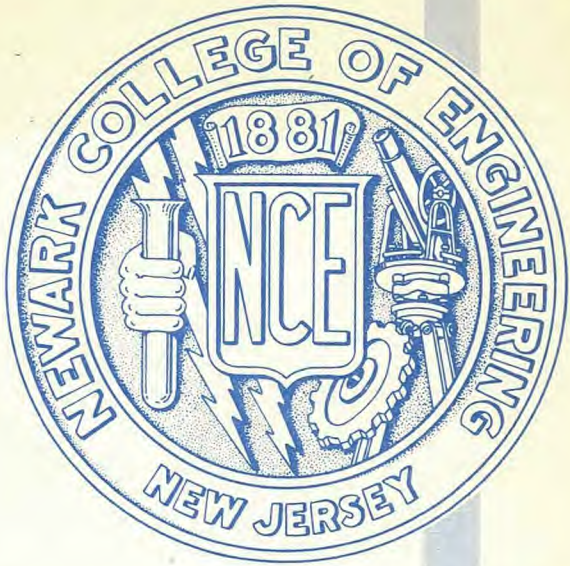

THE BULLETIN

GRADUATE DIVISION

1960-1961

VOLUME XXXIII, No. 2

MAY, 1960

DIRECTORY FOR CORRESPONDENCE

Mailing Address:
323 High Street, Newark 2, N. J.

Matters of General College Interest:
Address the President.

Admissions (Graduate or Undergraduate):
For everything concerned with admissions, including requests for publications, and information on scholarships and student aid, advanced standing, tuition, and fees, address Director of Admissions.

Registration:
Address the Registrar.

Alumni Activities:
Address Alumni Secretary.

Financial Matters:
Address the Business Manager.

Graduate Program:
Address the Chairman, Graduate Division.

Special Courses Admission or Program:
For all information concerning special courses programs and admissions, etc., address the Director, Special Courses Division.

Employment of Seniors and Graduates:
Address the Office of Industrial Relations.

Counseling:
Address the Counseling Center.

Transcripts:
For transcripts and student grades, address the Recorder.

Veterans:
For information on veteran status, address the Veterans' Co-ordinator.

Plant, Equipment, and Utilities:
Address the Plant Engineer.

The business and administrative offices of the College are open between the hours of 9:00 A.M. and 5:00 P.M. Monday through Friday during the academic year. The Registrar's Office is also open evenings between the hours of 6:00 P.M. and 9:00 P.M. daily except Saturdays. During the summer program, the business and administrative offices remain open until 4 P. M., Monday through Friday, while the Registrar's Office is open between the hours of 6:00 P. M. and 10.00 P. M., Monday through Thursday.

Telephone: MArket 4-2424

***The* BULLETIN**
Published by
THE BOARD OF TRUSTEES OF SCHOOLS FOR INDUSTRIAL EDUCATION
OF NEWARK, N. J.

NEWARK COLLEGE
OF ENGINEERING

GRADUATE
DIVISION

1960-1961

Newark 2, New Jersey

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COLLEGE CALENDAR

GRADUATE DIVISION

1960-1961

The College reserves the right to make changes in this calendar.

1960

Registration—Fall Semester	September 12 to 15 incl.
Fall Semester Begins	Wednesday, September 21
Thanksgiving Holidays	November 23 to 26 incl.
Christmas Holidays	December 21 to January 3, incl.

1961

Fall Semester Ends (Graduate Division)	January 21
Registration—Spring Semester	February 6 to 9 incl.
Spring Semester Begins	Monday, February 13
Washington's Birthday Holiday	February 22
Good Friday	March 31
Spring Vacation	April 10 to 15 incl.
Memorial Day Holiday	May 30
Spring Semester Ends (Graduate Division)	June 3
Commencement (tentative)	June 8
*Registration— Graduate Summer Session	June 16
Summer Session Begins	June 19
Independence Day Holiday	July 4
Summer Session Ends (Graduate Division)	August 11

*Graduate Division Summer Session announcements will be available on or about April 15, 1961.

NEWARK COLLEGE OF ENGINEERING

NEWARK 2, NEW JERSEY

Supported by the State of New Jersey and City of Newark

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1959-1960

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Professor in Mathematics.

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* Licensed Professional Engineer.
** Deceased.

GENERAL INFORMATION

Newark College of Engineering received its charter in 1919, as a development of the Newark Technical School, which was founded in 1881 by the Newark Board of Trade. The College is a public institution supported by both the City of Newark and the State of New Jersey. It is administered by a Board of Trustees appointed by the Governor of the State. The Governor and the Mayor of Newark are ex-officio members.

Since 1919 the College has offered four-year courses leading to the degree of Bachelor of Science in Chemical, Civil, Electrical, and Mechanical Engineering with, in recent years, an option in Engineering Management. In 1946 the New Jersey State Board of Education authorized the establishment of the Graduate Division of Newark College of Engineering and the granting, by its Board of Trustees, of the Degree of Master of Science in Chemical, Civil, Electrical, or Mechanical Engineering with the additional degree of Master of Science with a major in Management Engineering. In 1957 the Board of Trustees was authorized to grant the Master of Science degree in all five engineering fields and to add the undesignated Master of Science, M.S., for those graduate students electing either to undertake graduate work in engineering but with the emphasis on basic science, or to take such work in an engineering field other than the undergraduate major. The degrees offered are, therefore, the Master of Science in the designated fields of Chemical, Civil, Electrical, Mechanical, and Management Engineering, and the Master of Science (undesignated).

Graduate work in science and engineering is becoming increasingly necessary, not only from an individual but, equally important, from an industrial and technical point of view. The rapid growth and formulation of scientific theories, too intricate to be studied in undergraduate courses which are of necessity devoted to basic elements and operations, require additional study for the individual seriously interested in a thorough knowledge and understanding of his field. Industrial and technical uses, instrumentation and operation resulting from these theories make it mandatory that there be personnel capable not only of understanding the theory but also of intelligently and creatively initiating and maintaining its application. The Graduate Division of this College was organized and is maintained to meet this demand; to fulfill its academic obligations to the field of science and technology and to fulfill, to an equal extent, its obligations to the public and industrial community of the city, state and nation.

Requirements for admission to the Graduate Division and the qualifications for the degrees are set forth in this Bulletin. Sufficient

courses for the completion of all requirements are offered at the College, and it is expected that, in general, the work will be taken at this College. In some cases, a limited number of credits may be accepted from other colleges.

It is anticipated that many students may wish to do their graduate work in the evenings. Accordingly, classes in all courses may be scheduled for day or evening hours, or both, in accordance with the numbers enrolled.

The right is reserved to cancel classes for which the registration is insufficient.

The College feels that the development of a sensitivity in the students on the importance of dress and good grooming is a part of the social, technical and professional disciplines which constitute engineering education. The College therefore requires that all male students shall, in addition to the customary items of dress, wear a shirt, tie and coat to all formal classes and that women students shall also be suitably attired. Recognizing that time and employment may make complete compliance by some evening students difficult, the College expects conformance to the maximum possible extent. Certain concessions can be made during continuous warm weather and in laboratories, drafting rooms, and field trips.

The College requires that every student shall conduct himself with decorum and shall constantly adhere to ethical and professional behavior. No student may use or give any unauthorized aid in any test, report, or assigned paper. All work offered as the student's own must be the work of the individual student. Instances of alleged unethical or unprofessional conduct will be brought to the attention of the appropriate College authorities for investigation and action.

WESTINGHOUSE CONTINUED EDUCATION PROGRAM

Newark College of Engineering is one of twenty-five colleges and universities cooperating with the Westinghouse Electric Corporation in offering courses on the graduate level to Westinghouse employees. Details of the program will be found in the Westinghouse publication "Continued Education—Announcement of Courses — 1960-1961", which includes both a list of the institutions and their offerings and an explanation of the terms of financial support offered to the student-employee by the company.

ADMISSIONS

Candidates for admission to the Graduate Division must hold a baccalaureate degree from an accredited college or university in engineering or the physical sciences, i.e., physics, chemistry, or mathematics.

Application should be made on the Graduate Admission Form, which may be obtained from the Admissions Office. A $5.00 application fee in the form of a check or money order must accompany the application. Two transcripts from the institution which has conferred the baccalaureate degree and one transcript from all other undergraduate or graduate institutions attended are required. To be accepted as official, transcripts must be sent directly to the Admissions Office by the institutions concerned. Applications must be received by September 1 to be eligible for the fall semester and by January 15 to be eligible for the spring semester. Applications received after the dates indicated will be processed for the following semester.

An entrance examination may be required in cases of uncertainty as to the adequacy of a candidate's preparation for graduate study. Appointments for the examination should be made through the Counseling Center of the College. Permission to take courses will not be granted unless the examination indicates that the candidate is qualified, and for this reason the examination should be taken well in advance of the registration period.

Conferences with graduate advisers should be arranged as soon as possible after notification of admission. Appointments may be made by calling the department of major study. Appointments cannot be made between June 30 and September 1. The purpose of the conference is to formulate a program of required courses in fulfillment of the academic prerequisites for a degree. *Any change in this program of required courses must be approved by the chairman of the major department.*

CLASSIFICATION OF GRADUATE STUDENTS

Students admitted to studies in the Graduate Division are classified as *non-matriculated* or *special.*

Non-Matriculated Students

1. Students admitted to degree programs who have not completed the requirements for matriculation.
2. Students who are to complete graduate prerequisites prior to entrance into courses leading to matriculation.
3. Students who have completed the requirements for, or have been awarded advanced degrees and register for additional courses.

Special Students

1. Students who are not qualified for admission but have sufficient preparation and satisfactory prerequisites to enter individual and specified graduate courses.

2. Students, otherwise qualified, who do not desire to enter degree programs.
3. Students who desire graduate courses for advanced credit at other institutions.
4. Senior undergraduate students at Newark College of Engineering.

Special Students must apply for admission through the office of the Dean of Admissions and must have approval for registration for the specific course or courses from the department administering the course or courses and the Chairman of the Graduate Division. Registration, if approved, will be permitted only to the extent of available facilities and each such student is limited to a maximum of three courses.

MATRICULATION

Admission to studies in the Graduate Division does not imply matriculation and only matriculated students may become candidates for advanced degrees.

Requirements for matriculation:

1. Admission to the Graduate Division as acceptable for a degree program.
2. Satisfactory completion of 15 credits of graduate work.
3. Filing of an application for matriculation with the office of the Graduate Division, signed by the graduate adviser; this signature indicates acceptance of the student as a candidate for an advanced degree by the Department of Major Study.
4. Payment of the matriculation fee.

REGISTRATION

Prospective students will be informed of registration details by the Office of the Registrar, after an Acceptance for Admission form has been received from the Office of Admissions.

Currently enrolled students will be informed of registration details for the Fall and Spring Semesters by the Office of the Registrar during April and November respectively. Students who fail to comply with these instructions must make appointments to see their advisers during registration week, and present, *in person,* their approved registration forms to the registration staff for payment of tuition and fees.

Failure to complete registration before the close of the registration period will make the student subject to payment of a late fee (see page 18).

VETERANS

All veterans registering under Public Law 550 for the first time must register in person with the Veterans' Coordinator before the close of the registration period. A VA Certificate for Education and Training (VB 7-1993) should be presented at this time.

Before applying to the Veterans' Administration for a certificate, a newly-admitted student should check with his department chairman to ascertain whether any undergraduate prerequisite or graduate preparatory courses are required. If any such courses are required by the department, the number and name of each one should be made a part of paragraph 16 of the application form (VB 7-1990).

The VA certificate entitles a veteran to any listed prerequisite or preparatory courses, and to no more than 30 credits of graduate work regardless of grade received other than failure. The only exception to this regulation occurs in the Management Engineering Department where students who are not graduates of this College may be required to pass 36 credits of graduate work for the degree.

