawings	3	
Govt.	233	Amer. Govt. Org.	3	
Arch.	484	Arch. Des., Grade V		8
Elective				3
Arch.	4317	Arch.. Sculpture		3
Govt.	234	Amer. Govt., Func.		3
		Total credit hours	15	17

Minimum hours required for graduation — 169 and P.E., Band or Basic ROTC
*Exclusive of P.E., Band, or Basic ROTC

Department of ARCHITECTURE AND ALLIED ARTS

Nolan Ellmore Barrick, Head of the Department

Professors:
Mr. Barrick, Mr. Bradshaw, Mr. Kleinschmidt, Mr. Lockard, Mr. MacCollin
Associate Professors:
Mr. Duran, Miss Houghton, Mrs. Sasser
Assistant Professors:
Mr. Childers, Mr. Deans, Mr. Kohn, Miss Morse, Mr. Parkinson, Mr. Tracy
Visiting Assistant Professor:
Mr. Cyoni
Instructors:
Mr. Ballew, Mr. Hanna, Mr. Howze, Mrs. MacCollin, *Mr. Roberts, *Mrs. Thompson

* Part-time

The Department of Architecture and Allied Arts is a member of the Association of the Collegiate Schools of Architecture. It is affiliated with the National Institute for Architectural Education, the American Federation of Art, and the College Art Association; and it holds valuable teaching aids provided by the Carnegie Foundation. The courses of study in Architecture are accredited by the National Architectural Accrediting Board.

Curricula open to both men and women:
(1) Bachelor of Architecture — Construction Option, a five-year curriculum.
(2) Bachelor of Architecture — Design Option, a five-year curriculum.
(3) Bachelor of Advertising Art and Design, a four-year curriculum.

The five-year program for majors in architecture is a gradual, orderly, and integrated development toward apprenticeship and professional practice. Opportunities in many branches of the building industry are open to graduates having the background of architecture. Standards upheld by the various state registration boards are met, and a degree is the logical step toward apprenticeship and a license to practice architecture.

The primary objective is the creative development of the student as an individual through the enlargement of his capacities for principled and disciplined thought.

The Bachelor of Architecture Degree may be obtained through the design option or the construction option. In the design curriculum, emphasis is placed on general requirements which are

ADVERTISING ART & DESIGN CURRICULUM

Bachelor of Advertising Art & Design

FRESHMAN YEAR			SEMESTER 1st.	2nd.
Arch.	121	Freehand Drawing I	2	
Arch.	151	Prin. of Design, Grade I	5	
Al. A.	131	Hist. of Art	3	
Math.	130	Algebra	3	
Eng.	131	Col. Rhet.	3	
P.E., Band, or Basic ROTC				
Arch.	122	Freehand Drawing II		2
Al. A.	153	Pict. Comp.		5
Al. A.	132	Hist. of Art		3
Math.	131	Trigonometry		3
Eng.	132	Col. Rhet.		3
P.E., Band, or Basic ROTC				
		Total credit hours	16*	16*

SOPHOMORE YEAR			SEMESTER 1st.	2nd.
Al. A.	238	Pottery	3	
Arch.	224	Freehand Drawing III	2	
Al. A.	233	Intro. to Lettering	3	
Eng.	231	Mast. of Lit.	3	
Foreign Language			4	
P.E., Band or Basic ROTC				
Al. A.	239	Pottery		3
Arch.	326	Anat. & Life Drawing		2
Arch.	225	Beginning Watercolor		2
Al. A.	220	Advtg. Office Prac.		2
Foreign Language				4
Journ.	320	Advtg. Typog. & Layout		2
P.E., Band or Basic ROTC				
		Total credit hours	15*	15*

SUMMER SESSION		FIRST TERM	
Al. A.	421	Art Workshop	2
Hist.	231	Hist. U.S. to 1865	3
		Total credit hours	5

		SECOND TERM	
Al. A.	421	Art Workshop	2
Hist.	232	History U.S. Since 1865	3
		Total credit hours	5

JUNIOR YEAR			SEMESTER 1st.	2nd.
Arch.	327	Life Drawing I	2	
Al. A.	3314	Comm. Illus. I	3	
Al. A.	342	Comm. Des. I	4	
Al. A.	328	Adv. Lettering & Art Layout	2	
Elective or Foreign Language			3	
Spch.	338	Bus. & Prof. Speech	3	
Arch.	423	Life Drawing II		2
Al. A.	343	Comm. Des. I		4
Al. A.	4314	Fashion Illus.		3
Al. A.	329	Adv. Lettering & Art Layout		2
Eng.	232	Mast. of Lit. or Foreign Language		3
Phys.	237	Tech. of Photog.		3
		Total credit hours	17	17

SENIOR YEAR			SEMESTER 1st.	2nd.
Al. A.	4212	Comm. Illus. II	2	
Al. A.	433	Comm. Des. II	3	
Al. A.	4311	Ceramics or		
Al. A.	3311	Drawing, Painting & Des. Th.	3	
Al. A.	426	Adv. Painting	2	
Al. A.	4318	Hist. Painting & Sculpture	3	
Govt.	233	Amer. Govt., Org.	3	
Al. A.	4213	Comm. Illus. II		2
Al. A.	434	Comm. Des. II		3
Al. A.	4312	Ceramics or		
Al. A.	3312	Drawing, Painting & Des. Th.		3
Al. A.	427	Adv. Painting		2
Al. A.	4319	Hist. Painting & Sculpture		3
Govt.	234	Amer. Govt., Func.		3
		Elective		3
		Total credit hours	16	19

Minimum hours required for graduation — 141 and P.E., Band, or Basic ROTC
*Exclusive of P.E., Band, or Basic ROTC

fundamental to a comprehensive understanding of the many aspects of the profession. The role of an architect as a coordinator is stressed. Basic work in the scientific fields is required and at the same time there is more drawing and design. In the construction curriculum, considerable attention is given to design with emphasis being placed on the building aspects of the profession.

The two options follow the same sequence of design courses for four years. The fifth year of the design option places heavy emphasis on design culminating in a thesis of the student's choice with faculty approval. The fifth year of the construction option includes no design but emphasizes engineering subjects.

Architectural majors are urged to spend the summer months in the office of a registered architect. A student may be excused from the laboratory work in Architecture 435 upon presentation to the Head of the Department of satisfactory evidence of three months of full-time employment in the office of a registered architect and the submission of examples of work of satisfactory quality and scope.

The four-year program for majors in advertising art and design is carefully arranged to give a suitable balance of theories, backgrounds, sources, and skills to students who plan to enter any of the diversified branches of the profession. An excellent preparation is given to those entering specialized fields. Students seeking creative training in drawing and painting, sculpture and ceramics, and art history will find the courses especially designed to allow freedom of expression and to promote creative development.

Insofar as possible, the design work in the Department is taught by the program-competition method in which the students compete with each other in the solving of a wide variety of theoretical and practical problems. Individual development is encouraged by advice and criticism on a faculty-to-student personal conference level.

The problem-solving process, which is the essence of adequate education in the creative arts, is brought into play at every opportunity. Students are stimulated to recognize needs, to express them in terms of programs in which analysis and research may be applied in reaching creative solutions. A comprehensive collection of books, photographs, prints, projection slides, and art objects is available within the Department for research in the allied art fields.

Students who wish to work toward a Bachelor of Arts Degree with a major in art should consult with the Head of the Department and arrange for a degree plan.

The Department reserves the right to retain, exhibit, and reproduce work submitted by students for credit in any course.

Courses in Architecture

A key to the meaning of course numbers, symbols, abbreviations, etc., appears on Page 4.

For Undergraduates

121-122. Freehand Drawing I, II. (2:0:6 each)
Representational drawing in charcoal emphasizing fundamental skills. Alternating problems stressing creative interpretation. Culminating work introducing color with pastels.

151-152. Principles of Design, Grade I. (5:2:9 each)
Study of the basic principles of design with emphasis on three-dimensional non-objective problems. Exercises in drafting, lettering and rendering in several media. Basic problems in projections, perspective, and shades and shadows.

221. History of Ancient Architecture. (2:2:0)
A study of the architectural contributions of ancient Egypt. Mesopotamia, Persia, Greece, and Rome to the cultural heritage of Western civilization. Illustrated lectures.

222. History of Medieval Architecture. (2:2:0)
Prerequisite: Arch. 221. A study of Early Christian, Byzantine, Romanesque, and Gothic styles, and their relation to the development of Western culture. Illustrated lectures.

224. Freehand Drawing III. (2:0:6)
Prerequisite: Arch. 121-122. Pencil, pen and ink rendering, and sketching from life and nature.

225. Beginning Watercolor. (2:0:6)
Prerequisite: Arch. 122. Beginning course in watercolor painting from life and from nature.

226. Materials and Methods of Construction. (2:2:0)
Prerequisite: Registration in Arch. 231. Introduction to properties, specifications, and uses of architectural materials.

227. Materials and Methods of Construction. (2:2:0)
Continuation of Arch. 226 with emphasis on analysis of structural systems related to architecture.

231-232. Architectural Design, Grade II. (3:0:9 each)
Prerequisite: Arch. 151-152. 9-hour to 45-hour problems under individual criticism dealing with elements of plan and evaluation. Introduction to the project-completing method of study. 9-hour sketch problems emphasizing composition and presentation.

326. Anatomy and Life Drawing. (2:0:6)
Prerequisite: Arch. 224. Study of anatomical structure. Drawing from life. $5 model fee.

327. Life Drawing I. (2:0:6)
Prerequisite: Arch. 326. Drawing from life in a variety of media and approaches with emphasis upon aesthetic factors. Instruction by individual criticism. $5 model fee.

331. Fundamentals of Residential Architecture. (3:3:0)
Prerequisite: Junior standing. Consideration of fundamentals of residential architecture including historical, esthetic, and economic problems in the design of housing, with emphasis on single family dwellings.

333-334. Architectural Working Drawings. (3:0:9 each)
Prerequisite: Arch. 352. Preparation of working drawings and specifications for small residences or commercial buildings; drawing complete details for construction including heating, plumbing, and electrical services. Occasional visits to building under construction.

335-336. Mechanical Equipment of Buildings. (3:3:0)
Prerequisite: Arch. 227 and 232. Heating and air-conditioning requirements and systems for buildings. Basic theory and problems in illumination and acoustics.

351-352. Architectural Design, Grade III. (5:2:9 each)
Prerequisite: Arch. 231-232. 15-hour to 75-hour problems under individual criticism dealing with small building types. The project-completion method of study is used. 9-hour sketch problems dealing with details of architecture and with larger architectural compositions.

451-452. Architectural Design, Grade IV. (5:2:9 each)
Prerequisite: Arch. 351-352. 15 to 90-hour problems under individual criticism dealing with more comprehensive building types and groups of buildings. 9-hour sketches are offered to test creative ability and expression in a limited amount of time.

463. Architectural Design and City Planning, Grade V. (6:1:15)
Prerequisite: Arch. 451-452. 24 to 120-hour problems under individual criticism dealing with large compositions which include groups of buildings, site planning, and studies of circulation, etc. 9-hour sketches are also given.

484. Architectural Design, Grade V. (8:1:21)
Prerequisite: Arch. 463. Continuation of Arch. 463 with one final "thesis" problem selected and programmed by the individual student.

For Undergraduates and Graduates

320. History of Furniture and Costume. (2:2:0)
Prerequisite: Arch. 323. A study of furniture and costume from prehistoric times to the present emphasizing trends relative to man's social history and changing needs. Illustrated lectures.

323. History of Modern Architecture. (2:2:0)
Prerequisite: Arch. 142. A study of the cultural and social influences as they determine the development of contemporary architecture in Europe and the Americas. Illustrated lectures.

430. History of Early American Architecture. (3:3:0)
Prerequisite: Arch. 432 and consent of instructor. The American architectural heritage. Pre-Columbian, southwestern colonial, regional styles of the eastern seaboard. Western reserve, and Greek Revival. Illustrated lectures.

432. History of Renaissance Architecture. (3:3:0)
Prerequisite: Arch. 222. A study of the Renaissance architecture of Europe emphasizing the development of styles essential to an understanding of the background of Early American and modern architectural growth. Illustrated lectures.

420. Professional Practice. (2:2:0)
Prerequisite: Senior standing. Office organization, ethics, professional relations for architects.

423-424. Life Drawing II, III. (2:0:6 each)
Prerequisite: Arch. 327. Continuation of Arch. 327. $5 model fee each.

4316-4317. Architectural Sculpture. (3:1:6 each)
Prerequisite: Senior standing. Problems in modelling, carving and combined techniques using clay, wood, metal, plaster, and other materials with emphasis on architectonic forms. Study of the historic development of sculptural techniques. Plaster-mold making, glazing, and firing. Fee for ceramics materials, $5 each.

435. Advanced Architectural Working Drawings. (3:0:9)
A continuation of Arch. 333-334. Preparation of working drawings and specifications to comply with building and zoning codes for superior fire-resistant buildings; analyzing and integrating structural system details with architectural design details.

436. City Planning. (3:1:6)
Prerequisite: Senior standing. The theory and problems of city development, community planning, housing, and their drawn and rendered solutions under individual criticism.

Many courses in architecture and allied arts, especially those in city planning, history of architecture, and history of painting and sculpture, are available for electives to students majoring in education, history, music, government, landscape architecture, etc. Consent of the instructor may be secured in lieu of the professional prerequisites listed.

Advertising Art and Design

Allied arts courses which are combined with courses in architecture form the basis for the advertising art and design curriculum. The training and background of several departmental faculty members makes it possible to offer courses that are available to students pursuing training in public school art fields both on the undergraduate and graduate levels.

Allied Arts Courses in Advertising Art and Design

A key to the meaning of course numbers, symbols, abbreviations, etc., appears on Page 4.

For Undergraduates

131-132. History of Art. (3:3:0 each)
A survey of architecture, sculpture, painting, and the minor arts from prehistoric times to the present. Emphasis is placed upon the arts as they reveal the visual aspects of man's social, political, and cultural growth. Illustrated lectures. Open to all students except those majoring in architecture, design option and construction option.

153. Pictorial Composition. (5:2:9)
Prerequisite: Arch. 151. Theory of space design with emphasis on line and area composition. Basic problems in projections, perspective, and shades and shadows.

210. Introduction to the Arts. (1:1:0)
Prerequisite: English 132. Basic study of art as a contemporary philosophical concept, augmented by lectures on the major arts.

220. Advertising Office Practice. (2:2:0)
Prerequisite: Al. A. 153. Office organization, ethics, professional relations in the advertising field.

233. Introduction to Lettering. (3:1:6)
Prerequisite: Al. A. 153. Instruction in general commercial lettering, styles, and practices. Introduction to layout and lettering for reproduction.

238-239. Pottery. (3:1:6 each)
Prerequisite: Arch. 151-152, Al. A. 153, or consent of instructor. All hand and simple commercial methods of pottery production. Decorating, glazing, and firing of ware. For ceramic materials, fee $5 each.

328-329. Advanced Lettering and Art Layout. (2:0:6 each)
Prerequisite: Al.A. 233. Advanced commercial lettering and art layout as applied to newspaper, magazines, etc.

3311-3312. Principles of Drawing and Painting, and Theory of Design. (3:1:6 each)
Prerequisite: Arch. 225. Al.A. 3314. Advanced

analysis of principles governing good drawing and painting throughout the ages. Lectures illustrated. Laboratory work in line drawing and color.

3314. Commercial Illustration I. (3:0:9)
Prerequisite: Arch. 224, Al.A. 233. Illustration applicable to advertising and commercial fields. Drawing and painting in various media for designated processes of reproduction. Analysis of advertising value of drawings and force of design on subject matter. Problems in design of booklets, posters, and illustrations.

342-343. Commercial Design I. (4:1:9 each)
Prerequisite: Al. A. 233, Arch. 226. Structural representation of originally designed commercial products emphasizing effective techniques or rendering in a variety of media.

426-427. Advanced Painting. (2:0:6 each)
Prerequisite: Arch. 225. Principles of design related to various types of composition in conjunction with direct study from the human model, still life, or landscape. Problems in oil or water color may take the form of book illustration, painting, or mural decoration. $5 model fee each.

4212-4213. Commercial Illustration II. (2:0:6 each)
Prerequisite: Al.A. 3314. A continuation of Al.A. 3314, with problems in presentation and studio practice; specialization in illustration with completion of full-scale work.

4314. Fashion Illustration. (3:0:9)
Prerequisite: Arch. 327, Al.A. 3314. The drawing and design of the costumed figure for newspaper and magazine fashion illustration.

For Undergraduates and Graduates

421. Art Workshop. (2:0:6)
Advanced work in drawing, painting, pottery, sculpture, ceramics or other graphic media. Instruction on individual project basis. Course may be repeated four (4) times for credit. $5 material fee if taken in ceramics or pottery.

433-434. Commercial Design II. (3:0:9)
Continuation of Al.A. 342-343. Problems involving extended research and group product development. Construction of scale models or execution of the finished product where feasible.

4311-4312. Ceramics. (3:0:9 each)
Prerequisite: Al.A. 238-239. Advanced pottery design and production. Glaze calculation and clay body construction. Research. Ceramics materials fee, $5 each.

4318-4319. History of Painting and Sculpture. (3:3:0 each)
Prerequisite: Junior classification. Illustrated lectures in the development of painting and sculpture from the Egyptian period to the present day. Three hours of library research per week.

4351. Art in Elementary Education. (3:1:6)
Prerequisite: 12 semester hours of allied arts or equivalent, or two years' art teaching experience plus 6 hours of child psychology. Enrollment limited to graduate students in elementary education. A course in drawing and painting, composition, and color designed primarily for those who have had at least two years of teaching art in public schools.

For Graduates

5335. Art in the Modern World. (3:3:0)
Prerequisite: Graduate standing. A survey and development of influences upon art forces in the modern world.

Department of AGRICULTURAL ENGINEERING

Willie Lee Ulich, Head of the Department

Professors:
Mr. Ulich, Mr. Williams
Associate Professor:
Mr. Schwiesow

The Department of Agricultural Engineering is concerned with teaching and research activities for service to agriculture; and with the development and training of professional agricultural engineers. The curriculum is under the joint supervision of the Schools of Agriculture and Engineering.

Agricultural engineering, a relatively new field of work, deals with the application of basic engineering principles to the peculiar conditions and requirements of agriculture as an industry and as a field of applied science. The curriculum is designed for those students who desire to make such engineering applications to a challenging 90 billion dollar industry.

For those who wish to specialize within this field of work, there are five areas of specialization:

(1) Farm Power and Machinery
(2) Farmstead Buildings and Structures
(3) Farm Electrification and Utilities
(4) Agricultural Crop Processing
(5) Soil and Water Conservation Including Irrigation

Rapidly expanding agricultural mechanization has caused an increasing demand for agricultural engineering graduates. Employment is well distributed between industrial organizations, individual private enterprises, and government agencies.

Agricultural engineers are employed by agricultural equipment manufacturers producing farm machinery, farm processing equipment, rural electrical appliances, farm structures, and irrigation equipment. They are also employed as distributors, dealers, and company representatives for such firms as farm equipment suppliers; electric service companies; trade associations; agricultural processors; publishers; advertising agencies; consulting engineers; construction firms; and farm engineering and management services.

Many agricultural engineers are self-employed as owners or partners in some of the above types of businesses. Local, state and federal government agencies, including universities and conservation agencies, employ graduates for teaching, extension, research,

AGRICULTURAL ENGINEERING CURRICULUM

Bachelor of Science in Agricultural Engineering

FRESHMAN YEAR*			SEMESTER 1st.	2nd.
Math.	132	Anal. Geom.	3	
Math.	231	Calculus I	3	
Eng.	131	Col. Rhet.	3	
Grph.	131	Engr. Grph.	3	
Phys.	143	Prin. of Physics I	4	
P.E., Band, or Basic ROTC				
Math.	232	Calculus II		3
Math.	331	Calculus III		3
Eng.	132	Col. Rhet.		3
Grph.	132	Engr. Grph.		3
Phys.	241	Prin. of Physics II		4
P.E., Band, or Basic ROTC				
		Total credit hours	16**	16**

SOPHOMORE YEAR			SEMESTER 1st.	2nd.
Math.	335	Math. for Engrs.	3	
Phys.	242	Prin. of Physics III	4	
C. E.	233	Statics	3	
Agron.	131	Fund. of Agron.	3	
Chem.	141	Gen. Chem.	4	
Math.	336	Math. for Engrs.		3
Agron.	241	Soils		4
C. E.	332	Dynamics		3
Ag. Engr.	233	Ag. Process. and Util.		3
Chem.	142	Gen. Chem.		4
P.E., Band, or Basic ROTC				
		Total credit hours	17**	17**

JUNIOR YEAR			SEMESTER 1st.	2nd.
Ag. Engr.	336	F. Mach. & Power Mgt.	3	
C. E.	231	Plane Surveying	3	
E. E.	231	Prin. of E. E. I	3	
Eng.	233	Tech. Writing	3	
Govt.	233	Amer. Govt., Org.	3	
M. E.	3321	Engr. Thermodynamics	3	
C. E.	333	Strength of Mat.		3
C. E.	339	Fluid Mech.		3
E. E.	232	Prin. of E. E. II		3
Govt.	234	American Govt., Func.		3
Hist.	231	Hist. of U.S. to 1865		3
Elective		Humanity		3
		Total credit hours	18	18

SENIOR YEAR			SEMESTER 1st.	2nd.
Ag. Eco.	235	Fund. of Ag. Eco.	3	
Ag. Engr.	411	Seminar	1	
Ag. Engr.	436	Cotton Gin Engr.	3	
Ag. Engr.	437	Des. Farm Irr. Sys.	3	
Ag. Engr.	438	Struc. Des. Farm Bldgs.	3	
Hist.	232	Hist. of U.S. Since 1865	3	
Approved Elective			3	
Ag. Engr.	433	Elem. of Trac. Design		3
Ag. Engr.	434	Farm Elec.		3
Ag. Engr.	439	Func. Des. Farm Bldgs.		3
Ag. Engr.	442	Engr. for Soil Conserv.		4
Speech	338	Bus. & Prof. Speech		3
Approved Elective				3
		Total credit hours	19	19

Minimum hours required for graduation — 140 and P.E., Band, or Basic ROTC

*See Page 8 for Alternate Freshman Year

**Exclusive of P.E., Band, or Basic ROTC

and construction work. In summary, agricultural engineering prepares the student for a versatile and rewarding profession.

In order to provide students with appropriate course offerings, the department is housed in two buildings, encompassing approximately 25,000 square feet of classroom and laboratory floor space. Being located in the most highly mechanized farm area in the world, this department is able to provide cooperative research and inspection tours through many agricultural facilities and allied industrial plants.

Further information concerning the program in agricultural engineering may be found in the Bulletin of the School of Agriculture.

Courses In Agricultural Engineering

A key to the meaning of course numbers, symbols, abbreviations, etc., appears on Page 4.

For Undergraduates

111. Fundamentals in Agricultural Engineering. (1:1:2)
Fundamental principles of agricultural engineering, including areas of specialization. May be repeated for credit. May not be applied toward a professional degree.

121. Problems in Agricultural Engineering. (2:1:3)
Specific problems arising in, and techniques applying to, the agricultural industry. May be repeated for credit. May not be applied, however, toward a professional degree.

220. Farm Shop Woodwork. (2:1:3)
Selection, use, and maintenance of hand tools and power woodworking equipment. Techniques of selection and estimation of building materials. Methods of wood member construction and wood projects; also, quality of concrete, and rural construction.

221. Farm Shop Metalwork. (2:1:3)
Basic hand and power tools essential to the modern farm shop. Selection, use, and maintenance of tools; electric arc and oxy-acetylene welding; and the processes used in repairing farm equipment. Pipe fitting, cold metal work, and metal forming are also included.

222. Agricultural Surveying and Land Conservation. (2:1:3)
Techniques in measuring distances and areas; traversing; determining elevations; mapping; and running grade lines. Also, laying out and checking terraces, irrigation and drainage ditches, and using aerial photographic maps.

223. Farm and Home Utilities. (2:1:2)
Domestic water supply and its distribution; including plumbing, sewage, refuse, and garbage disposal. Also includes fundamentals of electric farm power; wiring of farm buildings; and electric appliances and equipment. Also, heating, lighting, ventilating, and cooling of farm structures.

232. Plane and Topographic Surveying. (3:2:3)
Prerequisite: Sophomore standing and Math. 130. Techniques and laboratory practice in measuring distances and areas; determining elevations and profiles; plotting sections; traversing; using planimeters; running grade lines. Includes laying out terraces, irrigation and drainage ditches; topographic mapping, and use of aerial photographs.

233. Agricultural Processing and Utilities. (3:2:2)
Prerequisite: Sophomore standing in engineering. Basic principles of farmstead layout and its function as a production plant. Engineering involved in agricultural crop conditioning and storage; feed preparation and processing; and livestock handling systems. Includes effective use of such utilities and labor-saving devices as water supply; electrical and mechanical equipment; disposal of sewage and refuse.

333. Farm Power and Machinery. (3:2:2)
Development of farm mechanization. Construction, operation, adjustment, and servicing of farm tractors and power units. Adaptation, selection, economical utilization, construction, operation, and adjustment of the principal tillage, planting, cultivating, harvesting, and feed-processing machines.

335. Irrigation and Erosion Control. (3:2:2)
Prerequisite: Ag. Engr. 222 or 232; or C.E. 231. Principles and practices of irrigation and water erosion control. Water control methods; land preparation; movement and storage of water in soils; quality of water; salinity control; use of water by plants. Includes irrigation of specific crops, water rights, elements of pumping, and pumping costs.

336. Farm Machinery and Power Management. (3:2:3)
Prerequisite: Junior standing in engineering. Mechanical design and materials used for farm machinery construction. Includes capacity, selection of type, adjustment, maintenance, and economical use of farm machinery; transmission, measurement, and efficient use of power furnished to farm machines.

For Undergraduates and Graduates

411. Agricultural Engineering Seminar. (1:1:0)
Prerequisite: Senior standing and approval of Department Head. Assigned readings, oral and written reports, and discussions relating to agricultural engineering. Lectures by visiting professional representatives, and field trips.

430. Agricultural Engineering Problems. (3)
Prerequisite: Senior standing and approval of Department Head. The work for this course may be individual study or joint investigation, or design problems of a technical nature for agricultural engineering or engineering students. May be repeated for additional credit.

433. Elements of Farm Tractor Design. (3:2:3)
Prerequisite: C.E. 332, and M.E. 3321. Kinematics and dynamics of tractor power application; drawbar, power take-off, and traction mechanisms; thermodynamic principles and construction of the internal combustion engine, including carburetion and ignition; fuels and lubricants.

434. Farm Electrification. (3:2:3)
Prerequisite: E.E. 232. Application of electric power to farm processes. Farm electric distribution systems; wiring, controls motor applications; refrigeration, heating, lighting, and ventilation. Special farm applications, and economical use of electric power.

435. Farm Mechanics Problems. (3)
Prerequisite: Senior standing and approval of Department Head. Individual study of an advanced phase of some agricultural engineering application such as the development of techniques in teaching farm shop work or a special construction project. Open to students in the School of Agriculture. May be repeated for additional credit.

436. Cotton Gin Engineering. (3:2:3)
Prerequisite: Senior standing in engineering, or approval of instructor. Basic principles of conveying, cleaning, ginning, conditioning, and compressing of cotton. Includes gin plant management, fiber quality evaluation, and total processing.

437. Design of Farm Irrigation Systems. (3:2:3)
Prerequisite: C.E. 339. Principles of design of gravity and sprinkler irrigation systems for the farm. Drilling, development, and hydraulics of wells. Pumping units, water conveyance structures, and efficiency determinations of irrigation systems.

438. Structural Design of Farm Buildings. (3:2:3)
Prerequisite: C.E. 333. Structural design of farm buildings involving economic aspects and estimation of construction costs. Includes load estimation and stress analysis; design: axial loading, columns, beams, connections, foundations, roofs, and floors.

439. Functional Design of Farm Buildings. (3:2:3)
Prerequisite: M.E. 3321. Functional design of farm and ranch structures. Building requirements as they relate to crop storage and animal shelters. Includes design functions for heating, cooling, moisture and ventilation control; the planning of layouts for the efficient processing of farm products.

442. Engineering for Soil and Water Conservation and Drainage. (4:3:3)
Prerequisite: C.E. 339. The engineering aspects, and design of, soil and water conservation structures, including terraces, diversion ditches, outlet channels, drop-structures, chutes, and small dams. Includes also runoff determination and design of drainage systems.

Department of CHEMICAL ENGINEERING

John R. Bradford, Acting Head of the Department

Professors:
Mr. Bradford, Mr. Oberg
Associate Professor:
Mr. Renard
Assistant Professor:
Mr. Heichelheim

Chemical engineering is that branch of engineering concerned with the manufacturing processes in which physical and chemical changes are involved. The college training which a student receives is directed toward preparing him for beginning professional work immediately after graduation.

Chemical engineers function in such occupations as research and development, production, design, technical service, testing and process control, teaching, sales, technical writing, management, etc., and involve work in such industries as those dealing with petroleum, cement, plastic, metal production, food products, and nuclear energy.

Some of the interesting aspects of work in the above categories, for example that in process control and instrumentation, are the facts that elaborate instrumentation is needed in some processes to ensure maintenance of product quality, and to permit safe operation of equipment; and that at times the engineer must devise new instruments to accomplish a piece of work. He will find scope, also, in the frequent demand that he find uses for waste materials.

Particularly is this ability to create ingenious equipment called upon in the field of nucleonics, where the new problems which radioactive materials pose must be dealt with. Again, the chemical engineer works closely with metallurgical and mining engineers in some industries, and uses techniques of both mechanical and electrical engineers in designing his equipment and laying out a complete plant. On the one hand, he must be familiar with the laboratory procedures of the chemist; on the other, be able to talk of plant size operations, and in the language of the plant operator.

Being one of the newest of the major branches of professional engineering, chemical engineering possesses a tremendous potential for growth. It is likely that more basic research has been carried on in this field than in any of the others. Many firms employing chemical engineers make products which were unknown, or even undreamed of 25 years ago. While the vast majority of chemical engineers work for the manufacturing industries, they find employment in all areas of technical activity: mining, construction, utilities, and the various levels of federal and local government.

CHEMICAL ENGINEERING CURRICULUM

Bachelor of Science in Chemical Engineering

FRESHMAN YEAR*			SEMESTER 1st.	2nd.
Math.	132	Anal. Geom.	3	
Math.	231	Calculus I	3	
Eng.	131	Col. Rhet.	3	
Grph.	131	Engr. Grph.	3	
Phys.	143	Prin. of Physics I	4	
P.E., Band, or Basic ROTC				
Math.	232	Calculus II		3
Math.	331	Calculus III		3
Eng.	132	Col. Rhet.		3
Grph.	132	Engr. Grph.		3
Phys.	241	Prin. of Physics II		4
P.E. Band, or Basic ROTC				
		Total credit hours	16**	16**

SOPHOMORE YEAR			SEMESTER 1st.	2nd.
Math.	335	Math. for Engrs.	3	
Phys.	242	Prin. of Physics III	4	
C. E.	233	Statics	3	
E. E.	231	Prin. of E.E. I	3	
Chem.	141	Gen. Chem.	4	
P.E., Band, or Basic ROTC				
Math.	336	Math. for Engrs.		3
Math.	4318	Finite Math. Struc.		3
C. E.	332	Dynamics		3
E. E.	232	Prin. of E.E. II		3
Chem.	142	Gen. Chem.		4
P.E., Band, or Basic ROTC				
		Total credit hours	17**	16**

SUMMER SESSION			FIRST TERM	SECOND TERM			
Ch. E.	330	Engr. Mat. Science	3	Ch. E.	3311	Prin. of Chem. Engr. I	3
Govt.	233	Amer. Govt., Org.	3	Govt.	234	Amer. Govt., Func.	3
		Total credit hours	6			Total credit hours	6

JUNIOR YEAR			SEMESTER 1st.	2nd.
Chem.	353	Organic Chemistry	5	
Chem.	347	Physical Chemistry	4	
Ch. E.	3312	Prin. of Chem. Engr. II	3	
Ch. E.	3111	Chem. Engr. Lab.	1	
Hist.	231	Hist. of U.S. to 1865	3	
Chem.	354	Organic Chemistry		5
Chem.	348	Physical Chemistry		4
Ch. E.	4311	Prin. of Chem. Engr. III		3
Engr.	4121	Engr. Seminar		1
Hist.	232	Hist. of U.S. Since 1865		3
		Total credit hours	16	16

SENIOR YEAR			SEMESTER 1st.	2nd.
Ch. E.	4312	Prin. of Chem. Engr. IV	3	
Ch. E.	4321	Chem. Engr. Thermodynamics	3	
Ch. E.	4241	Unit Operations Lab.	2	
Ch. E.	4341	Unit Processes	3	
Ch. E.	4353	Instrumentation	3	
Elective		(Humanity)	3	
Ch. E.	4322	Chem. Engr. Thermodynamics		3
Ch. E.	4242	Unit Operations Lab.		2
Ch. E.	4352	Process Development		3
Ch. E.	4351	Chem. Engr. Plant Design		3
Elective		(Humanity or Technical)		3
		Total credit hours	17	14

Minimum hours required for graduation — 140 and P.E., Band, or Basic ROTC

*See Page 8 for Alternate Freshman Year

**Exclusive of P.E., Band, or Basic ROTC

The undergraduate curriculum in chemical engineering follows the same pattern as that found in most of the engineering schools of the nation. The first two years include the fundamentals which are basic to all types of engineering. The last two years emphasize unit operations, unit processes, thermodynamics, and instrumentation, and their application to the industrial complex.

The Department is now housed in a new building specifically designed to accommodate the specialized laboratories for unit operations, unit processes, process control, instrumentation, fuels and combustion, nuclear processes and research. The equipment is of pilot plant size, but sufficiently large to obtain results comparable to those accomplished in industry.

Each year an inspection trip to a major plant is arranged, to supplement the advanced course work. Junior and senior students are required to participate in this trip.

It is highly desirable that a chemical engineering student's accomplishment be of the highest quality. Grades of D will not be accepted in more than 20 per cent of the hours counted in the major, and only one D will be accepted in a course, completion of which requires two semesters.

Courses in Chemical Engineering

A key to the meaning of course numbers, symbols and abbreviations, etc., appears on Page 4.

For Undergraduates

330. Engineering Materials Science. (3:3:0)
Prerequisite: Phys. 241. Fundamental properties of engineering materials. Inter-atomic and inter-molecular binding forces and energies; thermal energies; crystal structure; amorphous solids; aggregates and imperfections. Physical basis for common electrical, magnetic, and thermal properties.

3111. Chemical Engineering Laboratory. (1:0:3)
Prerequisite: Chem. 141-142. Elementary engineering measurements; testing of fuels, lubricants, and inhibitors; corrosion; water technology.

3311. Principles of Chemical Engineering I. (3:3:0)
Prerequisite: Phys. 241. An introduction to the equipment and calculations of chemical engineering. The problems involve material and energy balances.

3312. Principles of Chemical Engineering II. (3:3:0)
Prerequisite: Ch. E. 3311. Principles of the basic unit operations of chemical engineering, such as flow of fluids, heat transfer, etc.

3351. Analytical Instrumentation. (3:2:3)
Prerequisite: Ch. E. 3311 and 3111. A study of the analytical tools used in engineering plant control and instrumentation including analog computer control operation.

For Undergraduates and Graduates

4241-4242. Unit Operations Laboratory. (2:0:6 each)
Prerequisite: Ch. E. 3311-3312. Laboratory experiments on the unit operations of chemical engineering with written reports.

4311-4312. Principles of Chemical Engineering III-IV. (3:3:0 each)
Prerequisite: Ch. E. 3311-3312. Theory and problems on selected unit operations.

4321-4322. Chemical Engineering Thermodynamics. (3:3:0 each)
Prerequisite: Advanced standing. A problem course in chemical process calculations and thermodynamics.

4341. Unit Processes. (3:3:0)
Prerequisite: Chem. 353-354, Ch. E. 3311-3312. A study of the more important chemical industries from the point of view of the unit processes and unit operations involved.

4351. Chemical Engineering Plant Design. (3:1:6)
Prerequisite: Ch. E. 4311 and parallel registration in Ch. E. 4352. Development of a plant process from the pilot plant stage to the industrial size unit.

4352. Process Development. (3:3:0)
Prerequisite: Ch. E. 4341. This course must be taken before or parallel with Ch. E. 4351. A problem course on the application of funda-

mental principles in the process calculations and design of pilot plants.

4353. Instrumentation. (3:2:3)
Prerequisite: Ch. E. 3311-3312. A study of the characteristics of industrial instruments, and their manner of use in controlling process variables.

4371. Nuclear Engineering. (3:3:0)
Prerequisite: Thermodynamics or its equivalent. A survey of the basic principles applicable to engineering problems of the atomic energy field.