TUITION AND OTHER FEES FOR 1960-1961

REGULAR FEES

Tuition	$22.00 per credit
Registration Fee (Day)	10.00 per semester
Registration Fee (Evening)	5.00 per semester

APPLICATION, MATRICULATION AND SPECIAL FEES

Each candidate for admission to the Graduate Division must pay an application fee of $5.00 at the time the application for admission is submitted. The fee is not returnable regardless of whether or not the applicant is admitted to the Graduate Division. This fee covers service which is necessary to evaluate applications for admission.

Each student who is accepted by the Graduate Division as a **matriculated** student is required to pay a **matriculation fee** of $5.00.

Each student registering for thesis is charged a thesis fee of $5.00 at the time of registering.

Each student who submits a thesis is required to pay a binding fee of $13.50 for binding the required three copies of his typed thesis.

For each course, other than thesis, requiring laboratory work, a laboratory fee and/or deposit is charged, at the time of registration, for expendable supplies and the maintenance of apparatus and equipment used in the laboratories. Payment of a laboratory deposit for a

thesis course is due only upon notice to the student by the Finance Office rather than at the time of registration. Laboratory fees do not cover breakage or loss of college property. The charge to the student for laboratory expenses may in certain courses exceed the amount of the deposit.

Registration is required for each semester. An extra registration fee of $10.00 is required of those who register late.

For any graduate course, except thesis, a fee of $1.00 will be charged for the removal of an "I" (grade deferred).

Applicants to whom the entrance examinations are administered are charged a fee of $7.00.

A graduation fee of $25.00 is required of all candidates for the Master's degree. This fee includes rental of academic dress.

WITHDRAWAL AND REFUND

WITHDRAWAL PROCEDURE

Registration for a course places a definite responsibility upon the student to carry the course through to completion and to receive the grade he has earned. However, it is recognized that in exceptional cases withdrawal by a student may be necessary. If a student wishes to withdraw from a course, or courses, or from college, he must notify the Chairman of the Graduate Division. (Forms for this purpose may be obtained from the Office of the Graduate Division). The date of receipt of the notice by the Chairman of the Division will be considered to be the date of withdrawal.

WITHDRAWALS FROM COLLEGE — SELECTIVE SERVICE

A student who is forced to withdraw from college because of induction by Selective Service is entitled to a *pro rata* refund as of the date of his induction. In order to obtain a refund in a case of induction, a student should submit a copy of his notice of induction with the notice of withdrawal.

WITHDRAWALS FROM COLLEGE — GENERAL

A student who is forced to withdraw from college for reasons other than induction by Selective Service may, if the reasons are beyond his control, apply to the Business Manager for a refund. The application should state fully the reasons for the withdrawal and should include necessary verification such as, in the case of illness, a doctor's certificate. Refunds are based on the date on which the application is received. If the Committee on Refunds, to which the Business Manager will refer the application, approves it, a refund will be recommended to the Board of Trustees for consideration.

REFUNDS

Matriculation fees, registration fees, and all other fees except laboratory fees, are under no condition returnable.

If a refund is approved by the Board of Trustees, the percentage of tuition and laboratory fees refunded will be based on the following table:

Date of Receipt of Application	*Percentage Refund*
During the first week of the term	80%
During the second week of the term	80%
During the third week of the term	60%
During the fourth week of the term	40%
During the fifth week of the term	20%
During the remainder of the term	0

The above schedule applies only to the regular fall and spring semesters but will also be used as a guide to compute comparable percentage refunds for short terms, such as during a summer session.

CHANGE OF PROGRAM

A student who adds a course, or courses, to his program will be charged the full tuition and fee for the course, or courses, added, regardless of the date on which the addition takes place. If, within the first two weeks of the semester, a student drops a course, or courses, he must fill out a set of authorized schedule change forms provided by the Graduate Division and see to it that they are properly authorized. His charges will then be recalculated, and if he is entitled to a refund or financial credit, such refund or credit will be made.

COURSES AND CREDITS

The Master's degree will be granted to those students only, who have completed the required curriculum and fulfilled the conditions prescribed for that degree within seven continuous years from the date of admission to the Graduate Division. Candidates for the degree who desire a special ruling by reason of hardship may submit an appeal directly to the Faculty of the College.

The College reserves the right to require students registered in the Day Session to complete courses in the Evening Session.

Courses taken by non-matriculated students, who later qualify to meet the requirements for matriculation to a master's degree program, may be applied toward the required academic credits. The amount of credit so applied shall be determined by the Chairman of the department concerned, subject to review by the Chairman of the Graduate Division.

ADVANCED CREDIT

Graduate courses taken at other institutions may be offered for advanced credit toward the Master of Science degree with a maximum allowance of eight credits. Requests for extension of advanced credits must be in writing, on the form provided by the Graduate Division office, accompanied by appropriate catalogues of the college describing the courses, and other pertinent information, and addressed to the Chairman, Graduate Division, Newark College of Engineering. Official transcripts of the work should be sent directly from the college or institution concerned to the same office.

GRADES

The following grades and their respective significance will be used by the Graduate Division of the College:

A — Work of high merit

B — Work of commendable quality

C — Work of acceptable quality

D — Work of fair quality; but not acceptable for credit toward the Master's degree.

F — Failure

I — Grade deferred—given in rare instances for students who would normally complete work but because of special circumstances could not. In these cases the grade of I must be removed not later than the semester succeeding the one in which the grade was received.

For a student registered for and preparing thesis, the grade of I shall be given to indicate satisfactory progress, excepting at the end of the final semester of the thesis work.

W — Withdrawal

TIME AND PLACE OF CLASSES

Classes will meet in Newark College of Engineering. Room and laboratory assignments will be announced on the bulletin boards of the Graduate Division at the close of registration week.

For convenience, each building has a letter designation as follows:

Campbell Hall	C	110 Summit St.
Colton Hall	L	17 Summit Pl.
Cullimore Hall	M	70 Summit St.
Eberhardt Hall	E	323 High St.
Tiernan Building	T	240 High St.
Weston Hall	W	367 High St.

DEGREES AND GRADUATION

Students are responsible for checking their progress toward fulfillment of requirements for degrees by occasional inquiry at the office of the Graduate Division or the office of the department of major study.

Applications for candidacy must be filed with the chairman of the Graduate Division not later than January 31st preceding the proposed date of receiving the degree. Forms may be obtained from the office of the Graduate Division.

Candidates for a degree granted by the College shall appear in person upon the appointed Commencement Day to receive the degree, unless excused by the Faculty.

ACADEMIC HONORS

With the approval of the Trustees and Faculty of Newark College of Engineering, the honor *Summa cum Laude* or *cum Laude* will be conferred upon each graduate student, and inscribed upon his diploma, who successfully completes the prescribed curriculum for an advanced degree and who fulfills one of the requirements as given below:

1. For the award of *Summa cum Laude:* completion of all courses with no grade less than A.

2. For the award of *cum Laude:* completion of all courses with no grade less than C and a grade point score not less than 3.7. Grade point scores will be based on a scale of A=4, B=3, C=2.

COURSES

The courses offered to graduate students by the several departments are described in the following pages.

Courses are identified by a combination of letters and numerals. The letters indicate the department administering the course; numbers distinguish the individual courses.

Numbers from 100 to 199 indicate courses which are prerequisites for students who require such background before admission to the 200, 300, or 400 categories.

Numbers from 200 to 299 indicate one semester courses. These may be scheduled for either first or second semester, or in some cases, may be repeated each semester.

Numbers from 300 to 399 indicate courses that run through two successive semesters. Both semesters of work in these courses must be satisfactorily completed in order to establish any credit for the course.

Courses in the 400 group are directed toward highly advanced areas of specialization and are open to students only by permission of the departments as stated in the prerequisites for such courses.

Courses in heavy demand may be scheduled for additional classes at other times or in other semesters, if adequate enrollment can be assured. Day and evening classes during the summer months are possible under the same condition.

Evening classes begin at 7:00 P. M. except that some laboratory sessions begin at 6:30 P. M., and end at 10:00 P. M.

Course offerings are designated by semester and year during which these courses are offered. Years are considered as academic years, from September through January for the first semester, and from February through June for the second semester. Where no year designation is given the course is offered each year.

REQUIREMENTS FOR DEGREES

GRADUATE DIVISION REQUIREMENTS

The Graduate Division of the College is founded on the two principles of specialization in a major field of technology and generalization of the field selected as an integral part of the more extensive field of science. The first of these principles is embodied in the specific curriculum of the departments of specialization; the second in the basic requirements of the Division and the courses offered in physics, mathematics and chemistry. This purpose is also aided by provisions allowing students with an undergraduate degree in one field to enter another. The primary aim of the Division is the furtherance of the student's understanding and technical ability in his chosen field in order to prepare him for professional advancement and more qualified service in industry and research.

Two degrees are available to students of the Graduate Division. The general requirements for these degrees are given below.

GENERAL REQUIREMENTS FOR MASTER OF SCIENCE DEGREES

A. A Master of Science Degree in Chemical, Civil, Electrical, Management, or Mechanical Engineering will require of the student the following:

   1. Graduation from an ECPD and regionally accredited college of engineering with undergraduate work in the area of specialization desired. If the student wishes to change fields, he may do so by taking certain *undergraduate* prerequisites as determined by the advisor for the department under which he desires to study.

2. Six credits in Basic Requirements — History of the Physical Sciences: Phys 202 (3) and Technology of Materials: ChE 222 (3).

3. Fifteen credits of Specialization — courses taken from those offered by the department with the consent of the advisor. These courses must include a thesis or a course in design (or similar) which will require the equivalent of two semesters of *individual* effort on the part of the student.

   For departmental requirements refer to the following pages.

4. Nine credits of electives — These may be chosen from courses offered by any department with or without meeting prerequisites if the consent of the department giving the course is obtained.

   (The elective credits should, in a sense, represent a "minor" interest.)

   No graduate course taken as a prerequisite for the field of specialization shall be counted as elective credit.

B. Master of Science (without designation)
This degree will require of the student the following:

1. Graduation from an ECPD and regionally accredited college of engineering with undergraduate work in a field *other* than the field to be studied.

   Or, graduation from a regionally accredited college or university with a bachelor's degree with a major in Chemistry, Physics, or Mathematics, and a minor in Mathematics or Science.

2. Six credits in Basic Requirements — History of the Physical Sciences: Phys 202 (3) and Technology of Materials: ChE 222 (3).

3. Twelve credits of Specialization — courses taken from those offered by one of the degree granting departments with the consent of the advisor of that department *and* the student's advisor if they be different. These courses must include a course(or courses) which will require the equivalent of two semesters of individual effort on the part of the student (such as design or seminar.)

4. Twelve credits of electives — These may be chosen from courses offered by any department with or without meeting prerequisites if the consent of the department giving the

course is obtained. Some leniency should be shown in the matter of prerequisites where the course is to be taken as an elective and not in the field of specialization.

No graduate course taken as a prerequisite for any courses taken under the field of specialization shall be counted as elective credit.

Note: More than the minimum of 30 credits may be required to fulfill individual departmental requisites for a degree.

By action of the Faculty of the College, the following rule governs the submission of grades in candidacy for either the Master of Science in a specified field of Engineering, or the Master of Science (undesignated) degree for students matriculating after June 30, 1951:

"In order to obtain the degree of Master of Science as conferred by this College, a candidate must attain a grade of B or better in at least fifteen credits of his graduate work, of which at least nine credits must be in his field of major study."

SEQUENCE OF COURSES IN NUCLEAR ENGINEERING

The increasing use of nuclear processes in industrial research and technology has motivated the introduction of a sequence of courses in nuclear engineering. These courses, on a graduate level, are designed to implement accepted engineering principles and methods by extending them to this area.

The emphasis of the sequence is on an understanding of the basic theory and the problems arising from the extension of engineering to the nuclear field. The sequence of courses, therefore, is arranged so that it can be undertaken by any student accepted for graduate study, regardless of departmental affiliation.

Two courses of the sequence supply the necessary background material. The first is a course in Modern Physics, (Phys 220), dealing with concepts arising from the interaction of matter and radiation. These concepts are carried into the second course, *Nuclear Physics,* (Phys 221), in which the elements of atomic and nuclear processes are discussed.

Two specialized courses complete the sequence. One, *Elements of Nuclear Engineering,* (Phys 222), offered by the Department of Physics, applies the basic concepts to reactor theory, design and operation. The other, *Technology of Nuclear Materials,* (ChE 252), offered by the Department of Chemical Engineering, deals with the materials used in nuclear operations, the processing of these materials, and the effects of radiation on them. Attention is also directed to ME 214: Advanced Heat Transfer, and ChE 254: Process Industrial Wastes — Control and Treatment.

It is believed that combining courses in basic theory and applied principles will enable the engineer to acquire an insight into the field of nuclear energy sufficiently broad for him to enter it with a sound knowledge of its science and areas of application. Specific and specialized problems and techniques may then be left to those industries and research groups in which he is employed.

Detailed descriptions of the courses offered may be found on the pages of the Bulletin in which the administering department lists its courses. Credit hours available for electives, group C, should be used for the completion of the nuclear engineering sequence.

REQUIREMENTS OF THE DEPARTMENT OF CHEMICAL ENGINEERING

The Department of Chemical Engineering recommends as candidates for the degree of *Master of Science in Chemical Engineering,* those who are graduates in Chemical Engineering from recognized and accredited curriculums. The department also recommends as candidates for the degree of *Master of Science* those who are graduates from accredited colleges in a field other than that of Chemical Engineering or who have a Bachelor's degree with a major in Chemistry or related sciences.

Sequences of specialization in Chemical Engineering are available in the following fields: Chemical Engineering Practice, Chemical Engineering Science, Design and Materials, Organic Industries, and Physical Chemistry; as well as in an option largely related to courses ChE 252 and ChE 254 and designed for those students who are interested in materials of construction related to nuclear reactors and to the disposal of waste products from nuclear processes.

REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN THE DEPARTMENT OF CHEMICAL ENGINEERING

A. For the Master of Science in Chemical Engineering candidates must offer the major consisting of:

ChE 223 Heat Transfer and Fluid Flow (3)
ChE 312 Advanced Unit Operations Laboratory (3)
ChE 300 Thesis (6)

and six points in a minor selected from one of the following groups:

(1) Chemical Engineering Practice:
ChE 207 Electrochemical Engineering
ChE 217 Adsorption
ChE 227 Absorption and Extraction
ChE 228 Distillation
ChE 230 Extractive Metallurgy

(2) Chemical Engineering Science:
ChE 211 Chemical Engineering Thermodynamics
ChE 212 Kinetics of Reactions
ChE 220 Petroleum Refining
ChE 246 Catalysis
ChE 314 Advanced Chemical Principles

(3) Design and Materials:
ChE 225 Chemical Engineering Instrumentation
ChE 240 Chemical Process Development
ChE 241 Chemical Equipment and Plant Design

ChE 252 Technology of Nuclear Materials
ChE 254 Process Industry Wastes—Control and Treatment
ChE 255 Plastics Engineering

(4) Organic Industries:
ChE 201 Advanced Organic Chemistry
ChE 206 Physical Organic Chemistry
ChE 218 Industrial Synthesis
ChE 249 Advanced Organic Chemistry Laboratory
ChE 250 Advanced Organic Chemistry Laboratory

(5) Physical Chemistry:
ChE 205 Colloids Laboratory
ChE 245 Advanced Physical Chemistry
ChE 247 Colloids
ChE 303 Physico-Chemical Instrumentation Methods
ChE 314 Advanced Chemical Principles

B. For the Master of Science candidates the major shall consist of:
ChE 210 Elements of Diffusional Operations (3)
ChE 311 Intermediate Unit Operations Laboratory (3)
ChE 300 Thesis (6)
and a minor consisting of six points selected from groups 2, 3, 4, and 5.

It is expected that all candidates for the degree of Master of Science in Chemical Engineering will be graduates in Chemical Engineering from recognized and accredited curriculums or, by the completion of further prerequisites or preparatory work, will have reached the equivalent of this grade of preparedness.

It is expected that candidates for the degree of Master of Science will be graduates in science or in some field other than Chemical Engineering and will have adequate training in mathematics, at least through the calculus; in lecture and laboratory courses in chemistry, including inorganic, analytic, organic, and physical; and in physics and related sciences sufficient to comprehend satisfactorily the graduate work offered.

Courses Offered by the Department of Chemical Engineering

ChE 110 ELEMENTS OF CHEMICAL ENGINEERING Dr. AXELSON
A course designed for graduate students who have had other than chemical engineering undergraduate training. Flow of fluids, fluid transportation, thermal transfer, evaporation and fluid-solid separation.

Prerequisites: Differential and Integral Calculus, Physical Chemistry or equivalent.

3 hours per week — 3 credits
First Semester — M, 7-10

Required for all candidates for the M.S. without designation.

ChE 201 ADVANCED ORGANIC CHEMISTRY Professor BRADLEY

This is a course in particular topics in organic chemistry and is based chiefly on original papers and reviews. It will vary from year to year.

Prerequisite: Organic Chemistry.

3 hours per week — 3 credits
First Semester — Offered 1961-1962 and alternate years — W, 7-10

ChE 206 PHYSICAL ORGANIC CHEMISTRY Professor BRADLEY

Among the subjects studied will be: Resonance, free energy, rearrangements, reaction rates and mechanisms, equilibrium, free radicals, unsaturation and conjugation, condensations, and catalysis.

3 hours per week — 3 credits
Second Semester — Offered 1961-1962 and alternate years — Tu, 7-10

ChE 207 ELECTROCHEMICAL ENGINEERING Dr. MANTELL

A course dealing with electro-chemical theories, processes, and operations; the furnishing and utilization of electrical power to the industries; the design, construction and operation of electro-chemical plants.

Prerequisite: B.S. in ChE., or E.E., or Physics or Chemistry or previous training satisfactory to the instructor.

3 hours per week — 3 credits
First Semester — W, 7-10

ChE 210 ELEMENTS OF DIFFUSIONAL OPERATIONS

Dr. AXELSON

A course continuing elements of Chemical Engineering designed for graduate students who have had other than Chemical Engineering undergraduate training. Subjects covered include extraction, adsorption, distillation, filtration, drying, and problems pertaining to these unit operations.

Prerequisite: Physical Chemistry, and ChE 110.

3 hours per week — 3 credits
Repeated Each Semester. — Th, 7-10

Required for all candidates for the M.S. without designation.

ChE 211 CHEMICAL ENGINEERING THERMODYNAMICS Dr. JOFFE

The fundamental principles of thermodynamics are reviewed and developed quantitatively to include thermodynamic functions and their relations. Methods are developed for the treatment of gaseous mixture and liquid solutions with applications to vapor-liquid equilibria.

Prerequisite: Undergraduate courses in Unit Operations and Thermodynamics or equivalent.

3 hours per week — 3 credits
First Semester — Th, 7-10

ChE 212 KINETICS OF REACTIONS — Dr. JOFFE

A study of the thermodynamics of chemical reaction equilibria and statistical thermodynamics. The theory of absolute reaction rates is discussed briefly. The balance of the course deals with the kinetics of homogeneous and uncatalyzed heterogeneous reactions. Considerable attention is devoted to reactor design.

Prerequisite: Undergraduate courses in Unit Operations and Thermodynamics, or equivalent.

3 hours per week — 3 credits
Second Semester — Th, 7-10

ChE 217 ADSORPTION — Dr. MANTELL

Adsorption as a unit operation, theory and development, the solid adsorbents and ion exchangers, manufacture, applications for odor, taste, color and poison removal; dehydration and dehumidification; preservation of naval and military equipment; gas hydrates in pipe lines; fractionation of gases, liquids, ions, precious and rare metals, fission products, ions and molecules by fixed and moving beds; adsorption catalysts; replacement of other unit operations.

Prerequisite: Previous training satisfactory to the Department.

3 hours per week — 3 credits
First Semester — Offered 1961-1962 and alternate years — M, 7-10

ChE 218 INDUSTRIAL SYNTHESIS — Dr. KREPS

A seminar course dealing with industrial methods of chemical synthesis: unit processes, synthesis of specific types of compounds and recent significant developments. Topics discussed will present an integrated picture of chemical manufacture in such fields as fine chemicals, pharmaceuticals, dyes, surfactants, etc., according to the specific interests of the students.

Prerequisite: Previous training satisfactory to the Department.

3 hours per week — 3 credits
Second Semester — M, 7-10

ChE 220 PETROLEUM REFINING — Dr. SILVESTON

A study of petroleum fractionation, cracking, reforming, treating, equipment design, operation and economics of the various processes.

Prerequisite: Previous training satisfactory to the Department.

3 hours per week — 3 credits
Second Semester — Offered 1961-1962 and alternate years — Tu, 7-10

ChE 222 TECHNOLOGY OF MATERIALS Dr. MANTELL

A course coordinating the materials entering into engineering structures, machinery, and equipment from the viewpoints of service as a function of variation of chemical composition, mechanical processing and fabrication, thermal processing, protection against deterioration and corrosion, and adaptation to special services.

Prerequisite: Bachelor's degree in science, engineering or closely allied fields. Required of all students.

3 hours per week — 3 credits
Second Semester — §1 W, 7-10 or §2 M, 7-10

ChE 223 HEAT TRANSFER AND FLUID FLOW

Professors JOFFE and KEEFFE

A study of the most recent advances in the area of fluid flow and heat transfer. Analysis of the methods of operations, correlation studies, and the methods of design will be included.

Prerequisite: Undergraduate Unit Operations, or B.S. in M.E., or equivalent.

3 hours lecture per week — 3 credits
First Semester — M, 7-10

ChE 225 CHEMICAL ENGINEERING INSTRUMENTATION

Dr. DENGLER

The theory of instruments and methods of application for the measurement and control of temperature, flow, pressure, reactant and product quality and properties in Unit Operations and the process industries will be studied.

Prerequisite: B.S. in ChE., or M.E., or E.E., or engineering training satisfactory to the Department.

3 hours lecture per week — 3 credits
First Semester — F, 7-10

ChE 226 ADVANCED CHEMICAL ENGINEERING PROBLEMS

To be announced

This course will emphasize the use of linear and partial differential equations, generalized Fourier expansions, orthogonal functions and operational calculus for the solution of chemical engineering problems. Typical topics to be considered are plate efficiencies in fractionating columns, effect of catalyst size on catalytic activity, heat transfer in fluidized beds, unsteady state heat transfer and diffusion, and the development and solutions of basic equations for packed columns.

Prerequisite: Training satisfactory to the Chairman of the department.

3 hours lecture per week — 3 credits
Second Semester — Offered 1961-1962 and alternate years — Th, 7-10

ChE 227 ABSORPTION AND EXTRACTION Dr. SCHEIBEL

A study of the most recent advances in the field of absorption and absorptive processes, extraction and associated operations. Important analysis of design, operation and cost will be considered for each of these unit operations.

Prerequisite: ChE 223, Heat Transfer and Fluid Flow.

3 hours lecture per week — 3 credits
First Semester — Th, 7-10

ChE 228 DISTILLATION Dr. SCHEIBEL

A study of the most recent advances in the field of various types of distillation processes, including azeotropic and extractive distillation, equilibria calculations, still design, new fractionation theory, operational analysis and economic calculations.

Prerequisite: ChE 223, Heat Transfer and Fluid Flow.

3 hours lecture per week — 3 credits
Second Semester — Th, 7-10

ChE 230 EXTRACTIVE METALLURGY Professor BRYTCZUK

A study of the unit operations of chemical engineering and of metallurgical engineering applied to the winning of non-ferrous metals from their ores by ore dressing, pyrometallurgy, hydrometallurgy, gaseous reduction and distillation. Emphasis will be placed on thermochemical heat and material balances in problem form.

Prerequisite: B.S. in ChE., M.E., or training satisfactory to the Chairman of the department.