Graduate Chemical Engineering

Genaral requirements and more detailed information may be found in the Graduate Bulletin.

The graduate program of the Department of Chemical Engineering encompasses a wide range of subject material. Special work in extraction, absorption, distillation, and transport phenomena may be chosen by those interested in the petroleum and petrochemical industry. Course work in nuclear technology, nuclear chemical engineering, and radio-chemistry is available for graduate students preparing for the new and expanding field of atomic energy.

Graduate Course Descriptions

5311. Transport Phenomena - Heat Transmission. (3:3:0)
Prerequisite: Graduate standing. Fundamental relations governing energy, momentum and mass transfer between phases, with special emphasis on heat transmission.

5312. Transport Phenomena - Fluid Dynamics. (3:3:0)
Prerequisite: Graduate standing. Fundamental relations governing energy, momentum, and mass transfer between phases, with special emphasis on fluid dynamics.

5313. Transport Phenomena - Diffusion Processes. (3:3:0)
Prerequisite: Graduate standing. Fundamental relations governing energy, momentum, and mass transfer between phases, with special emphasis on diffusion processes.

5321. Advanced Chemical Engineering Thermodynamics. (3:3:0)
Prerequisite: Graduate standing. Advanced topics in applied thermodynamics, including phase equilibria, fluid flow, etc.

5331. Special Problems in Chemical Engineering. (3:3:0)
Prerequisite: Approval of Department Head. Individual student study of theoretical projects under the guidance of a member of the staff. May be repeated for credit in different areas.

5332. Experimental Studies in Chemical Engineering. (3:0:9)
Prerequisite: Approval of Department Head. Individual student study of experimental projects under the guidance of a member of the staff. May be repeated for credit in different areas.

5341. Distillation. (3:3:0)
Prerequisite: Graduate standing. Theory of distillation with special emphasis on multicomponent distillation and application of theory to problems of design.

5343. Reaction Kinetics. (3:3:0)
Prerequisite: Graduate standing. Theoretical and experimental aspects of the kinetics of uncatalyzed and catalyzed reactions and their mechanism. Rate theory and its application to the design of batch and flow reactors.

5348. Organic Syntheses. (3:3:0)
Prerequisite: Graduate standing. A detailed study of the major organic unit processes. Equipment, reaction theory, and the unitary aspects of each organic unit process are considered.

5351. Chemical Engineering Design. (3:1:6)
Prerequisite: Graduate standing. The design of the complete plant. Plant location, equipment design or selection, plant layout, building requirements, and estimation of the cost of the plant are included.

5371-5372. Principles of Nuclear Engineering. (3:3:0 each)
Prerequisite: Graduate standing in engineering, mathematics, or the physical sciences. This course is the basis for all other course work in the nuclear field.

5373-5374. Nuclear Chemical Engineering. (3:3:0 each)
Prerequisite: Graduate standing in engineering, chemistry, physics, or mathematics and preferably Ch. E. 4371. A graduate course in nuclear reactions, reactor fuel cycles, production of nuclear feed materials, properties of irradiated fuels, and separations processes.

5378. Reactor Shielding. (3:3:0)
Prerequisite: Graduate standing in engineering, mathematics, or the physical sciences. A detailed study of the data and techniques which are available for the design of a practical shield.

5379. Nuclear Reactor Instrumentation and Control. (3:3:0)
Prerequisite: Graduate standing in engineering,

mathematics, or the physical sciences. Reactor safety systems and automatic control equipment; the effects of various parameters such as temperature and fission product poisons on reactor control; feedback loops in power reactors and reactor simulation.

5381-5382. Nuclear Radiations Laboratory. (3:2:6 each)
Prerequisite: Graduate standing in engineering, mathematics, or the physical sciences. A course to acquaint the student with the instruments and techniques used directly or indirectly in the nuclear field. The laboratory is equipped with a water uranium-moderated subcritical reactor. The student will be allowed to a limited extent to carry out research problems as the course develops.

630. Engineering Report. (3)

631-632. Master's Thesis. (6)

CIVIL ENGINEERING CURRICULUM
Bachelor of Science in Civil Engineering

FRESHMAN YEAR*			SEMESTER 1st.	2nd.
Math.	132	Anal. Geom.	3	
Math.	231	Calculus I	3	
Eng.	131	Col. Rhet.	3	
Grph.	131	Engr. Grph.	3	
Phys.	143	Prin. of Physics I	4	
P.E., Band, or Basic ROTC				
Math.	232	Calculus II		3
Math.	331	Calculus III		3
Eng.	132	Col. Rhet.		3
Grph.	132	Engr. Grph.		3
Phys.	241	Prin. of Physics II		4
P.E., Band, or Basic ROTC				
		Total credit hours	16**	16**

SOPHOMORE YEAR			SEMESTER 1st.	2nd.
Math.	335	Math. for Engrs.	3	
Phys.	242	or Geol. 143	4	
C. E.	233	Statics	3	
E. E.	231	Prin. of E. E. I	3	
Chem.	141	Gen. Chem.	4	
P.E., Band, or Basic ROTC				
Math.	336	Math. for Engrs.		3
Math.	4318	Finite Math. Struc.		3
C. E.	332	Dynamics		3
E. E.	232	Prin. of E. E. II		3
Chem.	142	Gen. Chem.		4
P.E., Band, or Basic ROTC				
		Total credit hours	17**	16**

SUMMER SESSION		FIRST TERM		SECOND TERM		
C. E.	231	Plane Surveying	3	C. E.	333	Strength of Materials 3
C. E.	339	Fluid Mechanics	3	Eng.	233	Tech. Writing 3
		Total credit hours	6			Total credit hours 6

JUNIOR YEAR			SEMESTER 1st.	2nd.
C. E.	330	Structures I	3	
M. E.	3321	Thermodynamics	3	
Ch. E.	330	Engr. Mat. Science	3	
C. E.	4315	Hydrology	3	
C. E.	324	Strength of Mat. Lab.	2	
Hist.	231	Hist. of U.S. to 1865	3	
C. E.	334	Structures II		3
C. E.	3312	Soil Engineering I		3
C. E.	311	Soil Engineering Lab.		1
C. E.	437	Water Supply and Treatment		3
C. E.	325	Cement and Concrete Tech.		2
C. E.	312	Fluid Mechanics Lab.		1
Hist.	232	Hist. of U.S. Since 1865		3
		Total credit hours	17	16

SENIOR YEAR			SEMESTER 1st.	2nd.
C. E.	433	Structural Design I	3	
C. E.	430	Highways I	3	
C. E.	431	Reinforced Concrete	3	
Govt.	233	Amer. Govt., Org.	3	
Elective		(Technical)	3	
C. E.	436	Highways II		3
Govt.	234	Amer. Govt. Func.		3
Elective		(Humanity)		3
Elective		(Technical)		6
		Total credit hours	15	15

Technical Electives: C. E. 432, C. E. 438, C. E. 439, C. E. 4311, C. E. 4312, C. E. 4313, C. E. 4314, C. E. 4316, C. E. 4317.

Minimum hours required for graduation — 140 and P.E., Band, or Basic ROTC
*See Page 8 for Alternate Freshman Year
**Exclusive of P.E., Band, or Basic ROTC

Department of CIVIL ENGINEERING

James Harold Murdough, Head of the Department

Professors:
Mr. Murdough, Mr. Adams, Mr. Decker, Mr. Whetstone
Associate Professors:
Mr. Keho, Mr. Marmion, Mr. Sanger
Assistant Professors:
Mr. Aldridge, Mr. Bristor, Mr. Foreman, Mr. Kiesling, Mr. Parrish
Instructor:
Mr. LeFevre

The movement of men and materials involved in the construction of roads, bridges, harbors, and docks was for many years a military and naval enterprise. When the principles of engineering were adapted to civil projects, the term civil engineering, as distinguished from military engineering, came into use. The adaptation of steam power, electrical energy, and other sources of power to man's use gave rise to the terms mechanical engineering, electrical engineering, and the like. Civil engineering is the parent stem from which other branches have sprung.

Today, civil engineering has many diversifications, although most of the work of the civil engineer can be found among the following specialties:

Hydraulic engineering: the planning for the construction and operation of structures for the control and utilization of natural waters.

Sanitary engineering: the planning for the construction and operation of water supply and waste disposal systems.

Structural engineering: the design and construction of bridges, buildings, foundations, and other structures.

Transportation engineering: the planning, construction, and maintenance of highways, roads and streets, and other pavements such as airfields.

Civil engineering centers on the construction industry, the expenditures of which amount to more than 10 per cent of our national income. It is not surprising, then, that it is one of the most stable branches of the engineering profession, flourishing not only at a time of great expenditures for defense, but during periods when a greater proportion of our national resources can be employed in peaceful designs.

The undergraduate curriculum in civil engineering is arranged so that all students receive training in the basic principles of mathematics and science; in the humanities; in engineering science;

and in civil engineering subjects. A system of electives permits some degree of specialization in the areas of highway, hydraulic, sanitary and structural engineering.

The advances in knowledge and the demands for technical information developing in such specialties as soil mechanics, hydrology, sanitation, stress analysis, and structural design, suggest that a young man should give serious consideration to the pursuit of studies beyond the bachelor's degree.

Courses in Civil Engineering

A key to the meaning of course numbers, symbols and abbreviations, etc., appears on Page 4.

For Undergraduates

231. Plane Surveying. (3:2:3)
Prerequisite: Math. 132. The uses of surveying instruments; precision of measurements; differential and profile leveling; transit stadia; open and closed traverses; area calculations; simple and vertical curves; azimuth determination.

232. Route Surveying. (3:2:3)
Prerequisite: C.E. 231. Route location; mathematics of compound, spiraled, and vertical curves; field astronomy; earthwork calculations; mass diagram. (Not offered after September, 1964).

233. Statics. (3:3:0)
Prerequisite: Math. 232. Resultants of coplanar and non-coplanar force systems; equilibrium of force systems, friction, centroids, moments of inertia.

311. Soil Engineering Laboratory. (1:0:3)
Prerequisite: Concurrent enrollment in C.E. 3312. Laboratory determination and engineering evaluation of the physical properties of soils.

312. Fluid Mechanics Laboratory. (1:0:3)
Prerequisite: Registration in C.E. 339.

313. Sanitation Laboratory. (1:0:3)
Prerequisite: Registration in C.E. 321. Bacteriology and microscopy of public water supplies and sewage. (Not offered after September, 1964).

320. Structures. (2:2:2)
Prerequisite: C.E. 233. Graphic statics; shear, moment, and stresses in framed structures by graphical and analytical methods. (Not offered after September, 1964).

321. Municipal Sanitation. (2:2:0)
Prerequisite: Junior standing or approval of Head of Department. General principles of sanitation as applied to the community, including water supply, sewerage, refuse disposal, rodent and pest control, food and milk sanitation, housing, lighting, ventilation, and swimming pools. (Not offered after September, 1964).

322. Highway Engineering. (2:1:3)
Prerequisite: C.E. 233 and Chem. 142. Origin, production, specifications, and tests of bituminous materials and mixtures used in the construction and maintenance of roads and pavements. Design criteria for all types of asphaltic pavements. (Not offered after September, 1964).

324. Strength of Materials Laboratory. (2:1:3)
Prerequisite: Registration in C.E. 333. Laboratory study of physical properties of some engineering materials. Practice in problems in mechanics of materials.

325. Cement and Concrete Technology. (2:1:3)
Prerequisite: Junior engineering standing. The properties and tests of materials of engineering, with special reference to concrete materials.

330. Structures I. (3:3:0)
Prerequisite: C.E. 333. The analysis of stress functions in framed structures for fixed and moving load systems.

332. Dynamics. (3:3:0)
Prerequisite: C.E. 233. Motion of the particle and of rigid bodies; kinetics of translation, rotation, and plane motion; work, energy, impulse, momentum.

333. Strength of Materials. (3:3:0)
Prerequisite: C.E. 233. Stresses and strains in elastic bodies subject to tension, compression, and shear; bending and torsion; deflection in homogeneous beams; column theory, combined stresses.

334. Structures II. (3:3:0)
Prerequisite: C.E. 324 and 333. The theory of statically indeterminate structures.

337-338. Structural Mechanics. (3:3:0 each)
Prerequisite: Math. 131. Statics, strength of materials, and structural design. For students of architecture, design option, and others who desire a brief and general presentation of the material.

339. Fluid Mechanics. (3:3:0)
Prerequisite: C.E. 233. Dynamics of viscous and non-viscous fluids, impulse and momentum, pipe flow, fluid resistance, open channel flow.

3312. Soil Engineering I. (3:3:0)
Prerequisite: C.E. 333, 339, Geol. 143, Ch.E. 330, and concurrent registration in C.E. 311. Physical and mechanical properties of soils; theories of stress, settlement and consolidation.

430. Highways I. (3:2:3)
Prerequisite: C.E. 231, 3312, and 4315. Route location, highway planning, traffic engineering, geometric design, drainage, and earthwork; composition, properties, and uses of bituminous materials.

431. Reinforced Concrete. (3:3:0)
Prerequisite: C.E. 333. Study and application of the elastic and ultimate strength theories of reinforced concrete design. Topics considered are beams; tied and spiral columns; spread and combined footings; and prestressed concrete members.

433. Structural Design I. (3:2:6)
Prerequisite: C.E. 330 and 334. Design in homogeneous materials with special emphasis on steel for simple structures and the elementary indeterminate types.

435. Simple Theory of Reinforced Concrete. (3:3:0)
Prerequisite: C.E. 337. For architect-design option majors and others whose preparation to enter C.E. 431 is inadequate. May not be used in lieu of C.E. 431 to fulfill requirements.

For Undergraduates and Graduates

423. Traffic Engineering. (2:2:0)
Prerequisite: C.E. 333 or approval of Department Head. Studies of speed, volume, accident locations, driver observance of traffic control devices, time delay studies, and the statistical analysis of data. (Not offered after September, 1964).

424. Materials. (2:1:3)
Prerequisite: Junior engineering standing. The properties and tests of materials of engineering, with special reference to concrete materials. (Not offered after September, 1964).

425. Materials. (2:1:3)
Prerequisite: C.E. 333. The properties and tests of materials of engineering with special reference to wood and steel. (Not offered after September, 1964).

432. Reinforced Concrete. (3:3:0)
Prerequisite: C.E. 431. Continuation of C.E. 431. Topics considered are masonry dams; retaining walls; beams and girders, tile and joist, two-way flat slab, and edge-supported slab floor systems.

436. Highways II. (3:3:0)
Prerequisite: C.E. 325, 430, and 431. Design, construction, and maintenance of flexible pavement and bases; design, construction, and maintenance of rigid pavements; soil-aggregate roads and soil stabilization.

437. Water Supply and Treatment. (3:2:3)
Prerequisite: Registration in C.E. 4315. Consumption of water; quality of water; sources of supply-streams, lakes, impounding reservoirs, wells; theory of treatment-coagulation, softening, filtration, recarburation, aeration, chlorination; laboratory work in the chemistry of water.

438. Sewerage and Sewage Treatment. (3:2:3)
Prerequisite: Registration in C.E. 4315. Quantity of sewage — both sanitary and storm; composition of sewage; construction of sewers and sewerage systems; theory of different methods of treatment; laboratory work in the chemistry of sewage.

439. Law and Ethics in Engineering. (3:3:0)
Prerequisite: Senior standing in engineering or approval of Head of Department. Professional and industrial problems, contracts, specifications, ethics of engineering.

4311. Structural Design II. (3:2:3)
Prerequisite: C.E. 433 and 431. Design in homogeneous and non-homogeneous materials for complex structures based on the elastic theory. Introduction to principles of plastic design in steel.

4312. Soil Engineering II. (3:3:0)
Prerequisite: C.E. 3312. Slope stability, lateral earth pressures, pile foundations, bearing capacity, consolidation and settlement, and earth structures.

4313. Sanitary Engineering Design—Water. (3:1:6)
Prerequisite: Registration in C.E. 437. The design of structures used in collection, treatment, and distribution of public water supplies.

4314. Sanitary Engineering Design—Sewage. (3:1:6)
Prerequisite: Registration in C.E. 438 and C.E. 431. The design of structures employed in the collection of sanitary and storm sewage, the treatment of sewage, and its disposal.

4315. Hydrology. (3:3:0)
Prerequisite: C.E. 339. Study of the hydrologic cycle-evaporation, precipitation, infiltration, runoff, ground water hydraulics.

4316. Elements of Hydraulic Engineering. (3:3:0)
Prerequisite: C.E. 339. Dams; channels and pressure conduits; hydraulic machinery; hydroelectric power.

4317. Cost Estimating. (3:3:0)
Prerequisite: C.E. 333. Estimating costs of construction projects to include earthwork; pavements; and concrete, steel, masonry and timber structures.

Graduate Civil Engineering

General requirements and more detailed information may be found in the Graduate Bulletin.

The Department of Civil Engineering offers a graduate program leading to the Degree of Master of Science in Civil Engineering. Advanced courses in strength of materials, elasticity, structures,

fluid mechanics, soil mechanics, together with well-selected subjects of a cognate character given in other departments, provide the student with the opportunity of electing a balanced program of high-level work designed to suit his interests.

Graduate Course Descriptions

511. Advanced Soil Engineering Laboratory. (1:0:3)
Prerequisite: Concurrent enrollment in C.E. 5312 or consent of instructor. Laboratory determination and evaluation of the engineering properties of soils.

531. Advanced Strength of Materials. (3:3:0)
Prerequisite: C.E. 333. Stresses at a point, unsymmetrical bending, tension on circular sections, stress concentration, torsion on noncylindrical pieces, theories of failure.

532. Theory of Elasticity. (3:3:0)
Prerequisite: C.E. 333, Math. 331, Math. 332. General analysis of stress and of strain, relationship between stress and strain, structural applications.

533. Theory of Ultimate Strength Design. (3:3:0)
Prerequisite: C.E 334, 431. Study of the theory of plastic design of steel frames and of the ultimate strength theory as applied to reinforced concrete.

534. Advanced Structural Analysis. (3:3:0)
Prerequisite: C.E. 432, 433. Application of statically indeterminate methods of analysis to building frames, arches, rigid bents, continuous trusses.

535. Dams and Reservoirs. (3:3:0)
Prerequisites: C.E. 4312, 4315. Selection of dam sites. General principles of design of earth dams. Flow nets and seepage. Spillways and outlet works.

536. Open Channel Hydraulics. (3:3:0)
Prerequisite: C.E. 339. Channel geometry and parameters. Uniform and varied flow. Spillways, hydraulic jumps.

538. Advanced Water and Waste Treatment. (3:2:3)
Prerequisite: C.E. 437, 438. Study of advanced methods of water and waste treatment including industrial and radioactive wastes.