3 hours lecture per week — 3 credits
Second Semester — Offered 1961-1962 — F, 7-10

ChE 240 CHEMICAL PROCESS DEVELOPMENT Professor KEEFFE

Development of data obtained in both small and large scale laboratory experiments. The design course will include pilot scale operations. Integration of unit processes, operational variables and cost will be stressed. Comprehensive reports will be written and judged by a departmental committee. Work in the course will be on an individual basis at hours to be arranged by the students and the Professor. Enrollment is limited to six students each semester.

Prerequisite: Unit Operations or equivalent.

1 hour conference
4 hours Design per week. Laboratory fee $5.00; Laboratory deposit $25 — 3 credits
Repeated each semester — Hours by arrangement

ChE 241 CHEMICAL EQUIPMENT AND PLANT DESIGN
Dr. MANTELL

The design, for a chemical manufacturing plant or chemical engineering apparatus, involving selection of equipment auxiliaries, supplies, power, instrumentation, layout with general specifications for buildings, plant site preparation and location. Work in this

course will be on an individual basis at hours to be arranged by the student and Professor. Reports will be judged by a departmental committee. Enrollment is limited to six students each semester.

Prerequisite: Unit Operations or equivalent.

1 hour conference
4 hours Design per week — 3 credits
Repeated each semester — Hours by arrangement

ChE 243 CHEMICAL ENGINEERING COMMUNICATIONS
Now given as Hu 200, for description of which see page 68.

ChE 245 ADVANCED PHYSICAL CHEMISTRY — Dr. CARLSON
This course will cover a number of selected topics from the following list: Atomic and molecular structure, physical properties, the chemical bond, homogeneous and heterogeneous equilibrium, the phase rule with applications, ionic equilibria, and theoretical electrochemistry.

Prerequisite: Physical Chemistry.

3 hours per week — 3 credits
First Semester — Offered 1960-1961 and alternate years — M, 7-10

ChE 246 CATALYSIS — Dr. SILVESTON
A study of the background theory, reaction kinetics, commercial preparation of catalytic materials, reacto design and application of catalytic processes in the chemical engineering process industries.

Prerequisite: Previous training satisfactory to the Department.

3 hours per week — 3 credits
Second Semester — Offered 1961-1962 and alternate years — M, 7-10

ChE 247 COLLOIDS — Dr. CARLSON
Such subjects in colloidal chemistry as absorption of gases by solids, contact catalysis, wetting of surfaces, sols, gels, aerosols, electrophoresis are included among those studied.

Prerequisite: Undergraduate course in Physical Chemistry or equivalent.

3 hours per week — 3 credits
First Semester — Offered 1961-1962 and alternate years — M, 7-10

ChE 249 ADVANCED ORGANIC CHEMISTRY LABORATORY
Professor BRADLEY
The study of preparations and techniques of a more advanced type than those given in undergraduate courses in organic chemistry. A wide range of laboratory problems will be studied.

Prerequisite: Undergraduate Organic Chemistry.

6 hours per week
Laboratory fee $5.00 per semester, laboratory deposit $25.00 — 3 credits
First Semester — Offered 1961-1962 and alternate years — Tu and Th, 7-10

ChE 250 ADVANCED ORGANIC CHEMISTRY LABORATORY

Professor BRADLEY

This course will be a continuation of ChE 249 embracing specialized preparations and techniques of advanced types.
Admission to this course only by permission of the professor of the course and the chairman of the Department of Chemical Engineering.

Prerequisite: ChE 249 or equivalent.

6 hours per week
Laboratory fee $5.00 per semester
Laboratory deposit $25.00
Second Semester — Offered 1960-1961 and alternate years — 3 credits
M and W, 7-10

ChE 252 TECHNOLOGY OF NUCLEAR MATERIALS Dr. SALAMONE

The properties of materials related to reactor design and construction; utilization and disposal of fission products; effects of contamination; decontamination processes; insulation materials for reduction of radiation hazards to men and materials. Specialized fabrication of the rare metals. Other topics of current importance to the field.

Prerequisite: ChE 222.

3 hours per week
Second Semester — Offered 1961-1962 and alternate years — 3 credits
M, 7-10

ChE 254 PROCESS INDUSTRY WASTES—CONTROL AND TREATMENT To be announced

The control, treatment, and disposal of industrial gaseous, liquid, and solid effluents of the process and power industries will be discussed with respect to methods, equipment, economic considerations, and State and Federal regulatory agencies. Special emphasis will be placed on the problem of disposal of nuclear wastes, fission products, and related materials.

Prerequisite: ChE 222, Unit Operations, or equivalent, or B.S. in C.E., or Sanitary Engineering.

3 hours lecture per week
First Semester — Offered 1961-1962 and alternate years — 3 credits
M, 7-10

ChE 255 PLASTICS ENGINEERING Dr. INGBERMAN

Chemistry of high polymers, manufacturing processes, formation of shapes, molding, extrusion, lamination, and other fabrication; engineering properties of plastics and economic utilization.

Prerequisite: ChE 222.

3 hours lecture per week
Second Semester — 3 credits
F, 7-10

ChE 300 THESIS — Department Faculty

The completion, under the guidance of a Faculty member, of a research project in experimental research, equipment design or process development in the field of chemical engineering. The completed work in the form of a written thesis should be of a calibre sufficient to warrant publication in a technical journal. Enrollment in course permitted either semester.

Hours to be arranged — 6 credits
First and Second Semester

With the permission of the department, preparation for thesis may be scheduled over one to four consecutive terms. Credit will be limited, however, to the six credits indicated for the subject. The charges for each term will be: Registration Fee—$5.00; Thesis—$5.00; Tuition—$66.00. If use of laboratory facilities or equipment is necessary, a $25.00 deposit must be maintained.

ChE 303 PHYSICO-CHEMICAL INSTRUMENTATION METHODS — Dr. CARLSON

Industrial and theoretical applications of such instruments as the ultra-violet, visible, and infra-red spectrophotometers, flame photometers, dielectric apparatus, and polaragraph are stressed.

3 hours laboratory per week.
Laboratory fee $5.00; laboratory deposit $25.00 — 3 credits
First and Second Semesters — W, 7-10

ChE 311 INTERMEDIATE UNIT OPERATIONS—LABORATORY — Dr. SALAMONE

Prerequisite: ChE 210.

3 hours per week
Laboratory fee $5.00 per semester, laboratory deposit $25.00 — 3 credits
First and Second Semesters — Tu, 7-10

ChE 312 ADVANCED UNIT OPERATIONS LABORATORY — Professor KEEFFE

A study of the most recent advances, on a laboratory basis, in the areas of heat transfer and fluid flow, absorption and extraction, distillation and diffusional operations.

Prerequisite: Undergraduate course in Unit Operations.

3 hours laboratory, each semester
Laboratory fee $5.00 per semester, laboratory deposit $25.00 — 3 credits
First and Second Semesters — W, 6-9

ChE 314 ADVANCED CHEMICAL PRINCIPLES — Professor FREDERICK

Atomic structure nuclei, atomic and extra-nuclear properties, valence and chemical bonding, coordination complexes, resonance, non aqueous systems, half cell reactions, free radicals, states of aggregation, phase diagrams, allotropy, systems and compounds of sulfur, selenium, tellurium, nitrogen, phosphorus, silicon, arsenic, bismuth, the transition elements, the transuranium elements, the "synthetic" elements.

3 hours lecture — 6 credits
First and Second Semesters — Offered 1961-1962 and alternate years — Th, 7-10

REQUIREMENTS OF THE DEPARTMENT OF CIVIL ENGINEERING

Programs of specialization currently available to students in the Department of Civil Engineering are in the fields of Sanitation, Soil Mechanics, and Structural Engineering and twelve credits of prescribed work in one of these fields of specialization shall constitute a major area of work. Where the major is in the field of Sanitation or Soil Mechanics, laboratory work shall be part of the program.

Each student taking the degree of Master of Science in Civil Engineering shall elect two minor areas of work of six credits each with at least one minor related to his major.

Each student taking the degree of Master of Science shall elect two minor areas of work of six credits each, subject to the limitations of other requirements, or one minor consisting of four related courses.

Should a student elect a thesis when design courses are part of his required major, the thesis shall not parallel the work of the design courses.

The intent of these requirements is to create strong major and minor areas of work, each having depth of content. A reasonable concept will be placed upon the interpretation of related work.

Courses Offered by the Department of Civil Engineering

CE 211 SANITARY ENGINEERING (Water Treatment Plants)
Professor METZGAR

A detailed study of the principles controlling the design and operation of modern water treatment plants.

Prerequisite: Approved undergraduate courses in Water Supply and Public Health.

3 hours per week — 3 credits
First Semester — Offered 1960-1961 and alternate years — Tu, 7-10

CE 212 SANITARY ENGINEERING (Water Treatment Plant Design)
Professor METZGAR

A functional design is prepared for a complete water treatment plant for a given supply of known raw water quality.

Prerequisite: CE 211.

3 hours per week — 3 credits
Second Semester — Offered 1960-1961 and alternate years — Tu, 7-10

CE 213 SANITARY ENGINEERING (Waste Disposal Works)
Professor METZGAR

A detailed study of the principles controlling the design and operation of modern sewage and industrial waste disposal works.

Prerequisite: Approved undergraduate course in Sewage and Waste Treatment.

3 hours per week — Offered 1961-1962 and alternate years — 3 credits
First Semester — Tu, 7-10

CE 214 SANITARY ENGINEERING (Waste Disposal Works Design)
Professor METZGAR

A functional design is prepared for a sewage and industrial waste disposal plant for a nearby community or industrial plant.

Prerequisite: CE 213.

3 hours per week — Offered 1961-1962 and alternate years — 3 credits
Second Semester — Tu, 7-10

CE 233 ADVANCED STRENGTH OF MATERIALS
Also given as Phys 209, for a description of which see page 71.

CE 234 THEORY OF ELASTICITY
Also given as Phys 206, for a description of which see page 71.

CE 237 ADVANCED REINFORCED CONCRETE DESIGN
Professor LEHMAN

A study of advanced topics in reinforced concrete with particular emphasis on their application to building design. The topics will include general design concepts, properties of concrete, frame design based on both elastic and plastic theories, two way and flat slab design, and special design problems such as circular beams, beams on elastic foundations, and others of interest to the class.

Prerequisite: An undergraduate course in the theory and design of reinforced concrete or some practice in the design of reinforced concrete structures.

3 hours per week — Offered 1960-1961 and alternate years — 3 credits
First Semester — Th, 7-10

CE 238 PRESTRESSED CONCRETE DESIGN — Professor LEHMAN

A study of the principles of prestressed concrete and their application to problems in pipes, tanks, determinant and indeterminant beams. Topics will also include methods of prestressing, tests and properties of materials, and construction details.

Prerequisite: CE 237.

3 hours per week — Offered 1960-1961 and alternate years — 3 credits
Second Semester — Th, 7-10

CE 245 HYDRAULIC ENGINEERING I — Professor SHAPIRO

The first part is a study of the principles of non-uniform hydraulic

flow in open channels. The second part is a study of the principles, applications, and specifications for impulse wheels, reaction turbines, pumps of various types, and hydraulic control devices for engineering projects.

Prerequisite: Undergraduate course in Hydraulics or Fluid Mechanics.

3 hours per week — 3 credits
First Semester — Offered 1961-1962 and alternate years — Th, 7-10

CE 246 HYDRAULIC ENGINEERING II — Professor SHAPIRO

This course covers a study of the analytical approach to basic engineering statistics followed by applications from the field of hydraulics and hydrology.

Prerequisite: Undergraduate courses in Hydraulics and Hydrology.

3 hours per week — 3 credits
Second Semester — Offered 1961-1962 and alternate years — Th, 7-10

CE 251 ADVANCED SOIL MECHANICS I — Professor SHAPIRO

An advanced study of some of the basic problems dealing with soils. Topics include soil classification, capillarity, seepage, stresses in soils, consolidation, and stability of slopes. Work will be correlated between the lectures and the laboratory.

Prerequisite: An undergraduate course in soil mechanics or the equivalent field experience.

3 hours per week. Laboratory fee $5.00. — 3 credits
First Semester — Offered 1960-1961 and alternate years — W, 7-10

CE 252 ADVANCED SOIL MECHANICS II — Professor SHAPIRO

A continuation of CE 251. Topics include settlement analysis, stability, unretained slopes, lateral pressures on retaining walls, piles and earth dams.

Prerequisite: CE 251.

3 hours per week. Laboratory fee $5.00. — 3 credits
Second Semester — Offered 1960-1961 and alternate years — W, 7-10

CE 253 FOUNDATION ENGINEERING I — Professor SHAPIRO

A study of the methods which a soils engineer may use to solve various foundation problems. Topics will include spread footings, foundation walls, mats and combined footings, foundations subject to overturning, and bridge abutments. The course will be divided between lectures and recitations and design problems.

Prerequisite: Undergraduate course in soil mechanics and the design of structures or equivalent experience.

3 hours per week — 3 credits
First Semester — Offered 1961-1962 and alternate years — W, 7-10

CE 254 FOUNDATION ENGINEERING II Professor SHAPIRO

A continuation of CE 253. Topics will include piles, supports for open excavations, caissons, bridge piers, underpinning, design of a foundation for a large stack, and breakwaters, wharves and piers.

Prerequisite: CE 253.

3 hours per week — Second Semester — Offered 1961-1962 and aletrnate years — 3 credits — W, 7-10

CE 301 THESIS Department Faculty

The thesis is to be prepared on a subject in the student's major field. The subject is to be approved by the Department.

Hours to be arranged — First and Second Semester — 6 credits

With the permission of the department, preparation for thesis may be scheduled over one to four consecutive terms. Credit will be limited, however, to the six credits indicated for the subject. The charges for each term will be: Registration Fee—$5.00; Thesis—$5.00; Tuition—$66.00. If use of laboratory facilities or equipment is necessary, a $25.00 deposit must be maintained.

CE 310 SANITARY BIOLOGY AND CHEMISTRY

Also given as Chem 348, for a description of which see page 68.

CE 333 STRUCTURAL THEORY Professor LA LONDE

The Elastic Energy Theory is used in the solution of problems on continuous and curved beams, arches, and indeterminate frames and structures. The column analogy is studied as an added tool. This is followed by a study of the Slope Deflection Theory, with emphasis placed upon moment distribution. Problems include frames with rectangular and inclined members of uniform and variable cross-section.

Prerequisite: Undergraduate course in structures as given to civil engineering students, or equivalent.

3 hours per week — First and Second Semesters — Offered 1960-1961 and alternate years — 6 credits — Tu, 7-10

CE 334 STRUCTURAL DESIGN Professor LA LONDE

Designs for both arch and rigid frame bridges will be made and checks obtained using Beggs deformeter equipment and plastic models. Other designs will be made to fit class needs.

Prerequisite: CE 333.

3 hours per week — First and Second Semesters — Offered 1961-1962 and alternate years — 6 credits — Tu, 7-10

REQUIREMENTS OF THE DEPARTMENT OF ELECTRICAL ENGINEERING

The Department of Electrical Engineering offers programs leading to the degrees of *Master of Science in Electrical Engineering* and *Master of Science.*

The *M.S. in E.E.* is intended for the electrical engineering graduate, or equivalent, who wishes to further his formal electrical engineering education by specializing in some advanced phase of electrical engineering or in preparation for a further advanced degree.

The *M.S.* is intended for the science or non-electrical engineering graduate who wishes to specialize in some advanced electrical engineering work, or for the electrical engineering graduate who wishes to further his education by broadening his field and taking a relatively large number of courses in some other field of study.

Programs for both degrees are designed for students with an excellent undergraduate background in mathematics through Differential Equations and Vector Analysis, and in Electric Networks, Transients, Electronics, and Electromagnetic Fields, including laboratory work in some of these areas. Candidates for the *M.S. in E.E.* will be required to demonstrate proficiency in all of these fields. Candidates for the *M.S.* will be required to demonstrate proficiency in those areas which are fundamental to the graduate courses they propose to take.

Candidates demonstrating such proficiency to the satisfaction of their Advisor may proceed immediately to the advanced courses in Areas I through VII. Others will be required to take such undergraduate prerequisites as may be needed and some or all of the following basic graduate courses:

Ma 273—Differential Equations I

EE 120—Fundamentals of Electromagnetic Waves

EE 140—Electronic Circuits

EE 150—Circuit Analysis

A Program of more than the minimum number of credits will be necessary for a Candidate for the M.S. in E.E. requiring courses listed above.

For the convenience of the Candidate and his Advisor in the selection of an integrated program for his Master's degree, the specialized offerings of the Department have been divided into the following areas:

I Electric Circuit Design and Synthesis:
EE 229, 239, 248, 252, 253, 256, 273, 274, 276

II Automatic Control and Industrial Electronics:
EE 245, 250, 261, 262, 263, 264, 265, 266, 467

III Electronic Computers:
EE 248, 250, 262, 275, 280, 281

IV High Frequency Communications:
EE 222, 223, 229, 239, 242, 246, 250, 274, 276

V Electroacoustics:
EE 267, 269, 277, 278

VI Electric Power Systems:
EE 215, 216, 218, 229, 271, 272

VII Electric Machinery:
EE 217, 218, 254, 255, 261

The Advisor may require a Program of more than the minimum number of credits for a Candidate wishing to spread his Departmental Requirements over more than two of the above areas.

REQUIREMENTS FOR THE DEGREES OF MASTER OF SCIENCE IN THE DEPARTMENT OF ELECTRICAL ENGINEERING

A. For the Master of Science in Electrical Engineering, candidates must include EE 201, Electrical Engineering Design, or EE 301, Master's Thesis.
Electives must include at least one course in the Department of Mathematics.

B. For the Master of Science candidates must include EE 201, Electrical Engineering Design, or EE 301, Master's Thesis.
Electives must include at least one course in the Department of Mathematics.

Courses Offered by the Department of Electrical Engineering

EE 120 FUNDAMENTALS OF ELECTROMAGNETIC WAVES

Dr. REFF

A foundation course, laying a basis for advanced work in television, radar, and microwave techniques. Basic principles of electromagnetic field theory from modern engineering viewpoint, with advanced methods of analysis.

3 hours per week — 3 credits
First Semester — F, 7-10

EE 140 ELECTRONIC CIRCUITS Dr. LOUISELL

Untuned vacuum-tube and transistor amplifiers, with linear and nonlinear circuits. Feedback amplifiers and oscillators. Amplitude modulation. Rectifiers and filters.

Prerequisite: EE 150 or equivalent.

3 hours per week — 3 credits
Second Semester — F, 7-10

EE 150 CIRCUIT ANALYSIS Professor RIPS

Transient and steady-state analysis of linear, lumped-parameter electric circuits, using the pole-zero approach.
Mesh and nodal analysis, network theorems, analogues, Laplace transform method applied to systems with non-zero initial conditions.

Prerequisite: Ma 273 or equivalent.

3 hours per week — 3 credits
Repeated Each Semester — F, 7-10

EE 201 ELECTRICAL ENGINEERING DESIGN Department Faculty

An extensive paper involving design, construction and analysis, or theoretical investigation, will be required of all candidates for the Master's degrees who do not take course EE 301 Thesis. The paper must be initiated in an EE course as stated by the advisor, with the knowledge and approval of the instructor in such course, at the start of the course. Students electing to prepare such a paper must complete substantially half of the work while taking the designated course. They will then be required to register the succeeding semester for EE 201, during which semester the paper must be completed, usually with the original instructor as the student's advisor.

Prerequisite: Matriculation for an M.S. degree and substantial progress in writing an extensive paper for an EE course designated by the Advisor.

3 hours per week — 3 credits
Repeated each semester — Hours to be arranged

EE 207 ELECTROCHEMICAL ENGINEERING Dr. MANTELL

Also given as ChE 207, for a description of which see page 28.

EE 211 TRANSISTOR PHYSICS Professor TOWFIK

Also given as Phys 211, for a description of which see page 71.

EE 215 POWER TRANSMISSION Professor JORDAN

The fundamentals of mechanical and electrical design of transmission lines, power line operation, problems of system performance.

Prerequisite: Undergraduate courses in electric circuits and machines.

3 hours per week — 3 credits
Second Semester — Offered 1960-1961 and alternate years — F, 7-10

EE 216 POWER DISTRIBUTION — Professor JORDAN

The operation, maintenance and expansion of power distribution systems from the transmission substation to the customer's outlet. Modern practice in urban and rural distribution, overhead and under-ground lines, networks, lightning protection and voltage regulation.

Prerequisite: Undergraduate courses in electric circuits and machines.

3 hours per week — 3 credits
First Semester — Offered 1960-1961 and alternate years — F, 7-10

EE 217 MOTOR APPLICATION — Professor WINSTON

Standards, equivalent duty cycles, inertia considerations, torque characteristics and load demand, speed control of both d-c and a-c motors. Accurate positioning, control, and specific industrial applications.

Prerequisite: Undergraduate courses in D-C and A-C machines.

3 hours per week — 3 credits
Second Semester — Offered 1960-1961 and alternate years — M, 7-10

EE 218 SYMMETRICAL COMPONENTS — Mr. BLACKBURN

Principles of the method of symmetrical components. Use of the method in the calculation of faults in power systems, Behavior and characteristics of machines, lines and transformers under unbalanced conditions.

Prerequisite: B.S. in E.E. or equivalent.

3 hours per week — 3 credits
First Semester — Offered 1961-1962 and alternate years — Th, 7-10

EE 222 ELECTROMAGNETIC RADIATION — Dr. REFF

Electromagnetic field theory; rectangular waveguides; the differential antenna; linear antennas; antenna arrays.

Prerequisite: EE 120 or equivalent.

3 hours per week — 3 credits
Second Semester — Offered 1961-1962 and alternate years — Th, 7-10

EE 223 MICROWAVE TRANSMISSION — Mr. SABTO-AGAMI

Electric transmission theory; rectangular and circular waveguides; waveguide transmission lines; waveguide elements; waveguide filters, switches, phase shifters, hybrids, and attenuators; resonant lines, cavity resonators; coupling devices; waveguide radiators.

Prerequisite: EE 120 or equivalent.

3 hours per week — 3 credits
First Semester — Offered 1960-1961 and alternate years — Th, 7-10

EE 229 ADVANCED TRANSIENTS — Dr. RUSSELL

The inverse Laplace transformation applied to systems with lumped and distributed parameters. Synthesis of electric circuits for prescribed transient response, transients on power and communications transmission lines, delay lines, vibration of bars, conduction of heat,

electromagnetic radiation.

Prerequisite: EE 150 or equivalent.

3 hours per week — 3 credits
Second Semester — M, 7-10

EE 239 FEEDBACK AMPLIFIERS — Professor DICKEY

Mathematical definitions of feedback, return difference and sensitivity and their associated network functions. Performance criteria for phase shifts, amplitude margins and stability for both single loop and chain type amplifiers.

Prerequisite: EE 150 or equivalent.

3 hours per week — 3 credits
First Semester — F, 7-10

EE 242 RADIO-FREQUENCY COMMUNICATIONS — Mr. SABTO-AGAMI

Frequency modulation and pulse-time modulation; modulation and demodulation systems. Interference and noise; bandwidth. Radio and television transmitters and receivers.

Prerequisite: EE 140 or equivalent.

3 hours per week — 3 credits
Second Semester — Offered 1961-1962 and alternate years — Tu, 7-10

EE 245 INDUSTRIAL ELECTRONICS — Professor ANDERSON

Fundamental principles including thermistors, varistors, transistor, switching circuits; R.F. heating, electronic control (motor, welding and photoelectric); power rectifiers and inverters; X-ray applications; electrostatic precipitation.

Prerequisite: EE 140 or equivalent.