539. Flow in Porous Media. (3:3:0)
Prerequisite: C.E. 4315, Math. 434, registration in Math. 435. Flow of homogeneous liquids in confined or unconfined porous formations toward natural outlets or toward wells. Artificial recharge of ground water reservoirs.

5312. Soil Engineering III. (3:3:0)
Prerequisite: C.E. 4312. Specialized topics in the theoretical and practical aspects of foundation and earth work engineering.

5313, 5314. Advanced Work in Specific Fields. (1 to 6)
Prerequisites: Graduate standing and approval of Head of Department. Nature of course and amount of credit depend on the nature of the work and the student's interest and performance. An individual study course.

630. Master's Report. (3)

631-632. Master's Thesis. (6)

Department of ELECTRICAL ENGINEERING

Harold Aylesworth Spuhler, Head of the Department

Professors:
Mr. Spuhler, Mr. Houston
Associate Professor:
Mr. Stenis
Assistant Professors:
Mr. Easter, Mr. Seacat, Mr. Wright
Instructors:
Mr. Gatlin, Mr. Meeks

Electrical engineering is that field which is concerned with the conversion, transmission, and control of energy in electrical form; with the utilization of such energy in the performance of useful work; and with the application of related phenomena to the control, transmission, and processing of information.

The Department offers a program at the undergraduate level, leading to the Degree of Bachelor of Science, and an advanced one at the graduate, leading to the Master of Science. The basic objective of the undergraduate program is to provide the student with a broad and deep mastery of the enduring fundamentals upon which he can establish his professional career. Toward this end, the electrical engineering curriculum emphasizes basic concepts, analytical methods, and experimental techniques, rather than the acquisition of routine skills. Prerequisites for such training include mathematics, physics, and chemistry; emphasis upon mechanics, thermodynamics, electricity and magnetism; and a study of the properties of the materials with which the engineer must work. Humanistic courses such as English, history, government, and economics provide breadth and balance for the curriculum and strengthen the ability of the student to meet the obligations and responsibilities of his dual role of professional engineer and citizen.

The professional program has been arranged to provide training in the fundamentals of circuit theory, electronics, electro-magnetic theory, and energy conversion. Specialized training in their application is provided in the laboratory sequence, with emphasis on experimental techniques. This work involves individual projects which provide the student with training in the planning and execution of experimental investigations; the proper choice and use of laboratory equipment; and the evaluation and interpretation of experimental data. Technical electives in specialized areas such as those of control systems, computers, acoustics, electronic instrumentation and solid-state devices, are provided for students whose interests lie in these directions. The approach to the overall curriculum is from the standpoint of engineering science, with the purpose of providing the student with the background required

ELECTRICAL ENGINEERING CURRICULUM

Bachelor of Science in Electrical Engineering

FRESHMAN YEAR*			SEMESTER 1st.	2nd.
Math.	132	Anal. Geom.	3	
Math.	231	Calculus I	3	
Eng.	131	Col. Rhet.	3	
Grph.	131	Engr. Grph.	3	
Phys.	143	Prin. of Physics I	4	
P.E., Band, or Basic ROTC				
Math.	232	Calculus II		3
Math.	331	Calculus III		3
Eng.	132	Col. Rhet.		3
Grph.	132	Engr. Grph.		3
Phys.	241	Prin. of Physics II		4
P.E., Band, or Basic ROTC				
		Total credit hours	16**	16**

SOPHOMORE YEAR			SEMESTER 1st.	2nd.
Math.	335	Math. for Engrs.	3	
Phys.	242	Prin. of Physics III	4	
C. E.	233	Statics	3	
E. E.	231	Prin. of E. E. I	3	
Chem.	141	Gen. Chem.	4	
P.E., Band, or Basic ROTC				
Math.	336	Math. for Engrs.		3
Math.	4318	Finite Math. Struc.		3
C. E.	332	Dynamics		3
E. E.	232	Prin. of E. E. II		3
Chem.	142	Gen. Chem.		4
P.E., Band, or Basic ROTC				
		Total credit hours	17**	16**

SUMMER SESSION		FIRST TERM		SECOND TERM		
E. E.	3323	Meth. of Circuit Anal.	3	Ch. E.	330	Engr. Mat. Science	3
Govt.	233	Amer. Govt., Org.	3	Govt.	234	Amer. Govt., Func.	3
		Total credit hours	6			Total credit hours	6

JUNIOR YEAR			SEMESTER 1st.	2nd.
E. E	3311	Electronics I	3	
E. E.	3321	Circuit Theory I	3	
E. E.	3331	Measurements Lab.	3	
E. E.	3341	Electromagnetic Th. I	3	
Spch.	338	Bus. and Prof. Speech	3	
Hist.	231	Hist. U.S. to 1865	3	
E. E.	3312	Electronics II		3
E. E.	3322	Circuit Theory II		3
E. E.	3332	Experimental Lab. I		3
E. E.	3342	Electromagnetic Th. II		3
Eng.	233	Tech. Writing		3
Hist.	232	Hist. U.S. Since 1865		3
		Total credit hours	18	18

SENIOR YEAR			SEMESTER 1st.	2nd.
E. E.	4333	Experimental Lab. II	3	
E. E.	4351	Energy Conversion I	3	
M. E.	3321	Engr. Thermodynamics	3	
Elective		(Humanity)	3	
Elective		(Technical)	3	
E. E.	4352	Energy Conversion II		3
Elective		(Technical)		6
Elective				3
		Total credit hours	15	12

Minimum hours required for graduation — 140 and P.E., Band, or Basic ROTC.

*See Page 8 for Alternate Freshman Year

**Exclusive of P.E., Band, or Basic ROTC

for entrance into either a graduate program for continued formal training, or a professional career in any of the many specializations open to electrical engineering graduates.

Admission to junior standing as an electrical engineering major is conditioned upon the Department's acceptance of a petition, which must be submitted prior to registration for the third year. Such acceptance depends upon the grade record submitted after completion of the first two years. It is expected, initially, that an overall grade-point average of 2.0 or better will have been achieved in all courses taken; that above-average grades will have been attained in the mathematics courses taken; and, finally, that a grade of C or better will have been made in both E.E. 231, and E.E. 232.

Each student entering the electrical engineering program will be assigned a faculty adviser, and will be responsible for arranging a course of study with his advice and approval. All students enrolled in this program will be required to maintain a grade-point ratio of at least 2.0 in their major fields during each semester. Any student who fails to meet this requirement in any given semester must fulfill a program outlined by his faculty adviser before being allowed to proceed.

Courses in Electrical Engineering

A key to the meaning of course numbers, symbols, abbreviations, etc., appears on Page 4.

For Undergraduates

231-232. Principles of Electrical Engineering. (3:3:0)
Prerequisite: Concurrent enrollment in Math. 335. Fundamental principles of electric and magnetic circuits. Magnetic properties of iron and steel. Induced and generated electromotive force. Forces on conductors. Fundamentals of alternating current circuits. Fundamentals of resistance inductance, and capacitance. Network theorems, resonance phenomena, coupled circuits, analysis, three-phase circuits, and non-sinusoidal waveforms.

3311. Electronics I. (3:3:0)
Prerequisite: E.E. 3323, 232. Principles and methods of analysis of high vacuum tubes, gas tubes, rectifiers, photo-tubes, semiconductor diodes, and transistors.

3312. Electronics II. (3:3:0)
Prerequisite: E.E. 3311. Vacuum tube and transistor amplifiers, oscillators, modulators, demodulators, frequency converters, and wave-shaping circuits.

3321. Circuit Theory I. (3:3:0)
Prerequisite: E.E. 232, 3323. Transient behavior of electrical circuits and other physical systems. Application of differential equation and Laplace transformation techniques. Initial conditions and initial and final value theorems. Single energy-storage systems, double energy-storage systems, and coupled systems. Introduction to transfer functions.

3322. Circuit Theory II. (3:3:0)
Prerequisite: E.E. 3321. Generalized matrix formulation of the network problems. Two-port networks and parametric formulation. The filter problem, filter types and application to filter design. Introduction to the synthesis problem.

3323. Methods of Circuit Analysis. (3:3:0)
Prerequisite: E.E. 232, Math. 336. Rigorous treatment of the mathematical methods available and applicable to the analysis of linear circuits, applications of determinants, matrices, linear transformations, vector analysis, complex variable, Fourier series, and integrals.

3331. Measurements Laboratory. (3:0:9)
Prerequisite: Junior standing in engineering. A laboratory course to accompany third-year basic courses in electrical engineering. Detailed experimental study of the measurement problem. Projects assigned to correlate with the material presented in electronics, network theory, and electromagnetic theory. Use of test equipment and measurement devices.

3332. Experimental Laboratory I. (3:0:9)
Prerequisite: E.E. 3331. A laboratory course to accompany third-year basic courses in electrical engineering. Projects assigned to correlate with the theory presented in second-semester junior courses.

3341. Electromagnetic Theory I. (3:3:0)
Prerequisite: Junior standing in engineering. General treatment of static electric and mag-

netic fields from the vector viewpoint. Laws of Coulomb, Gauss, Ampere, Biot and Savart, and Faraday. Poisson's and Laplace's equations. Development of Maxwell's equations in differential and integral form.

3342. Electromagnetic Theory II. (3:3:0)
Prerequisite: E.E. 3341. General solutions for Maxwell's equations. Traveling waves in scalar media. Boundary conditions and constraints imposed by bounding surfaces. Guided waves in three dimensions. Detailed treatment of the one-dimensional case.

3351. Illumination. (3:3:0)
Prerequisite: Math. 132, 6 semester hours of physics. Basic theory and modern methods of illumination. Design considerations.

For Undergraduates and Graduates

4311. Analog and Digital Computation. (3:3:0)
Prerequisite: Senior standing in engineering. An introductory treatment of analog and digital computers. Circuit types and components. Number systems. Operational techniques. Storage devices. Input-output equipment. Programming.

4317. Electronics III. (3:3:0)
Prerequisite: E.E. 3312. Electronic systems for the processing and transmission of information. Application of matrix, topological, and signal-flow-graph methods to system analysis. Introduction to non-linear and time-varying linear systems. Effects of noise and saturation in electronic systems.

4333. Experimental Laboratory II. (3:0:9)
Prerequisite: E.E. 3332. A laboratory course to accompany fourth-year courses in electrical engineering. Projects assigned to correlate the theory presented in first-semester senior courses.

4343. Energy Transmission. (3:3:0)
Prerequisite: Senior standing in electrical engineering. Theory and application of transmission lines at power, signal, and high frequencies.

4351. Energy Conversion I. (3:3:0)
Prerequisite: Senior standing in electrical engineering. Elements of energy conversion applied to direct current and alternating current static and rotating machinery. Theoretical study of transient and steady state operating characteristics of machines with applications. Symmetrical components.

4352. Energy Conversion II. (3:3:0)
Prerequisite: E.E. 4351. Elements of energy conversion applied to alternating current rotating machinery with application to salient pole synchronous machines, and induction machines, both single and multiphase; and to balanced and unbalanced short circuits.

4353. Feedback Control Systems. (3:3:0)
Prerequisite: E.E. 4351. An introductory course in the theory of automatic control systems. Transfer functions and block diagrams. Basic servo characteristics. Frequency response and correlation with time response. Compensation. Stability criteria. Optimum response criteria.

4354. Acoustics. (3:3:0)
Prerequisite: Senior standing in engineering. General nature of the acoustics problem. Radiating systems. Dynamical analogies. Microphones and other transducers. Acoustic measurements.

Graduate Electrical Engineering

General requirements and more detailed information may be found in the Graduate Bulletin.

The Department offers a graduate program leading to the Master of Science Degree. Its objectives are to provide advanced formal training in the application of fundamental concepts in the investigation of new problems; to deepen the understanding of such concepts; and to acquaint the student with the methods and techniques of both fundamental and applied research in the engineering sciences. Emphasis is placed on the research program, and the course work is planned to provide the formal background required for the successful completion of the research investigation. Programs in network synthesis, solid-state circuits, analog and digital computers, microwave systems, and direct energy conversion are available. The facilities of the Data Processing Center and the Institute of Science and Engineering supplement those of the Department for programs which are interdisciplinary in scope.

Graduate Course Descriptions

5311-5312. Automatic Control Systems. (3:3:0 each)
Prerequisite: E.E. 4353 or equivalent. Quantitative study of closed-loop automatic control system behavior. Relation between transient and steady-state performance. System synthesis for prescribed design criteria.

5313-5314. Two-Port Network Theory and Solid-State Electronics. (3:3:0 each)
Prerequisite: B.S. in E.E. or consent of instructor. Two-port network theory, passive and active two ports, physical processes in semiconductors, circuit models of transistors and diodes, transistor pulse circuits, linear amplifiers, practical applications and limitations of transistors, selected topics (breakdown diodes, drift transistors, photosensitive devices, etc.)

5317. Advanced Transients. (3:3:0)
Prerequisite: Graduate standing in electrical engineering. Transient analysis using transform methods with emphasis on physical interpretations. Lumped constant linear approximations. Laplace, Fourier transformations. Convolution processes in real and complex domains. Z transforms. Applications to sampled data systems, difference and cyclic switching.

5318. Pulse and Timing Circuits. (3:3:0)
Prerequisite: Graduate standing in electrical engineering or consent of instructor. Electron devices as switching elements. R-C coupled circuits, multivibrators (bistable, monostable and astable). Sweep circuits, pulse transformers, blocking oscillators, lines and pulse-forming networks.

5319. Electronic Circuits and Systems. (3:3:0)
Prerequisite: Graduate standing in electrical engineering or consent of instructor. Fundamentals of linear amplifiers, speed of step responses (sag, overshoot, etc.), distributed amplifiers, stagger-tuned amplifiers, synchronous-tuned amplifiers, double-tuned interstages, physical analogies, design procedures, circuit noise, calculation of noise figure.

5321. Digital Systems. (3:3:0)
Prerequisite: Graduate standing in electrical engineering. A detailed treatment of the concepts and procedures involved in the logical design of digital systems. Boolean algebra and applications. Application equations. Memory units. Input-output equipment. Arithmetic units. The general design problem.

5322-5323. Advanced Network Theory I and II. (3:3:0)
Prerequisite: Graduate standing in electrical engineering or consent of instructor. Theory of two-terminal and four-terminal networks, impedance transformation, Foster's theorem and extensions, conventional and lattice filters, equalizers, network design and synthesis, application of network theory to vacuum-tube circuits.

5324. Symmetrical Components. (3:3:0)
Prerequisite: Graduate standing in electrical engineering or consent of instructor. The theory of the method of symmetrical components is reviewed and supplemented in detail; related components are described, and the method is applied to the calculation of voltage and currents in complex systems under conditions of fault and unbalanced loading. The symmetrical component impedances of machines are defined and calculated, also the zero sequence impedance of lines and cables.

5325. Information Theory. (3:3:0)
Prerequisite: Graduate standing in electrical engineering. Probability theory of finite systems. General properties of channels of various types. Transmission of information. Discrete channels with and without memory. Coding theorems.

5331. Theoretical Investigations in Engineering Applications. (3:3:0)
Prerequisite: Graduate standing in engineering. An individual study course involving a rigorous theoretical investigation of some aspect of an engineering problem of current interest. A formal report is required.

5332. Experimental Investigation in Engineering Application. (3:0:9)
Prerequisite: Graduate standing in engineering. An individual study course involving an experimental investigation of some aspect of an engineering problem of current interest. A formal report is required.

5341-5342. Advanced Electromagnetic Theory I and II. (3:3:0)
Prerequisite: Graduate standing in electrical engineering or consent of instructor. Rigorous treatment of the boundary-value problems encountered in the analysis of systems for guiding electromagnetic waves. Reduction of waveguide and obstacle problems to equivalent network problems.

5351. Electric Power Systems. (3:3:0)
Prerequisite: Graduate standing in electrical engineering or consent of instructor. Line constants, long-line equations, power-circle diagrams, traveling waves, system stability, line construction, corona.

5352-5353. Advanced Electrical Machine Theory I and II. (3:3:0)
Prerequisite: Graduate standing in electrical engineering or consent of instructor. A rigorous exposition of machine theory. Application of the methods of Doherty, Nickle, and Park to many problems. Direct and quadrature transient currents by operational calculus methods. Space and time harmonics of magneto-motive force. Emphasis is on operation, but design factors such as flux plotting are considered.

ENGINEERING PHYSICS CURRICULUM
Bachelor of Science in Engineering Physics

FRESHMAN YEAR*			SEMESTER 1st.	2nd.
Math.	132	Anal. Geom.	3	
Math.	231	Calculus I	3	
Eng.	131	Col. Rhet.	3	
Grph.	131	Engr. Grph.	3	
Phys.	143	Prin. of Physics I	4	
P.E., Band, or Basic ROTC				
Math.	232	Calculus II		3
Math.	331	Calculus III		3
Eng.	132	Col. Rhet.		3
Grph.	132	Engr. Grph.		3
Phys.	241	Prin. of Physics II		4
P.E., Band, or Basic ROTC				
		Total credit hours	16**	16**

SOPHOMORE YEAR			SEMESTER 1st.	2nd.
Math.	335	Math. for Engrs.	3	
Phys.	242	Prin. of Physics III	4	
C. E.	233	Statics	3	
E. E.	231	Prin. of E. E. I	3	
Chem.	141	Gen. Chem.	4	
P.E., Band, or Basic ROTC				
Math.	336	Math. for Engrs.		3
Math.	4318	Finite Math. Struc.		3
C. E.	332	Dynamics		3
E. E.	232	Prin. of E. E. II		3
Chem.	142	Gen. Chem.		4
P.E., Band, or Basic ROTC				
		Total credit hours	17**	16**

SUMMER SESSION		FIRST TERM		SECOND TERM		
M. E.	3321	Engr. Thermodynamics	3	C. E.	333	Strength of Materials	3
Phys.	335	Elec. & Magnetism	3	Phys.	336	Elec. & Magnetism	3
		Total credit hours	6			Total credit hours	6

JUNIOR YEAR			SEMESTER 1st.	2nd.
Phys.	312	Atomic Physics Lab.	1	
Phys.	337	Intro. to Atomic Physics	3	
Ch. E.	330	Engr. Mat. Science	3	
Math.	434	Advanced Calculus	3	
Hist.	231	Hist. U.S. to 1865	3	
Govt.	233	Amer. Govt., Org.	3	
Phys.	313	Nuclear Physics Lab.		1
Phys.	338	Intro. to Nuclear Physics		3
Phys.	341	Electronics		4
Hist.	232	Hist. of U.S. Since 1865		3
Math.	435	Advanced Calculus		3
Govt.	234	Amer. Govt., Func.		3
		Total credit hours	16	17

SENIOR YEAR			SEMESTER 1st.	2nd.
Phys.	434	Mechanics	3	
Ch. E.	4371	Nuclear Engineering	3	
M. E.	4314	Fluid Dynamics	3	
E. E.	4311	Analog and Digital Comp.	3	
Elective		(Humanity)	3	
Phys.	435	Mechanics		3
Phys.	433	439, or 432		3
M. E.	4315	Heat and Mass Transfer		3
E. E.	4353	Feedback Control Systems		3
Elective				3
		Total credit hours	15	15

Minimum hours required for graduation — 140 and P.E., Band, or Basic ROTC
*See Page 8 for Alternate Freshman Year
**Exclusive of P.E., Band, or Basic ROTC

ENGINEERING PHYSICS

Henry Thomas, Head of the Department

Staff: DEPARTMENT OF PHYSICS

Professors:
Mr. Thomas, Mr. Merrymon, Mr. Schmidt
Associate Professors:
Mr. Day, Mr. Gott, Mr. Sandlin
Assistant Professors:
Mr. Basford, Mr. Gardner, Mr. Mann, Mr. Phillips
Instructor:
Mr. Henson

The program leading to the degree of Bachelor of Science in Engineering Physics is primarily one of engineering science, and is administered by the Department of Physics, in the Schools of Arts and Sciences and Engineering.