3 hours per week — 3 credits
First Semester — Offered 1960-1961 and alternate years — M, 7-10

EE 246 MICROWAVE ELECTRONIC SYSTEMS — To be announced

Microwave diodes and triodes; klystrons and magnetrons; pulse modulation; radar components; radar transmitters and receivers.

Prerequisite: EE 140 or equivalent.

3 hours per week — 3 credits
Second Semester — Offered 1960-1961 and alternate years — Tu, 7-10

EE 248 WAVE SHAPE AND PULSE FORM CONTROL

Professor DICKEY

Analysis of non-sinusoidal voltage waves and pulses and methods of producing them. The effects on wave forms of linear, non-linear, unilateral, bilateral, single and multivariable circuit elements are examined, together with the selection and comparison of waves and pulses in respect to amplitude, frequency or phase, and time. The procedure for performing the common mathematical operations on wave forms and results therefrom.

Prerequisite: EE 150 or equivalent.

3 hours per week — 3 credits
Second Semester — F, 7-10

EE 250 TRANSISTOR PRINCIPLES AND CIRCUITRY

Professor MEOLA

A study of semi-conductor principles including the theory of the p-n junction and the mechanism of transistor action. The physical analysis is followed by a study of the transistor as a circuit element. Emphasis is placed on the special circuit requirements of the transistor rather than on the specific circuit type. Topics include, equivalent circuits, bias considerations, low frequency applications, high frequency applications, switch applications and oscillations.

Prerequisites: EE 140 and EE 150 or equivalent.

3 hours per week — 3 credits
Repeated each semester — Th, 7-10

EE 252 NETWORK SYNTHESIS — Professor PADALINO

General design of two- and four-terminal networks; effect of dissipative elements in reactive circuits; design of distortion correcting networks; phase correcting networks; recent advances in design of resistance-capacitance networks with prescribed frequency-response characteristics.

Prerequisite: EE 150 or equivalent.

3 hours per week — 3 credits
First Semester — Tu, 7-10

EE 253 ELECTRIC FILTER DESIGN — Professor PADALINO

Theory and design of reactance filters composed of inductors, and capacitors, crystals and/or coaxial lines. Filter theory based on lattice networks; ladder structures; impedance transformations; effect of dissipation; charts and tables as aids in computing response. Darlington's Insertion Loss Theory applied to filter design.

Prerequisite: EE 150 or approximate equivalent.

3 hours per week — 3 credits
First Semester — Offered 1961-1962 and alternate years — Th, 7-10

EE 254 ADVANCED ELECTRIC MACHINES — Professor WINSTON

Introduction to electric machine design, special topics in magnetic circuits, calculation of leakage reactance.
Design proportions, design of induction motors, synchronous machines and D-C machines.

Prerequisite: Undergraduate courses in Electric Machines both alternating and direct current types.

3 hours per week — 3 credits
First Semester — Offered 1961-1962 and alternate years — Tu, 7-10

EE 255 ELECTRIC MACHINE DESIGN — Professor WINSTON

An extension of EE 254 to include other types or sizes of machines, as servo motors and high frequency machines. Special problems such as heating, commutation, vibration and hunting will be studied.

Prerequisite: EE 254.

3 hours per week — 3 credits
Second Semester — Offered 1961-1962 and alternate years — Tu, 7-10

EE 256 ADVANCED NETWORK ANALYSIS To be announced
Network matrices; constant resistance, equivalent, dual, and inverse networks; lattice networks, Bartlett's bisection theorem; Foster's reactance theorem; attenuation - phase relationships, elementary network synthesis.

Prerequisite: EE 150 or equivalent.

3 hours per week — 3 credits
Second Semester — Tu, 7-10

EE 261 SERVOMECHANISM COMPONENTS Professor WINSTON
The steady-state and transient characteristics of commonly used magnetic components such as servomotors, rate generators, synchros, eddy-current and inertia dampers, polarized torquemotors, hysteresis clutches and particle clutches.
Emphasis is placed on problems affecting the performance of the complete system of which the component is a part.

Prerequisite: EE 263.

3 hours per week — 3 credits
First Semester — Offered 1960-1961 and alternate years — M, 7-10

EE 262 MAGNETIC AMPLIFIERS Professor ANDERSON
A study will be made of the theory, application and uses of the magnetic amplifier including loading, load characteristics, harmonics, frequency characteristics, output power, maximum power transfer, efficiency, gain, and feedback. Both steady-state and transient conditions will be investigated.

Prerequisites: Undergraduate Magnetic Circuits, EE 150, and EE 140, or the equivalents.

3 hours per week — 3 credits
First Semester — Offered 1961-1962 and alternate years — M, 7-10

EE 263 SERVOMECHANISMS Dr. BOGNER
Analysis and design of servomechanisms. Transient and steady-state frequency response methods with stress on the latter for design purposes. The principal emphasis is on linear electromechanical systems.

Prerequisite: EE 150 or Mechanical Engineering course in vibration theory.

3 hours per week — 3 credits
Repeated each semester — Th, 7-10

EE 264 SAMPLED-DATA AND A-C SERVOMECHANISMS
Dr. RUSSELL
Sampled-data servomechanisms: modulation, sampling, z-transform theory, predictors, servos with digital computers. A-C servomechanisms: analysis of modulators and demodulators, a-c motors, a-c compensation.

Prerequisite: EE 263 or equivalent.

3 hours per week — 3 credits
First Semester — Offered 1961-1962 and alternate years — M, 7-10

EE 265 NONLINEAR SERVOMECHANISMS Dr. RUSSELL

Non linearities in "linear" servomechanisms, linearization techniques, relay servos, nonlinear compensators, dual-mode systems. Small-signal theory, classical analytical and graphical methods, frequency-response describing-function method, phase-plane analysis.

Prerequisite: EE 263 or equivalent.

3 hours per week | Second Semester | Offered 1961-1962 and alternate years | 3 credits | M, 7-10

EE 266 SERVOMECHANISMS LABORATORY Professor PADALINO

A lecture and laboratory course in the practice of the principles developed in EE 263. Use of components, techniques of testing and synthesis of complete servosystems. Nonlinearities are emphasized.

Prerequisite: EE 263 or equivalent and undergraduate laboratory courses in electric machines and electronics.

3½ hours per week. Laboratory fee $15.00 | Second Semester | Offered each year | 3 credits | Tu, 6:30-10

EE 267 ELECTROACOUSTICS Professor ROSE

Basic principles of the behavior of mechanical and acoustical systems with particular emphasis on the method of dynamical analogies. The description of acoustical and electroacoustical techniques, including the mechanism and behavior of pickups, loudspeakers, telephone receivers, horns, recorders, and architectural acoustics.

Prerequisite: EE 140 and EE 150 or equivalent.

3 hours per week | First Semester | Offered 1961-1962 and alternate years | 3 credits | W, 7-10

EE 269 ELECTROACOUSTICS LABORATORY Professor ROSE

A lecture and laboratory course implementing the most important topics covered in EE 267 using modern electro-acoustical equipment including a sound-proof booth, audiometric equipment, absolute standard microphones and most of the transducer types in use today.

Prerequisite: EE 267 or equivalent and undergraduate laboratory course in electronics.

3½ hours per week. Laboratory fee $15.00 | Second Semester | Offered 1961-1962 and alternate years | 3 credits | W, 6:30-10

EE 271 ELECTRIC POWER SYSTEMS Professor JORDAN

Selected topics dealing with power generation, transmission and distribution. Among these topics are hydro and steam operation, economic and reliability factors involved in power system interconnections, load-frequency control, power factor economics, system protection, steady state and transient stability problems.

Prerequisite: Undergraduate courses in alternating current circuits and machines.

3 hours per week | First Semester | Offered 1961-1962 and alternate years | 3 credits | F, 7-10

EE 272 ELECTRIC ILLUMINATION — Professor JORDAN

A lecture and problem course covering the basic principles of illumination, the design and maintenance of indoor and outdoor illumination systems and the economics of light production.

Prerequisite: Undergraduate course in physics and electric circuits.

3 hours per week — 3 credits
Second Semester — Offered 1961-1962 and alternate years — F, 7-10

EE 273 RANDOM PROCESSES IN ELECTRICAL COMMUNICATION — Mr. WEBER

Introduction to Random Processes: Axiomatic formulation of probability theory. Discussion of random variables and random processes. Statistical averages, characteristic functions. Time dependent random variables. Ensemble statistics. Concepts of stationarity and ergodicity. Correlation coefficients and correlation and autocorrelation functions and their relation to power spectra. Gaussian processes. Response of linear systems to random inputs. Detection of signals in noise: Optimum filtering, Wiener filters. Signals and noise in communications systems.

Prerequisite: EE 150 or equivalent.

3 hours per week — 3 credits
First Semester — Offered 1961-1962 and alternate years — W, 7-10

EE 274 SEMINAR ON NOISE IN ELECTRIC CIRCUITS — Dr. LOUISELL

The common types of noise classified as to their origin and characteristics; methods of evaluating them analytically, and procedures for measuring them. Their effect on amplifier sensitivity and the design of minimal noise circuits.

Prerequisite: EE 140.

First Semester — Offered 1960-1961 and alternate years — 3 credits — Tu

EE 275 THE DESIGN OF DIGITAL CONTROL CIRCUITS — Professor ANDERSON

Switching apparatus; control paths; switching logic (algebra of switching circuits); combinational circuits; sequential circuits; electronic switching logic and circuits; applications (counters, coders, translators, selectors, etc.).

Prerequisite: EE 140 or equivalent.

3 hours per week — 3 credits
Second Semester — M, 7-10

EE 276 INFORMATION THEORY — Mr. WEBER

An introductory course in the modern communication theory of discrete and continuous random signals. Basic probability theory, communication in binary units through binary systems, statistical properties of continuous signals in time and frequency domains, communi-

cation through a channel with noise. Applications include binary systems, filters, PAM and PCM systems, potentiometer noise, servomechanism error functions, etc.

Prerequisite: EE 150 or equivalent.

3 hours per week — Offered 1961-1962 and alternate years — 3 credits
Second Semester — W, 7-10

EE 277 SOUND RECORDING AND REPRODUCING SYSTEMS
Professor ROSE

A study of disc, photoelectric, and magnetic systems and their limitations and performance in terms of their frequency response and distortion.

Prerequisite: Undergraduate laboratory courses in electron tube circuits and EE 150 or equivalent.

3 hours per week — Offered 1960-1961 and alternate years — 3 credits
First Semester — W, 7-10

EE 278 SOUND RECORDING AND REPRODUCING SYSTEMS LABORATORY
Professor ROSE

A lecture and laboratory course in sound systems. Tests are made on the performance of disc and magnetic recording and play-back equipment to measure the performance in terms of frequency response and distortion and to determine the effect of controllable variables on the system performance.

Prerequisite: EE 150 or equivalent and an undergraduate laboratory course in electronics.

3½ hours per week — Laboratory fee $15.00 — 3 credits
Second Semester — Offered 1960-1961 and alternate years — W, 6:30-10

EE 280 ANALOGUE COMPUTERS Professor DICKEY

This course is a detailed study of electrical analogue computers. Topics considered include the solution of differential equations, linear simultaneous equations, generating polynomials and root determination, Eigen values, function generation, non-linear phenomena, repetitive procedures and error considerations. The basic components of digital computers will be included.

Prerequisite: EE 150 or equivalent.

3 hours per week — Offered 1960-1961 and alternate years — 3 credits
First Semester — Tu, 7-10

EE 281 TECHNIQUES OF DIGITAL COMPUTERS Professor DICKEY

This course is an introduction to the use of digital computers. It includes arithmetic units, computer arithmetic, numerical analysis, basic programming, sub-programs, the storage of information, codes, checking procedures, computer organization and control, and special features of certain types of computers.

Prerequisite: EE 280 or EE 275.

3 hours per week — Offered 1960-1961 and alternate years — 3 credits
Second Semester — Tu, 7-10

EE 301 MASTER'S THESIS Department Faculty

Projects involving design, construction, experimental or theoretical investigation may be approved by the graduate advisor as the basis for a thesis. Approved cooperative projects with industry or governmental agencies may be acceptable. The work will be carried on under the supervision of a designated member of the department staff.

Prerequisite: Bachelor's degree in Electrical Engineering and matriculation for an M.S. degree.

6 hours per week — 6 credits
First and Second Semesters — Hours to be arranged

With the permission of the department, preparation for thesis may be scheduled over one to four consecutive terms. Credit will be limited, however, to the six credits indicated for the subject. The charges for each term will be: Registration Fee—$5.00; Thesis—$5.00; Tuition—$66.00. If use of laboratory facilities or equipment is necessary, a $25.00 deposit must be maintained.

EE 424 SEMINAR ON ADVANCED ANTENNA THEORY To be announced

Selected topics in advanced electromagnetic field theory, such as, radiation over a conducting earth, aperture type antennas, antenna pattern synthesis methods, supergain antennas, and others as determined by interests of the students.

Prerequisite: EE 222, Math 256, Math 274 or approximate equivalents, and permission of the Department.

Hours to be arranged — 3 credits
Second Semester — Offered 1960-1961 and alternate years — Th

EE 467 SEMINAR ON STATISTICAL DESIGN OF LINEAR SERVOMECHANISMS To be announced

Selected topics in Advanced Servomechanism Design. Considerations when the reference input is of a random nature and when noise is present in the input and random disturbances occur at the output The Weiner rms error criterion in terms of transfer functions and noise spectral density. Methods of minimizing the rms error. Recent advances in statistical design. Specialized topics as determined by interest of the students.

Prerequisites: EE 263, and EE 274 or EE 276 (or approximate equivalents) and permission of the Department.

Hours to be arranged — 3 credits
Second Semester — Offered 1960-1961 and alternate years — W

REQUIREMENTS OF THE DEPARTMENT OF MANAGEMENT ENGINEERING

The Department of Management Engineering subscribes to the philosophy that graduate study in this field is applicable to four general areas of managerial activity: the Management of Research, Design, and Development; the Management of Production; the Management of Personnel; and the Management of Distribution.

Concomitant with industrial practice, the graduate curricula of the Department provide the academic avenues toward managerial activity in these areas for those whose baccalaureate work led to a degree in engineering as well as for those who majored in Physics, Chemistry, or Mathematics.

The degree Master of Science in Management Engineering is the intended objective for the graduates of an engineering curriculum that included basic management subjects. As a matriculation prerequisite, the candidate for this degree must offer EM210 and EM211; or IE21, IE22, or EM68 and EM71, EM74, or IE44; or their equivalents.

The degree Master of Science is the intended objective for graduates of an engineering curriculum that did not include basic management subjects as well as for graduates who majored in Physics, Chemistry, or Mathematics.

Graduate courses in the Department of Management Engineering are grouped by areas as follows:

Group I—Management of Research, Design, and Development

EM204 Advanced Analytical Engineering Statistics
EM223 Psychology in Engineering
EM234 Planning and Management of Industrial Research
EM235 Management of Design and Development
EM250 Introductory Operations Research
EM255 Introduction to Systems Engineering and Electronic Data Processing
EM271 Industrial Costing and Management Control
EM280 Techniques of Executive Control
EM300 Thesis

Group II—Management of Production

EM204 Advanced Analytical Engineering Statistics
EM213 Production Engineering
EM214 Planning and Control of Products and Processes
EM215 Design of an Enterprise
EM216 Seminar in Design of an Enterprise
EM217 Production Engineering Estimating

EM218 Management of Small Business
EM223 Psychology in Engineering
EM250 Introductory Operations Research
EM251 Linear Programming
EM255 Introduction to Systems Engineering and Electronic Data Processing
EM260 Finance of Industrial Enterprise
EM271 Industrial Costing and Management Control
EM272 Industrial Quality Control
EM280 Techniques of Executive Control
EM293 Managerial Economics
EM300 Thesis

Group III—Management of Personnel

EM204 Advanced Analytical Engineering Statistics
EM212 Personnel Management
EM223 Psychology in Engineering
EM241 Labor and the Law
EM242 Contemporary Collective Bargaining
EM271 Industrial Costing and Management Control
EM273 Advanced Personnel Management
EM274 Job-Position Evaluation and Wage Determination
EM276 Scientific Selection of Personnel
EM280 Techniques of Executive Control
EM300 Thesis

Group IV—Management of Distribution

EM204 Advanced Analytical Engineering Statistics
EM215 Design of an Enterprise
EM216 Seminar in Design of an Enterprise
EM218 Management of Small Business
EM223 Psychology in Engineering
EM250 Introductory Operations Research
EM251 Linear Programming
EM260 Finance of Industrial Enterprise
EM271 Industrial Costing and Management Control
EM280 Techniques of Executive Control
EM290 Distribution and Marketing
EM292 Sales Engineering Management
EM293 Managerial Economics
EM300 Thesis

Note: Those courses appearing in more than one of the above groupings are sufficiently broad in scope to have direct application to the areas in which they are included.

Candidates for the degree Master of Science in Management Engineering must satisfy the Specialization Requirements from one of the above areas, and, if he so chooses, may satisfy the Elective Requirements from the same or other area.

Candidates for the Master of Science Degree who choose to specialize in the Department will fulfill their Specialization Requirements from one of the above areas. The Elective Requirements may or may not be chosen from the same or different area depending upon interest.

REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN THE DEPARTMENT OF MANAGEMENT ENGINEERING

A. For general requirements see page 22.

B. For the Master of Science in Management Engineering candidates must include:
   EM 201 — Advanced Management Engineering (3)
   EM 203 — Analytical Engineering Statistics (3)
   EM 300 — Thesis (6)

C. For the Master of Science candidates must include:
   EM 210 — Production Management I (3)
   EM 211 — Production Management II (3)
   EM 215 — Design of a Manufacturing Enterprise (3)
   EM 216 — Seminar in the Design of a Manufacturing Enterprise (3)

Courses Offered by the Department of Management Engineering

EM 201 ADVANCED MANAGEMENT ENGINEERING

Professor SIZELOVE

A study of the principles and philosophy of scientific management as evidenced in the classical writings of the pioneers; management fundaments applied to modern techniques; seminar of current management engineering problems.

Prerequisite: Undergraduate Industrial Management, or EM 210.

3 hours per week
Repeated Each Semester

3 credits
M, 7-10 1st semester
W, 7-10 2nd semester

EM 203 ANALYTICAL ENGINEERING STATISTICS

Professors SIZELOVE and MIHALASKY

An analytical approach to basic engineering statistics, with applications drawn largely from manufacturing industries. Emphasis is placed upon the utility of statistical inferences derived from engineering data.

Prerequisite: Undergraduate Engineering Mathematics.

3 hours per week — 3 credits
Repeated Each Semester — W, 7-10 1st semester; M, 7-10 2nd semester

EM 204 ADVANCED ANALYTICAL ENGINEERING STATISTICS — Professor MIHALASKY

A continuation of the analytical approach to engineering statistics in the areas of regression analysis, statistical inference, and design of tests. Industrial applications to engineering tests analysis and design procedures is stressed.

Prerequisite: EM 203.

Second Semester — Offered 1960-1961 and alternate years — 3 credits W, 7-10

EM 210 PRODUCTION MANAGEMENT I — Professors RIGASSIO and MIHALASKY

A survey course in the field of Industrial Management stressing the operational aspects of the techniques. Included topics are: plant organization, plant location, plant layout and materials handling, production planning and control, inspection, motion and time study, and wage payment plans.

Prerequisite: Bachelor's degree in science or engineering.

3 hours per week — 3 credits
Repeated Each Semester — Tu, 7-10 1st semester; F, 7-10 2nd semester

EM 211 PRODUCTION MANAGEMENT II — Professor MIHALASKY

A survey course stressing the financial, economy, and control aspects of plant management. It treats the accounting cycle and introduces cost accounting procedures, the techniques of making cost comparisons through economy studies, as an approach to problems of production management.

Prerequisite: Bachelor's degree in science or engineering.

3 hours per week — 3 credits
Repeated Each Semester — F, 7-10 1st semester; Tu, 7-10 2nd semester

EM 212 PERSONNEL MANAGEMENT — Adjunct Professor BUSSE

A survey of personnel management techniques including: job analysis, description and classification; recruitment; selection; training; wage policies; promotion and transfer; employment stabilization and representation; personnel research. Emphasis is placed upon the mechanics of the several techniques.

Prerequisite: Bachelor's degree in science or engineering.

3 hours per week — 3 credits
First Semester — Offered 1961-1962 and alternate years — F, 7-10

EM 213 PRODUCTION ENGINEERING — Mr. DANCO

The course is concerned with establishing and maintaining production. An analysis of the problems of engineering a product through

the stages of process determination, machine tool analysis, economic appraisal of process selection and tool engineering.

Prerequisite: Bachelor's degree in science or engineering.

3 hours per week — 3 credits
First Semester — Offered 1960-1961 and alternate years — M, 7-10

EM 214 THE PLANNING AND CONTROL OF PRODUCTS AND PROCESSES — Professor GOLDSTEIN

A study of the principles and procedures used by job order, continuous and batch types of industries in forecasting, planning and controlling production goods. Emphasis is placed on the organization of the control group and the development of control criteria. Among the topics discussed are: sales forecasting, product and process analysis including procurement, inventory handling and control, tool control, routing, scheduling, dispatching. Also treated are control mechanisms and systems.

Prerequisite: EM 210 or Undergraduate Industrial Management.

3 hours per week — 3 credits
First Semester — F, 7-10

EM 215 DESIGN OF AN ENTERPRISE — Dr. JAFFE

Organization and management of enterprises from initial planning through production and distribution of manufactured products. Each student will prepare a study for an industry of his choice.

Prerequisite: EM 201 or EM 210 and 211.

3 hours per week — 3 credits
First Semester — M, 7-10

EM 216 SEMINAR IN THE DESIGN OF AN ENTERPRISE — Dr. JAFFE

Each student will select an enterprise on the basis of the industry investigated in EM 215. The complete report of the design of the particular manufacturing enterprise will be prepared and reported in seminar.

Prerequisite: EM 215.

3 hours per week — 3 credits
Second Semester — M, 7-10

EM 217 PRODUCTION ENGINEERING ESTIMATING — Mr. DANCO

This course covers the work of the engineer in the field of production cost estimating and its evaluation by management. Special emphasis is placed on the principles and procedures used in cost estimating and its analysis with specific examples to illustrate the effect on selling price of various combinations of plant layout, tooling, product design, and machinery and equipment. Included subjects are: functional location and organization of an estimating department, material and cost estimating, distribution of burden, and managerial implications of predetermined costs.

Prerequisite: Bachelor's degree in science or engineering.

3 hours per week — 3 credits
First Semester — Offered 1961-1962 and alternate years — M, 7-10

EM 218 MANAGEMENT OF SMALL INDUSTRIAL PLANTS
Dr. JAFFE and Professor RIGASSIO

This course deals with management principles and practices as they are specifically applied to problems peculiar to "small" enterprise organization and operation. In addition to treating definitions of "small business," their place in the economy, recent trends, appraising "going" concerns, establishing and justifying new endeavors, etc., the course also emphasizes the "small business" aspect of such matters as financial resources, physical location and facilities, inventory and expense controls, sales and advertising promotion, pricing, credit, tax problems, and governmental and community relations.

Prerequisite: EM 210 and EM 211 or equivalent.

3 hours per week — 3 credits
Second Semester — M, 7-10

EM 223 PSYCHOLOGY IN ENGINEERING Professor CAMBRELENG

Psychology is reviewed historically to identify it with sciences already familiar to the engineer. Application of scientific methodology to psychology is discussed. Individual differences, individual variability, and integrated behavior are analyzed with respect to personnel selection and placement, training, rating, efficiency, conditions of work, and morale in the industrial scene.

Prerequisite: Bachelor's degree in science or engineering.