The curriculum provides adequate preparation for students who desire careers in either scientific research or in engineering development. Its first purpose, however, is their preparation for positions which require both a thorough, and a broad understanding of basic physical principles, and a clear conception of the methods and techniques involved in the application of these principles. The program, therefore, is one which includes course work in intermediate and advanced physics, supplemented by a firm grounding in mathematics and fundamental engineering.

The course of study includes work in the areas of mechanics, electricity and magnetism, thermodynamics, fluid dynamics, electronics, and contemporary physics.

Courses in Physics

A key to the meaning of course numbers, symbols, abbreviations, etc., appears on Page 4.

For Undergraduates

141, 142. General Physics. (4:3:3)
A general course in beginning physics covering mechanics, heat, sound, electricity and magnetism, light, and modern physics.

143. Principles of Physics I. (4:3:3)
Prerequisite: Parallel enrollment in Math. 231. Kinematics, dynamics, conservation laws, wave motion, fluids, kinetic theory and thermodynamics.

215-216. Physical Measurements. (1:0:2 each)
Must be taken parallel with Phys. 235-236.

235. Engineering Physics. (3:3:0)
Prerequisite: One year of high school or college physics and Math. 231. Kinematics, dynamics, conservation laws, rotational motion, elastic properties of materials, periodic motion, fluids, heat and thermodynamics, and wave motion and sound.

236. Engineering Physics. (3:3:0)
Prerequisite: Phys. 235. Geometrical and physical optics, electric and magnetic fields, dielectrics, current electricity, magnetic properties of materials, electromagnetism, and atomic and nuclear phenomena.

237. Techniques of Photography. (3:2:3)
Prerequisite: Sophomore standing and approval of instructor. A course in fundamental processes and techniques of photography for those who will later need photography as a scientific tool. May be taken by majors and minors but will not apply toward physics requirements. Additional time needed for darkroom processing to be arranged. A $20 fee for materials is required.

241. Principles of Physics II. (4:3:3)
Prerequisite: Phys. 143 and parallel enrollment in Math. 232. Electric and magnetic fields dielectrics, magnetic properties of materials. electromagnetism, geometrical and physical optics.

242. Principles of Physics III. (4:3:3)
Prerequisite: Phys. 241. A study of atomic and nuclear phenomena.

312, 313. Atomic, Nuclear Physics Laboratory. (1:0:3 each)
Prerequisite: Parallel enrollment in Phys. 337, 338. Approval of instructor. Credit will be given for either or both semesters.

314-315. Intermediate Laboratory. (1:0:3)
Prerequisite: Phys. 242 or equivalent and junior standing. A laboratory course in basic physical principles.

331. Optics. (3:2:3)
Prerequisite: Phys. 242. Major emphasis of course on physical optics.

335, 336. Electricity and Magnetism. (3:3:0 each)
Prerequisite: One year of physics and junior standing. Electrostatics, dielectric theory, Laplace's equation, transient and A. C. circuits, magnetic fields, vector potential, magnetic materials, and electromagnetic theory.

337. Introduction to Atomic Physics. (3:3:0)
Prerequisite: One year of physics and junior standing.

338. Introduction to Nuclear Physics. (3:3:0)
Prerequisite: One year of physics and junior standing.

341. Electronics. (4:3:3)
Prerequisite: Phys. 335. A general course in electronics stressing the fundamentals of electron tubes and the application of these tubes in instruments and apparatus that are of primary importance in the physical sciences.

For Undergraduates and Graduates

432. Thermodynamics. (3:3:0)
Prerequisite: Phys. 242 or equivalent and Math. 335. First and second laws of thermodynamics, entropy, equations of state, thermodynamics functions.

433. Statistical Mechanics. (3:3:0)
Prerequisite: Phys. 242 and Math. 335. Probability and law of entropy, Maxwell-Boltzmann statistics, Fermi-Dirac statistics, Bose-Einstein statistics and applications.

434-435. Mechanics. (3:3:0 each)
Prerequisite: Phys. 242 or equivalent and Math. 335. Statics, kinematics, and dynamics of rigid bodies including Euler's equations, damped and forced vibrations, Lagrange's equations, Hamilton's equations, special relativity.

439. Solid-State Physics. (3:3:0)
Prerequisite: Phys. 335, 336, and Math. 335 or consent of Department Head. Specific heats of solids, ionic conductivity, ferro-electronics, band theory of solids, semi-conductors and transistors, ferro-magnetism.

4121. Engineering Physics Seminar. (1:1:0) (Formerly E.Sem. 412)
Prerequisite: Approval of department. The investigation and study of engineering problems of special interest and value to the student. May be repeated for credit.

Department of INDUSTRIAL ENGINEERING and ENGINEERING DRAWING

Richard Albert Dudek, Head of the Department

INDUSTRIAL ENGINEERING STAFF
Professor:
Mr. Dudek
Associate Professors:
Mr. Jenkins, Mr. MacKenzie
Assistant Professor:
Mr. Ayoub
Instructor:
Mr. Miller

ENGINEERING GRAPHICS STAFF
Professor:
Mr. Perryman
Associate Professors:
*Mrs. Atkinson, Mr. Lindenmeier
Assistant Professors:
Mr. Graham, Mr. Power

* Part-time

Industrial engineering may be defined as the application of engineering methods and the principles of scientific analysis, to work and work systems. It is based upon the early works on scientific management by Frederick W. Taylor, and those on motion study and methods analysis by Lillian M. and Frank B. Gilbreth. Industrial engineering began as a profession during the early 1900's, and has advanced rapidly since World War II.

To quote the American Institute of Industrial Engineers: "Industrial engineering is concerned with the design, improvement, and installation of integrated systems of men, materials, and equipment. It draws upon specialized knowledge and skill in the mathematical, physical, and social sciences, together with the principles and methods of engineering analysis and design to specify, predict, and evaluate the results to be obtained from such systems." Industrial engineering is used most widely in manufacturing fields, but contributes and is growing in use in such areas as engineering sales, farm management, home economics, hospital work, surgery, hotel and restaurant operation, retail store operation, architecture, construction work, regional planning, mail order selling, and various branches of the Federal Government. The curriculum is designed to equip the student for graduate work, as well as the professional pursuits mentioned above.

The typical industrial engineer is often employed in an advisory capacity, usually on the management staff of an organization. His duties include such things as the design of systems for obtaining

INDUSTRIAL ENGINEERING CURRICULUM

Bachelor of Science in Industrial Engineering

FRESHMAN YEAR*			SEMESTER	1st.	2nd.
Math.	132	Anal. Geom.		3	
Math.	231	Calculus I		3	
Eng.	131	Col. Rhet.		3	
Grph.	131	Engr. Grph.		3	
Phys.	143	Prin. of Physics I		4	
P.E., Band, or Basic ROTC					
Math.	232	Calculus II			3
Math.	331	Calculus III			3
Eng.	132	Col. Rhet.			3
Grph.	132	Engr. Grph.			3
Phys.	241	Prin. of Physics II			4
P.E., Band, or Basic ROTC					
		Total credit hours		16**	16**

SOPHOMORE YEAR			SEMESTER	1st.	2nd.
Math.	335	Math. for Engrs.		3	
Phys.	242	Prin. of Physics III		4	
C. E.	233	Statics		3	
E. E.	231	Prin. of E. E. I		3	
Chem.	141	Gen. Chem.		4	
P.E., Band, or Basic ROTC					
Math.	336	Math. for Engrs.			3
Math.	4318	Finite Math. Struc.			3
C. E.	332	Dynamics			3
E. E.	232	Prin. of E. E. II			3
Chem.	142	Gen. Chem.			4
P.E., Band, or Basic ROTC					
		Total credit hours		17**	16**

SUMMER SESSION			FIRST TERM	SECOND TERM			
I. E.	3311	Prin. of I. E. I	3	I. E.	3321	Prin. of I. E. II	3
I. E.	3315	Indus. Statistics I	3	Eco.	235	Prin. of Eco.	3
		Total credit hours	6			Total credit hours	6

JUNIOR YEAR			SEMESTER	1st.	2nd.
I. E.	3331	Work Anal. and Des. I		3	
I. E.	3325	Indus. Statistics II		3	
M. E.	3321	Engr. Thermodynamics		3	
Acct.	231	Indus. Acct. for Engrs.		3	
Psy.	330	Psy. in Bus. & Indus.		3	
I. E.	417	Indus. Statistics Lab.		1	
I. E.	3334	Work Anal. and Des. II			3
I. E.	3341	Work Control I			3
I. E.	3351	Production Design I			3
Ch. E.	330	Engr. Mat. Science			3
Elective		(Technical)			3
Hist.	231	Hist. U.S. to 1865			3
		Total credit hours		16	18

SENIOR YEAR			SEMESTER	1st.	2nd.
I. E.	4334	Work Anal. and Des. III		3	
Elective		(Technical)		3	
Bus. Law	339	Bus. Law II		3	
Govt.	233	Amer. Govt., Org.		3	
Elective		(Humanity)		3	
I. E.	4221	Spec. Prob. in Indus. Engr.			2
I. E.	4361	Indus. Engr. Design			3
Elective		(Technical)			3
Govt.	234	Amer. Govt., Func.			3
Hist.	232	Hist. U.S. Since 1865			3
		Total credit hours		15	14

Minimum hours required for graduation — 140 and P.E., Band, or Basic ROTC

*See Page 8 for Alternate Freshman Year

**Exclusive of P.E., Band, or Basic ROTC

maximum utilization and control of the resources of the organization; the determination of cost, quantities, and quality standards for operations; the determination of schedules and standard times for the performance of specific jobs while maintaining a rigid control of quality; the determination of the layout for physical facilities; and the establishment and administration of such programs as job evaluation, wage incentive, training, safety, and suggestion systems. The industrial engineer must understand both employee and operating problems, for he is in contact with supervision and labor in regard to improvements which will benefit both groups.

The curriculum of industrial engineering includes a core of basic courses in mathematics, drawing, physics, chemistry, English, economics, and psychology, as well as the basic courses in mechanical and electrical engineering, and engineering mechanics.

All industrial engineering majors are encouraged to take I.E. 311, Computer Programming Techniques, during the sophomore or the first semester of the junior year, since many problems presented in advanced courses can be solved best with the aid of an electronic computer, and the student is expected to make use of this facility. The departmental courses include the basic principles of industrial engineering, industrial statistics, work systems analysis and design, work control, and production design. Problems with which these courses deal are, primarily, those of cost, quality, and quantity of work. Their solution involves organizing, planning, coordinating the effective utilization and control of money, materials, facilities and personnel; and requires the consideration of human and economic, as well as technical, factors.

It is highly desirable that the student's accomplishment be of the best quality. While he may receive a grade of D at junior or senior level in one single course with impunity, any additional courses in which he has received a grade of D must be repeated.

Special programs sponsored by the Student Chapter AIIE and Alpha Pi Mu, the national honor society, as well as organized departmental seminars, supplement course instruction, thus keeping the student informed of latest developments in the growing field of industrial engineering.

Courses in Industrial Engineering

A key to the meaning of course numbers, symbols, abbreviations, etc., appears on Page 4.

For Undergraduates

311. Computer Programming Techniques. (1:1:0)
Prerequisite: Consent of instructor. Programming techniques for digital and analog computers.

***330. Industrial Relations and Wage Policies. (3:3:0)**
Prerequisite: I.E. 332 or parallel registration. A study of the policies and practices of industrial organizations relative to employees. Emphasis is on responsibility of the personnel department in recruitment, maintenance of personnel, training new workers, working conditions, remuneration, handling of grievances, job evaluation, merit rating, pension plans.

***332. Industrial Organization and Management. (3:3:0)**
Prerequisite: Junior standing. A study of modern manufacturing management. Forms of

ownership, financial sources; organization charts; plant location and types of buildings; design of manufacturing processes; use of motion and time study in the management field; principles and methods of quality, production, and inventory control; wage and salary policies.

335. Safety Engineering. (3:3:0)
Prerequisite: Junior standing in engineering or business management. Principles of safety engineering as applied to industrial situations. Costs of accidents, accident prevention methods, industrial safety programs, frequency and severity rates, protective equipment, jigs and fixtures, accident investigations and reports, student reports on related safety subjects.

337. Production Planning and Control. (3:3:0)
Prerequisite: I.E. 3311 or equivalent. Control functions; types of production and types of control; forecasting and estimating; basic information required for control; initiating production control; flow control; block and load control. Reproduction of forms and communications systems, relationships of product control department with other departments. Value of production control. Linear programming applications to production control.

338. Elements of Methods Analysis. (3:2:3)
Prerequisite: Non-major student and consent of instructor. Science and work, the work system, work simplification, operation analysis, forms control and design. Methods improvement techniques and principles of effective work. A survey of work measurement, work sampling, and inventory control. Applications to many areas, as business concerns, the home, the farm, the hospital, etc., will be considered.

3311. Principles of Industrial Engineering I. (3:3:0)
Prerequisite: Math. 4318. Consideration of the organization through systems approach. Management objectives, decision theory, "model" formulation, and introduction to operations research techniques.

3315. Industrial Statistics I. (3:3:0)
Prerequisite: Math 232. Elements of industrial statistics; descriptive statistics, probability, and quality control.

3321. Principles of Industrial Engineering II. (3:3:0)
Prerequisite: I.E. 3311 and 3315. Continuation of operations research techniques. Study of the principles and theories of quantitative methods for analysis of work systems.

3325. Industrial Statistics II. (3:3:0)
Prerequisite: I.E. 3315 or equivalent. Statistical inference techniques and applications to work systems.

3331. Work Analysis and Design I. (3:2:3)
Prerequisite: I.E. 3315 and 3321. Principles and techniques of analysis of work measurement, engineering economy, and work flow with applications of design for better work systems. Emphasis on methods and measurement.

3334. Work Analysis and Design II. (3:3:0)
Prerequisite: I.E. 3331. Continuation of work analysis and design. Emphasis on engineering economy analysis.

3341. Work Control I. (3:3:0)
Prerequisite: I.E. 3331. Basic designs of work control systems. Emphasis on forecasting; material and product control.

3351. Production Design I. (3:2:3)
Prerequisite: I.E. 3331. Elements of machines and manufacturing processes, metal removal theory; principles of machine tool design; introduction to automation principles and design.

For Undergraduates and Graduates

417. Industrial Statistics Problem Laboratory. (1:0:3)
Prerequisite: Parallel registration in I.E. 3315, 3325 or 5317, and consent of instructor. Experimental study of statistical techniques. Problem design and data analysis.

***421. Materials Handling. (2:2:0)**
Prerequisite: I.E. 3331 and 3351. A study of the various types of materials handling, such as railroads, trucks, elevators, conveyors of various types, and the application of the proper type to various materials handling problems.

439. Analysis of Industrial Operations. (3:3:0)
Prerequisite: I.E. 3315 or equivalent. Introduction to operations research techniques. Study of the applications of quantitative methods for analysis of industrial operating problems.

4221. Special Problems in Industrial Engineering. (2:2:0)
Prerequisite: Graduating industrial engineering seniors. A practical solution of a variety of problems which the industrial engineer may be expected to encounter in his work. Problems cover the following subjects: plant layout; production planning; engineering economy; methods improvement; materials handling; and other industrial engineering problems.

4311. Automatic Data Processing Systems. (3:3:0)
Prerequisite: Junior standing and consent of instructor. Introduction to automatic data processing systems, types of equipment, programming procedures, principles of processing in systems design for computer applications in industry.

4331. Individual Studies in Industrial Engineering. (3:3:0)
Prerequisite: Senior standing in industrial engineering. To be used by the student for individual studies in advanced industrial engineering fields. May be repeated.

4334. Work Analysis and Design III. (3:2:3)
Prerequisite: I.E. 3334. Continuation of work analysis and design. Emphasis on work flow design.

4341. Work Control II. (3:3:0)
Prerequisite: I.E. 3341. Continuation of work control. Emphasis on inventory theory, "model" formulation of work control systems, etc.

4351. Production Design II. (3:2:3)
Prerequisite: I.E. 3351. Continuation of production design. Emphasis on automation and automatic controls.

4361. Industrial Engineering Design. (3:3:0)
Prerequisite: Graduating industrial engineering seniors. Design of a complete operational organization with emphasis on the application of theories covered in previous course work.

* These courses will be offered for the last time in the 1963-64 school year.

Graduate Industrial Engineering

General requirements and more detailed information may be found in the Graduate Bulletin.

The Department of Industrial Engineering offers advanced study in the areas of: work analysis, work management, production analysis, control systems and systems analysis.

The course selection for the Master of Science Degree in Industrial Engineering may be arranged to meet the interests of the individual student. For those desiring minor work, suitable cognate work can be taken in other branches of engineering, mathematics, physics, industrial psychology, and industrial management.

Graduate Course Descriptions

512. Industrial Engineering Graduate Seminar. (1:1:0)
Prerequisite: Graduate standing and consent of instructor. Discussion will concern present research being conducted in the industrial engineering field. Other special topics will also be considered.

531. Advanced Work Measurement. (3:2:3)
Prerequisite: Graduate standing and consent of instructor. Measurement of variable type jobs, a critical analysis of micromotion study, memomotion study; chronocyclegraph; other filming techniques and work sampling.

532. Standard Data Systems. (3:2:3)
Prerequisite: Graduate standing and consent of instructor. Concepts of standard time data and standard data systems, consideration of company, commercial, and statistical standard data systems; use of multivariable charts and nomographs.

535. Engineering Controls for Industrial Safety. (3:3:0)
Prerequisite: Graduate standing and consent of instructor. The design of the industrial safety program under widely variant conditions through proper combination of accident control activities. Consideration of workmen's compensation, and minimum safety standards legislation, health hazards present in industry because of exposure of workers to dusts, fumes, skin irritants. Statistical measurements of safety performances. Analytical studies of fire prevention techniques.

536. Dynamics of Engineering Economy. (3:3:0)
Prerequisite: Graduate standing and consent of instructor. A continuation of equipment selection and investment, emphasizing depreciation and other economic approaches to the selection and replacement of equipment and structures. Relationship between accounting and engineering economy. MAPI formula. Income tax aspects of economy studies.

537. Advanced Production Control. (3:3:0)
Prerequisite: I.E. 4341 or equivalent and consent of instructor. A study of the most modern practices and theory or making optimal decisions concerning production, inventories, and human resources. The use of the analytical and mathematical approach to solve complicated decision problems.

538. Engineering Aspects of Wage Policies. (3:3:0)
Prerequisite: Graduate standing and consent of instructor. Study of the engineering aspects of wage problems based on wage incentives, plans, job analysis, job descriptions, merit rating, and job evaluation.

5111, 5212, 5213, 5214. Industrial Engineering Case Analysis. (1-3: arranged: 0 each)
Prerequisite: Graduate standing and consent of instructor. Special studies and investigations by the student, in the library, laboratory, or in local industry, considering the application of the various industrial engineering techniques.

5311, 5312. Analysis Techniques for Management. (3:3:0 each)
Prerequisite: Graduate standing and consent of instructor. General concepts and principles of operations research. Mathematical and statistical tools which aid management decisions; applications and case studies.

5316. Statistical Reliability Analysis. (3:3:0)
Prerequisite: 3 hours of statistics and consent of instructor. The role of probability and statistics in reliability analysis; statistical models for fatigue and failure, with emphasis on exponential, Weibull, Gamma, and extreme-value distributions. Design, analysis, and interpretation of multifactor reliability experiments; increased severity testing; improved reliability through redundance and maintenance; applications to component and systems reliability.

5317. Advanced Industrial Statistics. (3:3:0)
Prerequisite: 6 hours of statistics and consent of instructor. Analysis of variance, multiple correlation, analysis of covariance, design of experiments, randomized blocks and Latin square, response-surface analysis, and determination of optimum conditions.

5318. Selected Topics in Advanced Statistics. (3:3:0)
Prerequisite: 6 hours of statistics and consent of instructor. Selected topics chosen from such areas as: nonparametric statistical methods; sequential analysis; multivariate analysis; etc. May be repeated in different areas.

630. Master's Report. (3)

631-632. Master's Thesis. (6)

Engineering graphics courses are required for all engineering students. The objective of these courses is to familiarize the student with the graphic language of the engineer and to train the student to use skillfully and intelligently engineering sketching and drawing techniques as a background for specialized engineering and design problems.

Courses in Engineering Graphics

A key to the meaning of course numbers, symbols, abbreviations, etc., appears on Page 4.

For Undergraduates

131. Engineering Graphics I. (3:1:5)
Fundamentals of shape description, free-hand sketching, engineering geometry, pictorial presentations of ideas, and principles of size description. Stress is given to the essentials of sketching and drafting in conveying ideas in the graphic language of the engineer.

132. Engineering Graphics II. (3:1:5)
Prerequisite: E.Grph. 131. Graphical presentation of data, fundamentals of nomography, advanced space relationships, concepts of surface intersections and developments.

Department of MECHANICAL ENGINEERING

Louis John Powers, Head of the Department

Professors:
Mr. Powers, Mr. Mason, Mr. Newell
Associate Professors:
Mr. Fung, Mr. Helmers, Mr. Martin
Assistant Professors:
Mr. Davenport, Mr. Lawrence
Instructors:
Mr. Horton, *Mr. Reis

* On leave 1961-1962

In mechanical engineering, instruction leading to the Degrees of Bachelor of Science and Master of Science is offered. Although the bachelor's program is designed as a terminal one, it leads toward graduate study in a specialized engineering field. It recognizes the increasing national growth in graduate engineering education, and through counseling and elective freedom builds an adequate preparation.

The undergraduate program of instruction is organized on a four years plus one summer basis, and includes thorough training in the basic sciences of physics, chemistry, and mathematics, in conjunction with a substantial number of cultural studies. Mechanical engineering instruction is provided in three general areas: (1) design and dynamics, (2) physical metallurgy and mechanics of materials, (3) thermodynamics, heat transfer, and heat power. A dynamics laboratory is provided for the study of problems in vibration, transient phenomena in mechanical systems, and experimental stress analysis by means of special mechanical and electronic equipment.

Instruction in physical metallurgy is made possible by a well-equipped metallography laboratory, in which metals may be prepared, heat-treated, analyzed, and studied microscopically. Laboratory facilities have been developed for analysis, design, and evaluation of machine elements. Work in the field of thermodynamics and heat power is implemented by laboratories containing heat power and heat transfer apparatus. An additional activity arises in conjunction with the analysis laboratory. It is built around an analog computer, thus merging the interests in applied mechanics, applied thermodynamics, and applied mathematics in the solution of engineering problems.

For many students, graduate study in specialized aspects of mechanical engineering will be the goal. It is recommended that these students consider additional mathematics, or graduate subjects, in satisfying their undergraduate electives. For others, immediate

MECHANICAL ENGINEERING CURRICULUM

Bachelor of Science in Mechanical Engineering

FRESHMAN YEAR*			SEMESTER	1st.	2nd.
Math.	132	Anal. Geom.		3	
Math.	231	Calculus I		3	
Eng.	131	Col. Rhet.		3	
Grph.	131	Engr. Grph.		3	
Phys.	143	Prin. of Physics I		4	
P.E., Band, or Basic ROTC					
Math.	232	Calculus II			3
Math.	331	Calculus III			3
Eng.	132	Col. Rhet.			3
Grph.	132	Engr. Grph.			3
Phys.	241	Prin. of Physics II			4
P.E., Band, or Basic ROTC					
		Total credit hours		16**	16**

SOPHOMORE YEAR			SEMESTER	1st.	2nd.
Math.	335	Math. for Engrs.		3	
Phys.	242	Prin. of Physics III		4	
C. E.	233	Statics		3	
E. E.	231	Prin. of E. E. I		3	
Chem.	141	Gen. Chem.		4	
P.E., Band, or Basic ROTC					
Math.	336	Math. for Engrs.			3
Math.	4318	Finite Math. Struc.			3
C. E.	332	Dynamics			3
E. E.	232	Prin. of E. E. II			3
Chem.	142	Gen. Chem.			4
P.E., Band, or Basic ROTC					
		Total credit hours		17**	16**

SUMMER SESSION			FIRST TERM	SECOND TERM			
M. E.	3321	Engr. Thermodynamics	3	M. E.	237	or Ch. E. 330	3
M. E.	3212	Heat Power	2	M. E.	3213	Heat Power	2
		Total credit hours	5			Total credit hours	5

JUNIOR YEAR			SEMESTER	1st.	2nd.
M. E.	3214	Air Conditioning		2	
M. E.	3313	Dynamics		3	
M. E.	3314	Machine Elements		3	
M. E.	4314	Fluid Dynamics		3	
Eng.	231	Mast. of Lit.		3	
Hist.	231	Hist. U.S. to 1865		3	
M. E.	3117	Physical Metallurgy Lab.			1
M. E.	3215	Air Conditioning			2
M. E.	3315	Machine Elements			3
M. E.	3317	Physical Metallurgy			3
M. E.	4315	Heat and Mass Transfer			3
Hist.	232	Hist. U.S. Since 1865			3
		Total credit hours		17	15

SENIOR YEAR			SEMESTER	1st.	2nd.
M. E.	4131	Engr. Reports		1	
M. E.	4212	Thermodynamics		2	
M. E.	4214	Engr. Analysis		2	
M. E.	4216	Design		2	
M. E.	4312	Mech. Engr. Lab.		3	
Govt.	233	Amer. Govt., Org.		3	
Elective***				3	
M. E.	4213	Thermodynamics			2
M. E.	4217	Design			2
M. E.	4313	Mech. Engr. Lab.			3
Engr.	4331	Special Problems			3
Govt.	234	Amer. Govt., Func.			3
Elective***					3
		Total credit hours		16	16

Minimum hours required for graduation — 139 and P.E., Band, or Basic ROTC

*See Page 8 for Alternate Freshman Year

**Exclusive of P.E., Band, or Basic ROTC

***Junior, Senior, or Graduate Level Course

industrial work, and ultimately administration, is the objective. Such students may wish to broaden their training by electing courses such as additional electrical or industrial engineering, in preparation for the future.

The mechanical engineering staff maintains close relationships with many industries and research agencies, which provide new basic problems and facilities for study and research in the broad field of mechanical engineering.

Courses in Mechanical Engineering

A key to the meaning of course numbers, symbols and abbreviations, etc., appears on Page 4.

For Undergraduates

237. Metals Engineering. (3:3:0)
Prerequisite: Chem. 141. Metallography, heat treatment, and metal fabrication processes for engineering applications.

3117. Physical Metallurgy Laboratory. (1:0:3) (Formerly 412)
Corequisite: Concurrent enrollment in M.E. 3317. Metallurgical laboratory techniques, lattice and grain structure analysis, metals testing.

3212, 3213. Heat Power. (2:2:0 each) (Formerly 335)
Corequisite: M.E. 3321. Study of power system components such as fans, compressors, pumps, turbines and steam generators. Economic and thermodynamic analysis of chemical, solar, and nuclear energy conversion systems.

3214, 3215. Air Conditioning. (2:2:0 each) (Formerly 338)
Prerequisite: M.E. 3321. Air-steam mixtures; refrigeration; heating, cooling, and ventilation for various environmental requirements.

3313. Dynamics. (3:3:0)
Prerequisite: C.E. 332. Vector treatment of Newtonian dynamics, Hamilton's principle, Lagrange's equations, central-force motion, oscillatory motion.

3314, 3315. Machine Elements. (3:3:0 each) (Formerly Mechanical Design)
Prerequisite: C.E. 233. Analysis of stresses in and functions of machine elements such as gears, cams, linkages, and structural elements. Introduction to mechanical design.

3317. Physical Metallurgy. (3:3:0) (Formerly 422)
Prerequisite: Ch.E. 330 or M.E. 237. Concurrent enrollment in M.E. 3117. Fundamentals of metal behavior in terms of atomic structure, energy levels, and crystal imperfections. Equilibruim diagrams, time-temperature-transformation phenomena.

3321. Engineering Thermodynamics. (3:3:0) (Formerly 330)
Prerequisite: Phys. 241, Math. 335. Basic laws of thermodynamics, fundamental properties and interrelationships between properties. Maxwell relations, Joule-Thompson effect, Clausius-Clapeyron equation. Application to gases as well as to other systems. Introduction to kinetic theory.

For Undergraduates and Graduates

4131. Engineering Reports. (1:1:0) (Formerly 410)
Prerequisite: Senior standing. Oral and written report presentation of selected current topics in mechanical engineering technology. May be repeated for credit in different areas.

4212, 4213. Thermodynamics. (2:2:0 each)
Prerequisite: M.E. 3321. Kinetic theory, basic chemical thermodynamics, non-equilibrim thermodynamics, introduction to statistical mechanics.

4214. Engineering Analysis. (2:1:3)
Prerequisite: C.E. 332, Math. 335. Numerical analysis and analog simulation of typical problems in mechanical engineering.

4216, 4217. Design. (2:1:3 each) (Formerly 320, 321)
Prerequisite: M.E. 3315, 3317. Case studies in product design, evaluation and modification of existing product designs, synthesis of mechanical and electro-mechanical products.

4312. Mechanical Engineering Laboratory. (3:1:6) (Formerly 430)
Corequisites: M.E. 3212, 3214. Experimental and developmental testing of basic mechanical equipment.

4313. Mechanical Engineering Laboratory. (3:1:6) (Formerly 431)
Corequisites: M.E. 3313, 3314. Experimental analysis using strain gage, photoelastic and dynamic testing techniques.

4314. Fluid Dynamics. (3:3:0) (Formerly 435)
Prerequisites: M.E. 3321. Hydrodynamic theory, compressible flow, dynamic lift and propulsion, dynamic similitude.

4315. Heat and Mass Transfer. (3:3:0)
Prerequisites: Math. 335, M.E. 3321. Heat transfer by conduction, convection, and radiation. Mass transfer in liquids, vapors, and gases.

Graduate Mechanical Engineering

General requirements and more detailed information may be found in the Graduate Bulletin.

The Department of Mechanical Engineering offers advanced work in the engineering sciences of thermodynamics, heat transfer and dynamics, also courses in the engineering art consisting of computer techniques and of experimental stress analysis. The course selections for the Master of Science Degree in Mechanical Engineering may be arranged to meet the interests of the individual student. For those wishing specialization in nuclear engineering, dynamics, or electro-mechanical systems, suitable cognate work offered by the Departments of Chemical Engineering, Civil Engineering, or Electrical Engineering are available for balanced programs in these areas.

Graduate Course Descriptions

531. Statistical Thermodynamics. (3:3:0)
Prerequisite: M.E. 3321. Quantum mechanics, molecular spectra, statistical mechanics, intermolecular forces.

532, 533. Heat Transmission. (3:3:0 each)
Prerequisite: Math. 335. The fundamental laws of the various modes of heat transmission, numerical and approximate solutions, application of the combined modes of heat transmission to design.

534. Gas Dynamics. (3:3:0)
Prerequisite: M.E. 3321. Isentropic and diabatic flow, wave phenomena, aero-thermochemistry.

538. Machine Computations. (3:2:6)
Prerequisite: Math. 335. Linear computer elements, time and amplitude scale factors, computer techniques, computations on the repetitive analog computer and on the digital differential analyzer.

539. Physics of Metals. (3:3:0)
Prerequisite: M.E. 3317. Theory of lattice structures, dislocations and slip interference, and semi-conductors.

5311. Experimental Stress Analysis. (3:2:6)
Prerequisite: Math. 335. Theory and application of electric strain gages, brittle coatings, and photo-elastic techniques to static and dynamic strain measurements.

5312. Mechanical Vibrations. (3:3:0)
Prerequisite: Math. 335, C.E. 332. Free and forced vibrations of linear and non-linear mechanical systems. Vibration of elastic bodies.

5313. Classical Dynamics. (3:3:0)
Prerequisite: Math. 335, C.E. 332. Newton's laws, Lagrange's equations of motion, Euler's equations, precessional effects and motions, relativity effects.

5331. Theoretical Studies in Advanced Topics. (3:3:0)
Prerequisite: Graduate standing and approval of the department. Individual theoretical study of advanced topics selected by departmental recommendation. May be repeated for credit in different areas.

5332. Experimental Studies in Advanced Topics. (3:3:6)
Prerequisite: Graduate standing and approval of the department. Individual experimental study of advanced topics selected by departmental recommendation. May be repeated for credit in different areas.

630. Master's Report. (3)

631, 632. Master's Thesis. (3 each)

Department of PETROLEUM ENGINEERING

William Lyon Ducker, Jr., Head of the Department

Professor:
Mr. Ducker
Associate Professor:
Mr. Johnson
Assistant Professor:
Mr. Crawford

The petroleum engineering curriculum is concerned with the development, production, reservoir mechanics, valuation, and conservation of petroleum and natural gas reserves.

The student is trained in mathematics, chemistry, physics, geology, engineering mechanics, and related subjects, embracing all background needed in the study of petroleum engineering. Advanced work in production, natural gas, and reservoir engineering, prepares the student for the more specialized technical problems encountered in industry. By completing the degree requirements, the graduate is trained for employment as a production, research, or reservoir engineer for oil and gas companies, either domestic or foreign; or for a position with educational or governmental agencies.

The reservoir and production laboratories are equipped for studies in core analysis, the colloidal properties of fluids, viscosimetry, P-V-T relationships, surface energies, permeabilities, areal sweep efficiencies, and other specialized subjects.

The natural gas laboratory is equipped for standard tests on natural gas and natural gasoline, measurement and calibration of flow-metering devices, and experiments in the use of regulation and control equipment.

The Department maintains, also, a drilling fluid laboratory, with all of the equipment that is necessary to enable each student to perform the standard tests determining drilling fluid characteristics. The use of special drilling fluids, recognition and control of mud contamination, properties and effects of drilling mud additives, and special drilling mud problems, are included in the material covered in the laboratory.

In addition to instructional and laboratory work, field trips to points of interest within the oil-producing area surrounding Lubbock are conducted by the Department and by the petroleum engineering student organizations. Laboratory experiments on dynamometer testing of pumping equipment, and standard tests on natural gas, are performed in the field by the students.

PETROLEUM ENGINEERING CURRICULUM

Bachelor of Science in Petroleum Engineering

FRESHMAN YEAR*			SEMESTER	1st.	2nd.
Math.	132	Anal. Geom.		3	
Math.	231	Calculus I		3	
Eng.	131	Col. Rhet.		3	
Grph.	131	Engr. Grph.		3	
Phys.	143	Prin. of Physics I		4	
P.E., Band, or Basic ROTC					
Math.	232	Calculus II			3
Math.	331	Calculus III			3
Eng.	132	Col. Rhet.			3
Grph.	132	Engr. Grph.			3
Phys.	241	Prin. of Physics II			4
P.E., Band, or Basic ROTC					
		Total credit hours		16**	16**

SOPHOMORE YEAR			SEMESTER	1st.	2nd.
Math.	335	Math. for Engrs.		3	
Phys.	242	Prin. of Physics III		4	
C. E.	233	Statics		3	
E. E.	231	Prin. of E. E. I		3	
Chem.	141	Gen. Chem.		4	
P.E., Band, or Basic ROTC					
Math.	336	Math. for Engrs.			3
Math.	4318	Finite Math. Struc.			3
C. E.	332	Dynamics			3
E. E.	232	Prin. of E. E. II			3
Chem.	142	Gen. Chem.			4
P.E., Band, or Basic ROTC					
		Total credit hours		17**	16**

SUMMER SESSION			FIRST TERM	SECOND TERM
Chem.	236	Analytical Chem.	3	
Elective		(Humanity)	3	
		Total credit hours	6	
M. E.	3321	Engr. Thermodynamics		3
Ch. E.	330	or C. E. 333		3
		Total credit hours		6

JUNIOR YEAR			SEMESTER	1st.	2nd.
Pet. E.	331	Petrol. Devel.		3	
Pet. E.	322	Rot. Drill Fluids		2	
Geol.	141	Phys. Geol.		4	
Chem.	343	Phys. Chem.		4	
Govt.	233	Amer. Govt., Org.		3	
Pet. E.	333	Petrol. Prod. Meth.			3
Pet. E.	320	Well Logging Meth.			2
Pet. E.	314	Production Lab.			1
Geol.	142	Hist. Geol.			4
C. E.	339	Fluid Mech.			3
C. E.	312	Fluid Mech. Lab.			1
Govt.	234	Amer. Govt., Func.			3
		Total credit hours		16	17

SENIOR YEAR			SEMESTER	1st.	2nd.
Engr.	4121	Engr. Seminar		1	
Pet. E.	433	Reservoir Engr.		3	
Pet. E.	434	Nat. Gas Engr.		3	
Pet. E.	416	Reservoir Engr. Lab.		1	
Geol.	332	Struc. Geol.		3	
Hist.	231	Hist. U.S. to 1865		3	
Engr.	4121	Engr. Seminar			1
Pet. E.	435	Adv. Nat. Gas Engr.			3
Pet. E.	413	Nat. Gas Lab.			1
Pet. E.	436	Adv. Reservoir Engr.			3
Pet. E.	420	Petrol. Prop. Eval. & Mgt.			2
Bus. Law	3313	Oil & Gas Law			3
Hist.	232	Hist. U.S. Since 1865			3
		Total credit hours		14	16

Minimum hours required for graduation — 140 and P.E., Band, or Basic ROTC

*See Page 8 for Alternate Freshman Year

**Exclusive of P.E., Band, or Basic ROTC

Courses in Petroleum Engineering

A key to the meaning of course numbers, symbols and abbreviations, etc., appears on Page 4.

For Undergraduates

314. Production Laboratory. (1:0:3)
Prerequisite: Enrollment in Pet. E. 333. Laboratory work in reservoir characteristics, core analyses, oil dehydration, corrosion, lease operation, and pumping well characteristics.

320. Well Logging Methods. (2:2:0)
Prerequisite: Pet. E. 331 and Phys. 241. A study of the theories of electrical, microelectrical, radiation, optical, chemical, and mechanical well-logging methods, and applications of these theories. Field examples and problems.

321. Phase Behavior. (2:2:0)
Prerequisite: Phys. 241 and enrollment in M.E. 3321. Introduction to the phase behavior of multiple-component hydrocarbon systems. Application to the production of crude oil and condensate reservoirs, and to the separation of natural gasoline from natural gas.

322. Rotary Drilling Fluids. (2:1:3)
Prerequisite: Chem. 142 and enrollment in Pet. E. 331. Testing methods for determining drilling fluid characteristics, drilling fluid problems, and the use of special drilling fluids. Laboratory exercises consist of the practice of altering properties of fresh water and special drilling fluids for drilling through troublesome zones with the rotary system.

330. Introduction to Petroleum Industry. (3:3:0)
Prerequisite: Junior standing in geology or engineering. A general study of the industry, including its history; the chemistry of petroleum; its occurrence in nature, and its importance in the world economy; leasing and royalty; exploration, drilling, and production methods; conservation, transportation, and refining; economics of the industry.

331. Petroleum Development. (3:3:0)
Prerequisite: Junior standing. Exploration methods; spacing of wells; rotary and cable tool drilling methods; directional drilling; drilling hazards; oil field hydrology; and well completion practices.

333. Petroleum Production Methods. (3:3:0)
Prerequisites: Pet. E. 331 and Chem. 343. Properties of reservoir fluids and characteristics of the reservoir which influence oil recovery. Production of wells by flowing, gas lift, hydraulic and sucker rod pumping.

For Undergraduates and Graduates

413. Natural Gas Laboratory. (1:0:3)
Prerequisite: Registration in Pet. E. 434 or 435. Natural gas analysis and testing; measurement and calibration of flow-metering devices; regulation and control devices; gas-phase relations; and natural gasoline techniques.

416. Reservoir Engineering Laboratory. (1:0:3)
Prerequisite: Pet. E. 433. Experiments relating to flow of fluids in porous media, including viscosimetry, P-V-T relationships, surface energies, relative permeability, mobility ratios and areal sweep efficiencies.

420. Petroleum Property Evaluation and Management. (2:1:3)
Economic and physical evaluation of oil and gas producing and processing properties. Contour and isopachous mapping procedures, well log and core analysis interpretation, reserve estimates, reservoir performance, and economic analysis. Evaluation of actural oil properties.

430. Special Natural Gas and Production Problems. (3:3:0)
Prerequisite: Pet. E. 333. Theory, design, and operation of gas lift systems. Production problems to include gas-oil control, water control, decline curves, formation damage due to well completion, and well workovers.

433. Reservoir Engineering. (3:3:0)
Prerequisite: Pet. E. 333. Fundamentals of fluid flow in porous media, including petrophysics; reservoir energy and producing mechanisms; and application of the material balance.

434. Natural Gas Engineering. (3:3:0)
Prerequisite: Pet. E. 333. The properties and behavior of hydrocarbons and related systems, and the associated thermodynamics.

435. Advanced Natural Gas Engineering. (3:3:0)
Prerequisite: Pet. E. 434. The application of the fundamentals of natural gas engineering to the production of natural gas and condensate reservoirs; the processing, transportation, distribution and measurement of natural gas and its derivatives. Problems and design.

436. Advanced Reservoir Engineering. (3:3:0)
Prerequisite: Pet. E. 433. Analysis of primary depletion mechanisms, including water drive, solution drive, gas-cap reservoir, and condensate reservoirs. Economic studies of secondary recovery methods.

TEXTILE ENGINEERING CURRICULUM
Bachelor of Science in Textile Engineering

FRESHMAN YEAR*			SEMESTER	1st.	2nd.
Math.	132	Anal. Geom.		3	
Math.	231	Calculus I		3	
Eng.	131	Col. Rhet.		3	
Grph.	131	Engr. Grph.		3	
Phys.	143	Prin. of Physics I		4	
P.E., Band, or Basic		ROTC			
Math.	232	Calculus II			3
Math.	331	Calculus III			3
Eng.	132	Col. Rhet.			3
Grph.	132	Engr. Grph.			3
Phys.	241	Prin. of Physics II			4
P.E., Band, or Basic		ROTC			
		Total credit hours		16**	16**

SOPHOMORE YEAR			SEMESTER	1st.	2nd.
Math.	335	Math. for Engrs.		3	
Phys.	242	Prin. of Physics III		4	
C. E.	233	Statics		3	
E. E.	231	Prin. of E. E. I		3	
Chem.	141	Gen. Chem.		4	
P.E., Band, or Basic		ROTC			
Math.	336	Math. for Engrs.			3
Math.	4318	Finite Math. Struc.			3
C. E.	332	Dynamics			3
E. E.	232	Prin. of E. E. II			3
Chem.	142	Gen. Chem.			4
P.E., Band, or Basic		ROTC			
		Total credit hours		17**	16**

SUMMER SESSION			FIRST TERM	SECOND TERM			
Govt.	233	Amer. Govt., Org.	3	Govt.	234	Amer. Govt., Func.	3
Ch. E.	330	Engr. Mat. Science	3	M. E.	3321	Engr. Thermodynamics	3
		Total credit hours	6			Total credit hours	6

JUNIOR YEAR			SEMESTER	1st.	2nd.
T. E.	331	Prin. of Fiber Proc. I		3	
T. E.	335	Textile Fibers		3	
T. E.	333	Textile Bleaching		3	
Hist.	231	Hist. U.S. to 1865		3	
Chem.	341	Intro. Org. Chem.		4	
T. E.	332	Prin. of Fiber Proc. II			3
T. E.	334	Text. Dyeing & Finishing			3
Hist.	232	Hist. U.S. Since 1865			3
Elective		(Technical)			3
Elective		(Humanity)			3
		Total credit hours		16	15

SENIOR YEAR			SEMESTER	1st.	2nd.
T. E.	430	Mfg. Process Control		3	
T. E.	436	Fabric Des. and Const.		3	
T. E.	439	Cotton Eval. and Mkt.		3	
M. E.	3214	Air Conditioning		2	
Elective		(Technical)		3	
T. E.	432	Man-Made Fibers			3
T. E.	437	Fabric Anal. and Adv. Des			3
Mgt.	331	Indus. Mgt.			3
M. E.	3215	Air Conditioning			2
C. E.	439	Law and Ethics in Engr.			3
		Total credit hours		14	14

Minimum hours required for graduation — 136 and P.E., Band, or Basic ROTC
*See Page 8 for Alternate Freshman Year
**Exclusive of P.E., Band, or Basic ROTC

Department of TEXTILE ENGINEERING and TEXTILE RESEARCH LABORATORIES

L. E. Parsons, Acting Head of the Department

Professor:
Mr. Parsons
Assistant Professor:
Mr. Power

The textile industry is basic in nature and extremely broad in scope. The necessity for the provision of textiles for clothing and shelter, for home, industrial, and military uses, ensures its importance and continuity. In the past decade it has developed into a highly scientific, modern, research-oriented industry. It is on the threshold of an almost complete revolution in methods and products, and is greatly in need of young men and women with an engineering science background who are thus acquainted with the fundamental principles involved in this modern, complex operation.

The field of man-made fibers alone has brought about tremendous advances in the textile industry, creating new, highly technical job opportunities, as well as many new consumer products. This segment of the industry, as well as that involving more conventional fibers, offers challenging employment to people with the proper training.

It is the purpose of the Department of Textile Engineering to provide this newly revitalized and constantly changing industry with graduates who are able to cope with its problems. Because of their ability to apply scientific and engineering principles to the solution of problems in automated production and control, textile engineers are much in demand in the production and distribution of textiles. There is a very definite shortage of this type of personnel and the demand grows steadily.

The Textile Research Laboratories are available to both private and public agencies for research on cotton utilization and textile manufacturing problems. The manufacturing facilities comprising the laboratories, complete and very modern, are used jointly for teaching and research. They are being improved constantly and, together with the Fiber Laboratory, are the equal of any in the country.

Close cooperation between the teaching and research staffs allows the joint use of the talents of each. Students profit greatly by being able to observe, and even participate in the continuous re-

search operations, thus gaining first-hand knowledge of the manner in which they are carried on. This knowledge is often found applicable by students upon their entrance into industry.

Courses in Textile Engineering

A key to the meaning of course numbers, symbols, abbreviations, etc., appears on Page 4.

For Undergraduates

230. Applied Textiles. (3:3:0)
A study of textile raw materials, manufacturing processes, and end uses. This course is designed to be of special use to students interested in buying, selling, marketing, merchandising, or advertising textiles. It has a broad coverage of the field and should be helpful in understanding the applications of the many new synthetic fibers of today. Not for textile engineers.

331. Principles of Fiber Processing I. (3:2:3)
Fundamental principles and practices for processing cotton and man-made fibers into yarn. Analysis of machine operations and performance standards.

332. Principles of Fiber Processing II. (3:2:3)
Continuation of T.E. 331, including preparation of yarns to meet specific end uses. Correlation of machine performance capabilities of fundamental fiber properties.

333. Textile Bleaching. (3:2:3)
Prerequisite: Current registration in Chem. 341. A study of the physical and chemical principles of processes required to prepare yarns and fabrics for dyeing and finishing.

334. Textile Dyeing and Finishing. (3:2:3)
Theory and practice of dyeing and coloring all types of textile fibers, yarns, and fabrics, as well as industrial finishing of these fabrics.

335. Textile Fibers. (3:3:0)
A study of the physical and chemical properties of the natural fibers. Attention is given stress-strain and other characteristics affecting manufacturing performance. First introduction to theory of fiber structure.

430. Manufacturing Process Control. (3:2:3)
Instrumentation for manufacturing process control. Test data are correlated and process control charts prepared from data obtained in mill scale operation methods of sampling and testing for product and machine performance. Technical reports emphasize rigorous statistical treatment of test data.

432. Man-Made Fibers. (3:3:0)
The physical, chemical and engineering properties of the most important man-made fibers. Studied also are raw materials used, manufacturing methods, classification of fibers and their principal fields of application.

436. Fabric Design and Construction. (3:2:3)
Theory and practice in designing and weaving fabrics. In the laboratory, engineering analysis is made of weaving mechanisms and their application to fabric construction.

437. Fabric Analysis and Advanced Design. (3:2:3)
Prerequisite: T.E. 436. Fabrics are analyzed for data to permit duplication or improved design. Special mechanisms and design of complex fabric structures are covered.

439. Cotton Evaluation and Marketing. (3:2:2)
Prerequisite: Junior standing. Open also to other majors. A study of the structure of the cotton marketing system. Special emphasis devoted to new lab techniques of fiber analysis and evaluation. Grading and stapling covered in the lab.

SPECIAL ENGINEERING COURSES FOR ADVANCED STUDY

For Undergraduates and Graduates

4121. Engineering Seminar. (1:1:0)
Prerequisites: Advanced standing and approval of Head of Department. Individual study of engineering problems of special interest and value to the student. May be repeated for credit in different areas.

4331. Special Problems in Engineering. (3:3:0)
Prerequisites: Advanced standing and approval of Head of Department. Individual studies in advanced engineering areas of special interest. May be repeated for credit.

4332. Special Experimental Problems in Engineering. (3:0:9)
Prerequisites: Advanced standing and approval of Head of Department. Individual experimental studies in current problems in advanced engineering technology of special interest. May be repeated for credit.

NON-PROFESSIONAL COURSES FOR ENGINEERING STUDENTS

In addition to the preceding professional courses, and equally important for study, are those which form much of the basic training of the engineering student. On the following pages are listed many of the courses that are required in engineering curricula but are offered by departments outside the School of Engineering. For description of courses not listed, the student should refer to the bulletin of the appropriate school.

COURSES IN ACCOUNTING

231. Industrial Accounting for Engineers. (3:3:0)
Intended for engineers interested in the process and executive uses of industrial accounting. Offers a foundation in basic accounting principles, a treatment of the essentials of cost accounting theory and practice, and training in managerial aspects of accounting.

COURSES IN AGRICULTURAL ECONOMICS

235. Fundamentals of Agricultural Economics. (3:3:0)
Analysis of fundamental economic principles and their application to farm and ranch problems.

COURSES IN AGRONOMY

131. The Fundamentals of Agronomy. (3:2:2)
A survey course. Crops, their classification, identification, distribution, production, and use. Tillage and elementary soils. Diseases and pests.

COURSES IN AIR FORCE ROTC AND ARMY ROTC

(See General Information Bulletin.)

COURSES IN BAND

(See Music, A&S Bulletin)
COURSES IN BUSINESS LAW (See Finance)

COURSES IN CHEMISTRY

141-142. General Chemistry. (4:3:3 each)
Prerequisite for all other courses in chemistry except 133-134. A general course in chemistry for all students of the College.

235. Hydrocarbon Chemistry. (3:3:0)
Prerequisite: Chem. 141-142. A service course for petroleum engineers. The study of the chemistry of hydrocarbons with particular reference to petroleum, natural gas, and synthetic fuels.

236. Analytical Chemistry. (3:1:6)
Prerequisite: Chem. 141-142. A service course for petroleum engineering students. Principles of gravimetric and volumetric quantitative analysis.

241-242. Analytical Chemistry. (4:2:6 each)
Prerequisite: Chem. 141-142. The basic course in the theories and techniques of analytical chemical methods. The qualitative separation, detection, and confirmation of selected cations and anions. The quantitative gravimetric and volumetric methods are considered. Instrumental methods of analysis are introduced. Prerequisite for all higher numbered courses in analytical chemistry.

341. Introductory Organic Chemistry. (4:3:3)
Prerequisite: Chem. 141-142. A brief study of the compounds of carbon for students in agriculture, home economics, and other fields who require an introduction to the subject. Not open to majors in chemistry for credit.

343. Introductory Physical Chemistry. (4:3:3)
Prerequisite: Chem. 141-142, 8 hours of physics and Mathematics 231-232, or their equivalents. An introduction to the physical chemistry of gases, liquids, solutions and physico-chemical measurements, with selected topics from thermodynamics, equilibria and kinetics.

347-348. Physical Chemistry. (4:3:3 each)
Prerequisite: Chem. 141-142, 8 hours of physics and Mathematics 231-232, or their equivalents. The introductory physical chemistry of gases, liquids, solids, solutions, thermodynamics, equilibria, electro-chemistry, kinetics, atoms and molecules, and physico-chemical measurements. For chemistry majors, chemical engineers and other students. Prerequisite for higher numbered courses in physical and inorganic chemistry.

353-354. Organic Chemistry. (5:3:6 each)
Prerequisite: Chem. 141-142. A thorough foundation course in organic chemistry for chemical engineering majors, chemistry majors, premedical and other students. Prerequisite for all higher numbered courses in organic chemistry.

COURSES IN ECONOMICS

231. Principles of Economics I. (3:3:0)
An introduction to modern economic society and theories of production, exchange, and distribution.

232. Principles of Economics II. (3:3:0)
Prerequisite: Eco. 231. A continuation of Eco. 231. The application of economic theory to current economic problems.

235. Principles of Economics. (3:3:0)
An abridged course for students not majoring in economics or business administration.

COURSES IN ENGLISH

131-132. College Rhetoric. (3:3:0 each)
Essentials of correct and effective writing. Reading and discussing good literature.

133-134. Advanced Composition and Literature for Freshmen. (3:3:0 each)
An honors course designed for those who demonstrate competence in English composition as measured by the English placement test. Expository, narrative, and descriptive writing. Reading of various types of literature.

231, 232. Masterpieces of Literature. (3:3:0 each)
A careful study of outstanding literary masterpieces. In 231, Greek plays, Chaucer, Shakespeare, and Milton are read. In 232, instructors will select outstanding novels, poems, plays, or biographies written during the eighteenth, nineteenth, and twentieth centuries. Required course for most sophomores.

233. Technical Writing for Engineers. (3:3:0)
Prerequisite: 6 hours of freshman English. Techniques of verbal efficiency in the various media of engineering and scientific communication, with stress on report and research-report preparation and letter-writing. Required by most branches of engineering and by chemistry and open to students of all sciences.

COURSES IN FINANCE (Business Law)

338. Business Law I. (3:3:0)
Prerequisite: 60 semester hours. Nature and source of law, courts and procedure, contracts. Texas law of separate and community property, agency.

339. Business Law II. (3:3:0)
Second course in business law. Law of negotiable instruments, business organizations including partnerships and corporations, sales.

3313. Oil and Gas Law. (3:3:0)
General contracts, oil and gas leases and their interpretation, titles, royalty, proration and conservation of oil and gas, regulations governing drilling operations, government lands, cases on oil and gas.

COURSES IN FOREIGN LANGUAGES

(See A&S Bulletin)

COURSES IN GEOLOGY

141-142. GENERAL GEOLOGY. (4:3:3 each)
Physical and historical geology. A foundation course for all advanced work in geology. Required of all students majoring in geology.

143. Physical Geology. (4:3:2)
An introductory study of geologic features and processes of the earth.

144. Historical Geology. (4:3:2)
Prerequisite: Geol. 143 or 141. An introductory study of geologic history.

233. General Geology for Engineers. (3:2:3)
Similar to Geol. 141-142, but a shorter course adapted to the needs of engineering students other than petroleum students.

234. Mineralogy and Petrography for Petroleum Engineers. (3:2:3)
Prerequisite: Geol. 143-144. Field identification and classification of minerals and rocks.

332. Structural Geology. (3:2:3)
Prerequisites: Geol. 141-142, and approval of instructor. Systematic analysis of the deforming processes and resultant structures in the earth's crust. Graduate credit for minors only.

433. Petroleum Geology. (3:3:0)
Prerequisite: Geol. 241; Phys. 141-142 or 235-236, and approval of instructor. The origin, migration, and accumulation of oil and gas; petroliferous provinces.

434. Petroleum Geology. (3:2:3)
Prerequisites: Geol. 433, and approval of instructor. Subsurface methods; advanced principles.

COURSES IN GOVERNMENT

233. American Government, Organization. (3:3:0)
A study of the constitutions and organizations of the governments of the United States, the states in general, and Texas in particular.

234. American Government, Functions. (3:3:0)
A study of the functions and services of the government of the United States, the states in general, and Texas in particular. This course will follow Govt. 233.

437. Political Geography. (3:3:0)
Study of the principal political areas of the world from the point of view of politico-geographic factors of power including size, location, population, political and social organization, natural and industrial resources, and national morale.

COURSES IN HISTORY

231. History of the United States to 1865. (3:3:0)

232. History of the United States Since 1865. (3:3:0)

235. History of Texas. (3:3:0)
Survey of Texas history from colonial times to the present.

COURSES IN JOURNALISM

320. Typography. (2:1:3)
Brief history and evolution of typography: choice of types and their arrangement; type harmony and readability; mechanics of printing and publishing; engraving, printing processes, and presses.

3312. Specialized Journalism. (3:3:0)
Designed for students of agriculture, home economics, engineering, and science. Preparation in the principles of gathering and writing news, feature stories, and magazine articles in their respective fields. Lectures on layout, editing and marketing copy, and on preparing the radio and television newscast. Study of technical publications and of job possibilities.

COURSES IN MATHEMATICS

032. Introductory Geometry. (3:3:0)
A course in elementary geometry open to students who cannot satisfy the plane geometry prerequisite for Math. 131. Credit for this course may not be used to satisfy normal degree requirements, and will not be allowed to students who use high school geometry for college entrance.

130. Algebra. (3:3:0)
Prerequisite: One unit of high school algebra. Review of high school algebra; quadratic equations; graphs; binomial theorem; variations; progressions. Course will not be allowed for engineering degree credit.

131. Trigonometry. (3:3:0)
Prerequisite: One unit of high school algebra, one unit of plane geometry, and Math. 133 or 130, or concurrent registration in Math. 133 or 130. Trigonometric functions; radians; logarithms and exponential equations; solutions of triangles; functions of composite angles; identities; trigonometic equations. Required of all engineering students not making a satisfactory score on advanced placement examination (See Alternate Freshman Year).

132. Analytic Geometry. (3:3:0)
Prerequisite: Math. 133 or 130, or satisfactory score on advanced placement examination. The straight line and conic sections; transformation of coordinates, polar coordinates; parametric equations; introduction to solid analytic geometry.

133. College Algebra. (3:3:0)
Prerequisite: Two units of high school algebra. A standard course in college algebra. Required of all engineering students not making a satisfactory score on advanced placement examination (See Alternate Freshman Year).

231. Calculus I. (3:3:0)
Prerequisite: Math. 132 or concurrent registration. Differentiation; rates, maxima, and minima; rectilinear and curvilinear motion.

232. Calculus II. (3:3:0)
Prerequisite: Math. 231. Formal integration; definite integrals; areas; volumes; lengths; centroids; moments of inertia.

331. Calculus III. (3:3:0)
Prerequisite: Math. 232. Surfaces; pressure work; partial differentation; series; multiple integrals; indeterminate forms; hyperbolic functions.

332. Differential Equations. (3:3:0)
Prerequisite: Math. 232. Solutions of ordinary differential equations, with geometric and physical applications.

335, 336. Higher Mathematics for Engineers and Scientists. (3:3:0 each)
Prerequisite: Math. 331 or concurrent registration. Ordinary differential equations; determinants and matrices; vector algebra and calculus; Laplace transforms; partial differential equations; numerical methods; complex variables.

432. Advanced Differential Equations. (3:3:0)
Prerequisite: Math. 332. Total differential equations; systems of differential equations; partial differential equations.

433. Theory of Equations. (3:3:0)
Prerequisite: Math. 232. Complex numbers; polynomial equations; symmetric functions; determinants and matrices; systems of equations.

434, 435. Advanced Calculus. (3:3:0 each)
Prerequisite: Math. 232. Sets; functions; vector fields, partial derivatives; theory of integration; line, surface, and space integrals; introduction to complex functions and to Fourier series.

436. Introduction to Finite Groups. (3:3:0)
Prerequisite: Math. 232 and consent of instructor. Lagrange theorem; Cayley theorem; gamma groups; conjugate classes; normalizer; Sylow theory.

437. Theory of Numbers. (3:3:0)
Prerequisite: Math. 232. Prime numbers; congruences; theorems of Fermat, Euler, and Wilson; residues; reciprocity law; Diophantine equations.

439. Vector Analysis. (3:3:0)
Prerequisite: Math. 331. Scalar and vector products; gradient; divergence; curl; applications.

4318. Finite Mathematical Structures. (3:3:0)
Prerequisite: Math. 232. Logical developments in modern mathematical structures with applications of principles to physical sciences; compound statements and truth tables; sets and functions; linear algebra and vector spaces; convex sets; probability theory and Markov chains.

COURSES IN PHYSICAL EDUCATION

010. Introduction to Physical Education Activities. (1:1:1)
To ascertain the student's physical efficiency and health status through standardized physical efficiency tests and medical reports which will enable the staff to prescribe a sports program that will meet each student's physical needs; to introduce the student to a variety of sports offered in the Department through such media as movies, class observation, expert demonstrations, and lectures by the regular staff.

The remaining three semesters of physical education activities will be recommended to the student as to his needs from the following list of courses:

011. Adapted Sports
***012. Beginning Swimming**
***013. Advanced Swimming**
***014. Life Saving**
***015. Springboard Diving**
016. Elementary Tumbling
017. Golf
018. Archery
019. Track and Field
****0111. Bowling**
0112. Weight Lifting
****0113. Advanced Bowling**
0114. Fly & Bait Casting
0121. Handball
0122. Badminton
0123. Wrestling
0124. Fencing (Foil)
0125. Social Dancing
0126. Fencing (Saber-Epee)
0127. Tennis
0128. Advanced Tennis
0141. Touch Football
0142. Basketball
0143. Soccer
0144. Speedball
0145. Softball
0146. Folk Dance
0147. Volleyball
***0148. Water Polo**

Students who pass any one course may not repeat the same course for additional credit. These are all laboratory courses involving individual instruction.

* Course fee, $5.
** Bowling alley charge, $10.

COURSES IN PHYSICS

(See Engineering Physics)

COURSES IN PSYCHOLOGY

230. General Psychology. (3:3:0)
A presentation of psychology as a biological science. Suggested as an elective for science and engineering majors and pre-medical students; lectures and demonstrations.

330. Psychology in Business and Industry. (3:3:0)
Prerequisite: Psy. 130. Basic psychological principles of behavior in the management of personnel.

COURSES IN SPEECH

338. Business and Professional Speech. (3:3:0)
Prerequisite: Sophomore classification. Basic principles of speech applied to the speech needs of the professional man and woman. Practice in the construction and delivery of the various types of speeches and participation in group conference, discussion, and interviews. For majors in other fields than speech.

BOARD OF DIRECTORS

C. I. WALL, Chairman, Amarillo. Term expires Feb. 19, 1963.

HAROLD HINN, Vice Chairman, Plainview. Term expires Feb. 19, 1963.

ALVIN R. ALLISON, Levelland. Term expires Feb. 19, 1967.

R. WRIGHT ARMSTRONG, Fort Worth. Term expires Feb. 19, 1967.

MANUEL DeBUSK, Dallas. Term expires Feb. 19, 1965.

JAMES L. LINDSEY, Midland. Term expires Feb. 19, 1965.

J. EDD McLAUGHLIN, Ralls. Term expires Feb. 19, 1967.

WILMER SMITH, Wilson. Term expires Feb. 19, 1965.

FLOYD A. WOOLDRIDGE, Houston. Term expires Feb. 19, 1963.

OFFICERS OF ADMINISTRATION*

ROBERT CABANISS GOODWIN, B.A., M.A., Ph.D., President
121 Administration Building

WILLIAM MARTIN PEARCE, B.A., M.A., Ph.D., Academic Vice President
121 Administration Building

JOHN ROSS BRADFORD, B.S., M.S., Ph.D., Dean of Engineering
105 West Engineering

ROBERT LEE NEWELL, B.S., M.S., Assistant Dean of Engineering
105 West Engineering

* A complete list of Officers of Administration appears in the General Information Bulletin. Those listed here are for the convenience of students in the School of Engineering.

FACULTY OF THE SCHOOL OF ENGINEERING

First date indicates year of original appointment; second date, year of appointment to present position and rank.

WELDON W. ALDRIDGE, Assistant Professor of Civil Engineering, 1958, 1961
B.S., M.S., in C.E., Texas A&M; Reg. Prof. Engr. (Texas)

MOHAMED MOHAMED AYOUB, Assistant Professor of Industrial Engineering, 1961
B.S., University of Cairo; M.S., University of Iowa

KENNETH SYE BALLEW, Instructor in Architecture and Allied Arts, 1961
B. of Arch., Texas Tech

NOLAN ELLMORE BARRICK, Professor and Head Department of Architecture and Allied Arts, and Supervising Architect, 1953
B.A., B.S. in Arch., M.A., Rice; Reg. Arch. (Texas)

JOHN ROSS BRADFORD, Professor and Acting Head Department of Chemical Engineering and Dean of Engineering, 1943, 1955
B.S., M.S. in Ch.E., Texas Tech; Ph.D., Case Institute of Technology; Reg. Prof. Engr. (Ohio, Texas)

WELDON LEROY BRADSHAW, Professor of Architecture, 1938, 1943
B.S. in Arch., Texas A&M; Reg. Arch. (Texas)

JOHN DRAKE BRISTOR, Assistant Professor of Civil Engineering, 1959
B.S., U.S. Military Academy; M.S. in C.E., Cornell University; Reg. Prof. Engr. (Texas, Oklahoma, Kansas)

CHARLES VICTOR BULLEN, Professor of Electrical Engineering, Emeritus, 1932, 1960
B.S. in E.E., Texas University; M.S. in E.E., M.I.T.; Reg. Prof. Engr. (Texas)

CARL JOHN CHILDERS, JR., Assistant Professor of Architecture and Allied Arts, 1959
B. of Arch., Texas Tech; Reg. Arch. (Texas)

DUANE AUSTIN CRAWFORD, Assistant Professor of Petroleum Engineering, 1958
B.S., Missouri School of Mines; M.S., Pennsylvania State

CHRISTOPHER CYONI, Visiting Assistant Professor of Architecture and Allied Arts, 1961
Diploma in Arch., Liverpool University; Reg. Arch. (England, British Columbia)

MONTY EARL DAVENPORT, Assistant Professor of Mechanical Engineering, 1956, 1961
B.S. in M.E., Texas Tech; M.S. in M.E., Ph.D., Stanford University

JOHN J. DEANS, Assistant Professor of Architecture and Allied Arts, 1961
B. of Arch., Pratt Institute; M.S. in Arch., Columbia University

CHARLES GARFIELD DECKER, Professor of Civil Engineering, 1938, 1956
B.S. in C.E., M.S. in E., Michigan; Reg. Prof. Engr. (Texas)

WILLIAM LYON DUCKER, Professor and Head Department of Petroleum Engineering, 1948
B.S., Oklahoma; Reg. Prof. Engr. (Texas, Oklahoma)

RICHARD ALBERT DUDEK, Professor of Industrial Engineering, Head Department of Industrial Engineering and Engineering Drawing, 1958
B.S. in M.E., U. of Nebraska; M.S. in I.E., and Ph.D., U. of Iowa; Reg. Prof. Engr. (Iowa)

RICHARD DURAN, Associate Professor of Architecture, 1951, 1956
B.A., Florida; M.S., Illinois Institute of Technology; Reg. Arch. (Texas)

BILLY HOWARD EASTER, Assistant Professor of Electrical Engineering, 1955
B.S., Texas Tech; S.M., M.I.T.; Reg. Prof. Engr. (Texas)

STANLEY DALE FOREMAN, Assistant Professor of Civil Engineering, 1956, 1960
B.S., Texas Tech; M.S. in C.E., Colorado

SUI-AN FUNG, Associate Professor of Mechanical Engineering, 1959
B.S. in M.E., National Central Univ., China; M.S. in M.E., Univ. of Rochester; Reg. Prof. Engr. (Texas)

HERBERT ELDRED GATLIN, JR., Instructor in Electrical Engineering, 1961
B.S. in E.E., Texas Tech

L. M. GRAHAM, JR., Assistant Professor of Engineering Drawing, 1956, 1959
B.S., M.S., North Texas State University

PAUL DEAN HANNA, JR., Instructor in Architecture and Allied Arts, 1960, 1961
B.A., Austin College

HUBERT REED HEICHELHEIM, Assistant Professor of Chemical Engineering, 1961
B.S., M.S., University of Notre Dame

DONALD JACOB HELMERS, Associate Professor of Mechanical Engineering, 1948, 1957
B.S., Texas Tech; M.S., Michigan; Reg. Prof. Engr. (Texas)

WILLIAM RAY HORTON, Instructor in Mechanical Engineering, 1961
B.S., Texas Tech

EDNA NAWANNA HOUGHTON, Associate Professor of Architecture, 1932, 1957
B.S. in A.E., Texas Tech; B.A. in F.A., U.S.C.

CHARLES ERNEST HOUSTON, Professor of Electrical Engineering, 1932, 1957
B.S. in E.E., M.A., Texas Tech

JAMES D. HOWZE, Instructor in Architecture and Allied Arts, 1958
B.A. in Art, Austin College; M.S. in Design, U. of Michigan

WILLIAM LOYD JENKINS, Associate Professor of Industrial Engineering, 1946, 1959
B.S., Texas Tech; M.S. in S.E., Georgia Tech; Reg. Prof. Engr. (Texas)

PHILIP JOHNSON, Associate Professor of Petroleum Engineering, 1947, 1957
B.S., Texas Tech; Reg. Prof. Engr. (Texas)

CLIFF HUTCHINSON KEHO, Associate Professor of Civil Engineering, 1957
B.S., Swarthmore; M.S., Harvard; Reg. Prof. Engr. (Texas)

ERNST WILLIE KIESLING, Assistant Professor of Civil Engineering, 1956, 1959
B.S. in M.E., Texas Tech; M.S. in A.M., Michigan State; Reg. Prof. Engr. (Texas)

FLORIAN ARTHUR KLEINSCHMIDT, Professor of Architecture and Allied Arts, 1928, 1953
B.S. in Arch., Minnesota; M. in Arch., Harvard; Reg. Arch. (Texas)

JOHN HUBERT KOHN, Assistant Professor of Architecture and Allied Arts, 1961
B.S. in Arch., Kansas State College

JAMES HAROLD LAWRENCE, JR., Assistant Professor of Mechanical Engineering, 1956, 1960
B.S., M.S. in M.E., Texas Tech; Reg. Prof. Engr. (Texas)

E. WALTER LEFEVRE, JR., Instructor in Civil Engineering, 1958
B.S., M.S. in C.E., Texas A&M

LEE CLAIRE LINDENMEIER, Associate Professor of Engineering Drawing, 1957
B.S. in C.E., Colorado State; M.A. in Ed., Colorado State College of Education

ROBERT IVAN LOCKARD, Professor of Architecture, 1935, 1953
B.S., M.S., Kansas State; Reg. Arch. (Texas)

EDMOND MacCOLLIN, Professor of Architecture and Allied Arts, 1958
B. Arch., Yale; M. Arch., Cornell; Reg. Arch. (Oregon)

FRANCES KELLS MacCOLLIN, Instructor in Architecture and Allied Arts, 1958
B.F.A., Yale

HORACE JURS MacKENZIE, Associate Professor of Industrial Engineering and Engineering Drawing, 1949, 1956
B.S. in I.E., Texas Tech; M.S., Oklahoma State; Reg. Prof. Engr. (Texas)

KEITH ROBERT MARMION, Associate Professor of Civil Engineering, 1955, 1961
B.S. in C.E., Univ. of Denver; M.S. in C.E., Univ. of Colorado; Ph.D., California; Reg. Prof. Engr. (Texas)

ROBERT EDWARD MARTIN, Associate Professor of Mechanical Engineering, 1954, 1957
B.S., Texas Tech; M.S., Wisconsin; Reg. Prof. Engr. (Texas)

ROBERT LOUIS MASON, Professor of Mechanical Engineering and Supervising Engineer, 1942, 1961
B.S. in M.E., Texas Tech; M.S. in M.E., Kansas State; Reg. Prof. Engr. (Texas)

ROBERT DOSHER MEEKS, Instructor in Electrical Engineering, 1959
B.S. in E.E., Texas Tech

RICHARD N. MILLER, Instructor in Industrial Engineering, 1959
B.S. in I.E., Texas Tech

EUGENIA MORSE, Assistant Professor of Architecture and Allied Arts, 1959
B.A. in Arch., B.S. in Arch., Rice; Reg. Arch. (Texas, Louisiana)

JAMES HAROLD MURDOUGH, Professor and Head Department of Civil Engineering, 1925, 1927
S.B., M.I.T.; M.S.E., Michigan; Reg. Prof. Engr. (Texas)

ROBERT LEE NEWELL, Professor of Mechanical Engineering and Assistant Dean of Engineering, 1941, 1956
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