3 hours per week — 3 credits
First Semester — W, 7-10

EM 234 PLANNING AND MANAGEMENT OF INDUSTRIAL RESEARCH Dr. LEYES

An objective study of industrial research, covering management problems in the organization and operation of a research unit as well as methods used to solve research problems. This course is designed for both the individual research worker and those in various levels of supervisory capacities.

Prerequisite: Bachelor's degree in science or engineering.

3 hours per week — 3 credits
First Semester — W, 7-10

EM 235 MANAGEMENT OF DESIGN AND DEVELOPMENT
Professor RIGASSIO

The basic techniques and current practices for effective management of the engineering function. Includes engineering organization for machine and process design and development, project assignment and control, budgeting, work loads, forecasting, communications, progress reports, and engineering personnel practices. Emphasis is placed on liaison between the engineering function and those of research, manufacturing, accounting, and purchasing.

Prerequisite: BS in Engineering.

3 hours per week — 3 credits
Second Semester — W, 7-10

EM 241 LABOR AND THE LAW — Professor RICH

The following areas are treated in this course: early organization of unions and criminal conspiracy, free enterprise in England and America, judicial restriction, removal of judicial control, federal controls over expanding union power, some phases of the Wagner Act and the Taft-Hartley Act.

Prerequisite: Bachelor's degree in science or engineering.

3 hours per week — 3 credits
First Semester — Th, 7-10

EM 242 CONTEMPORARY COLLECTIVE BARGAINING

Professor RICH

The purpose of the course is to provide an analytical rather than a descriptive approach to the complex problems of management and union representatives. The analysis centers principally on managerial authority and the scope of collective bargaining, structural wage problems, the principal non-income objectives of collective bargaining, effective administration of collective agreements and the impact of public policy on collective bargaining.

Prerequisite: Bachelor's degree in science or engineering.

3 hours per week — 3 credits
Second Semester — Th, 7-10

EM 250 INTRODUCTORY OPERATIONS RESEARCH

Professor GOLDSTEIN

A survey course treating the foundations, methodology and applications of Operations Research. Topics treated include statistical techniques, theory of games, waiting line theory, symbolic logic, feed-back or servomechanism phenomena, information theory and linear programming. Operation Research teams and the utility of their findings to guide managerial decision is discussed. The practical limitations and the criteria of effectiveness for the several techniques is stressed.

Prerequisite: EM 203 or equivalent.

3 hours per week — 3 credits
Second Semester — F, 7-10

EM 251 LINEAR PROGRAMMING — Professor GOLDSTEIN

This course treats the methodology and practical applications of mathematical programming to complex problems in production and marketing. Emphasis is placed on problem formulation, the choice of criteria and the evaluation of results within the framework of managerial restrictions. Included are representative problems in such areas as: the allocation of plant facilities, personnel assignments, production scheduling, product mix, "make or buy," transportation. The use of modern high speed computers is treated as a tool in solving multivariable problems.

Prerequisites: EM 203 or equivalent.

3 hours per week — 3 credits
First Semester — Tu, 7-10

EM 255 INTRODUCTION TO SYSTEMS ENGINEERING AND ELECTRONIC DATA PROCESSING Professor GOLDSTEIN

Treating information flow in a company as an integrated system, the course discusses the engineering of electronic data processing systems which will optimize managerial requirements. Consideration is given to: systems studies, feasibility studies, the selection, installation, staffing and controlling of electronic data processing equipment. Particular attention is given to the coding and programming techniques of a typical large-scale computer.

Prerequisite: Permission of the Department. B.S. Degree in Science or Engineering.

3 hours per week — 3 credits
Second Semester — Offered 1961-1962 and alternate years — Tu, 7-10

EM 260 FINANCE OF INDUSTRIAL ENTERPRISE Dr. JAFFE

The principles and problems of financing research, design and development, production, personnel and distribution of product in an industrial enterprise. Access to capital for new designs or products; determination, establishment and operation of financial controls as related to management and cost controls; analysis and modification of financial structure to meet competitive challenge.

Prerequisite: Bachelor's degree in science or engineering.

3 hours per week — 3 credits
First Semester — Offered 1961-1962 and alternate years — Tu, 7-10

EM 271 INDUSTRIAL COSTING AND MANAGEMENT CONTROL Dr. JAFFE

The analysis and control of the "cost" aspects of industrial enterprises. Included are managerial controls, manufacturing and distribution costs, analytical financial statements, budgeting controls, and reports for executive direction.

Prerequisite: Principles of Accounting and EM 201, or EM 210 and 211 or equivalent.

3 hours per week — 3 credits
Second Semester — Tu, 7-10

EM 272 INDUSTRIAL QUALITY CONTROL Professor MIHALASKY

The management of quality control, development and treatment of the operational and statistical principles of acceptance sampling and process control, design of experiments, and special problems in control chart operation.

Prerequisite: EM 203 or equivalent.

3 hours per week — 3 credits
Second Semester — Offered 1961-1962 and alternate years — W, 7-10

EM 273 ADVANCED PERSONNEL MANAGEMENT Dr. JOHNSON
The course builds upon the basic techniques of the management of personnel; first, through a survey of current literature pertaining to recent developments in the field, and second through a study of the philosophy and techniques of personnel management currently existing in industry.

Prerequisite: Undergraduate Personnel Management or EM 212.

3 hours per week — 3 credits
Second Semester — Offered 1961-1962 and alternate years — F, 7-10

EM 274 JOB — POSITION EVALUATION AND WAGE DETERMINATION Adjunct Professor BISHOP
A study of the economic worth of both the employee and the job. It considers job analysis, job evaluation, merit rating, the economics of wages, wage plans, and related legislation.

Prerequisite: Undergraduate Industrial Management or EM 210.

3 hours per week — 3 credits
Second Semester — Offered 1960-1961 and alternate years — F, 7-10

EM 276 THE SCIENTIFIC SELECTION OF PERSONNEL Professor CAMBRELENG
A study of the modern criteria essential to scientific selection of personnel, work-job characteristics, analysis of tests for measuring occupational aptitudes, design of special tests, predicting job success.

Prerequisite: Undergraduate Personnel Management or EM 212.

3 hours per week — 3 credits
Second Semester — W, 7-10

EM 280 TECHNIQUES OF EXECUTIVE CONTROL Adjunct Professor BUSSE
First, an analysis and definition of the management philosophy as a distinct kind of work, and the many phases of industrial activity subject to executive control; and second, how to plan and organize effective managerial controls through successful executive conduct.

Prerequisite: EM 271 or previous training satisfactory to the Department.

3 hours per week — 3 credits
First Semester — Offered 1960-1961 and alternate years — F, 7-10

EM 290 DISTRIBUTION Dr. JAFFE
This course, specifically designed for graduate engineers, parallels courses usually given under the title of marketing in engineering schools. It places special emphasis on industrial marketing with particular concern for the relationship between production and distribution. Among the subjects treated are marketing research, distribution media, financial control, advertising, sales, materials

handling in storaging and warehousing, packaging and pricing. The material in this course has been closely integrated with the needs of engineers in this general field.

Prerequisite: Bachelor's degree in science or engineering.

3 hours per week — 3 credits
First Semester — Offered 1960-1961 and alternate years — Tu, 7-10

EM 292 SALES ENGINEERING MANAGEMENT

Adjunct Professor MEYSTRE

This course covers the broad areas of the Sales Engineer in the field of Sales Management: the planning and administration of sales management, the development of sales channels, the building of a sales organization and the use of modern selling techniques including operations research in the field of sales management. Some of the specific techniques are: determination of market and sales potentials, pricing, design and control of sales engineering personnel organization, territory determination, performance evaluation and compensation.

Prerequisite: Bachelor's degree in Science or Engineering.

3 hours per week — 3 credits
Second Semester — Tu, 7-10

EM 293 MANAGERIAL ECONOMICS — Dr. JAFFE and Professor RIGASSIO

This course analyzes modern industry and its practices from an economic viewpoint. It aims at using such analyses as aids not only in understanding industrial operations but also as guides in executive decisions. It draws on economic theory, practice and methods for treating managerial problems. Among the specific topics treated are: capital expenditure planning and control, divergent "cost" concepts, demand analyses, competitive practices, product policies, pricing theories practices and profit principles and measurement.

Prerequisites: EM 210 and EM 211 or equivalent.

3 hours per week — 3 credits
First Semester — Th, 7-10

EM 300 THESIS — Department Faculty

All candidates for the degree Master of Science in Management Engineering must submit an acceptable thesis on an approved subject. The thesis must be a desirable contribution to the literature of the field; it should preferably be an aid to the candidate's efforts in his present position or toward a potential position; while original research is not a requirement, the thesis should result in a new conclusion or application; the thesis should demonstrate the candidate's acquaintance with and knowledge of the accessible literature bearing on the subject.

Hours to be arranged — 6 credits
First, Second and Summer Semesters

With the permission of the department, preparation for thesis may be scheduled over one to four consecutive terms. Credit will be limited, however, to the six credits indicated for the subject. The charges for each term will be: Registration Fee—$5.00; Thesis—$5.00; Tuition—$66.00. If use of laboratory facilities or equipment is necessary, a $25.00 deposit must be maintained.

EM 311 RESEARCH IN MOTION AND TIME STUDY

To be announced

Experimental investigation of the variables in motion and time study procedures, and research in the preparation of universal elemental times. Development of existing motion and time practice into engineering tools is stressed.

Prerequisite: Undergraduate Motion and Time Study courses.

3 hours per week. Laboratory fee $10.00 each semester. 6 credits
First and Second Semesters W, 7-10

REQUIREMENTS OF THE DEPARTMENT OF MECHANICAL ENGINEERING

The Department of Mechanical Engineering offers the following degrees to qualified students:

Master of Science in Mechanical Engineering
Master of Science

Requirements for each degree are indicated below.

It is the intention of the Department to allow substantial latitude in the selection of courses so that areas of specialization and extension may be selected in terms of individual need. While it is not necessary that all of the departmental requirement (15 credit hours for Master of Science in Mechanical Engineering, 12 for Master of Science) be selected wholly from one of the areas in mechanical engineering listed below, it is essential that the final selection of courses encompass sufficient depth and breadth to reflect some mastery of the area of major interest. Frequently very satisfactory programs can be developed through thoughtfully selected combinations of courses from groups "a" or "b" and "c" or from groups "a" and "b". If group "c" is chosen as the area of concentration for the Master of Science in Mechanical Engineering degree, at least nine additional credits must be selected from group "a" and/or group "b". In the final analysis, the acceptability of the student's program of departmental requirements will be governed by the degree to which it represents a coordinated, cognate unit.

Electives may be selected from graduate courses offered by the Mechanical Engineering Department or by other departments. A wide choice of courses is available, provided the student satisfies necessary prerequisites. Final selection of courses in this area should constitute either the equivalent of a minor program in a field of secondary interest or a series of courses integrated with the program of departmental requirements in such a manner as to broaden or strengthen the major program.

Graduate courses offered by the Mechanical Engineering Department may be grouped as follows:

(a) *Behavior of Fluids*
- ME 201 Heat Transfer
- ME 202 Advanced Thermodynamics
- ME 203 Gas Turbines
- ME 204 Internal Combustion and Aircraft Engines
- ME 212 Dynamics of Compressible Fluids
- ME 214 Advanced Heat Transfer
- ME 215 Dynamics of Incompressible Fluids
- ME 216 Refrigeration and Air Conditioning Design

ME 218 Instrumentation *(formerly ME 209)*
ME 227 Steam Power Plant Design
ME 228 Steam Turbine Design
ME 301 Thesis

(b) *Stress Analysis and Machine Design*
ME 205 Advanced Machine Design
ME 206 Mechanical Vibrations
ME 208 High Speed Machinery
ME 217 Bearings and Bearing Lubrication
ME 223 Experimental Stress Analysis
ME 224 Photoelasticity
ME 230 Dynamics of Machinery
ME 301 Thesis

(c) *Behavior of Metals*
ME 210 Physical Metallurgy of Alloy Steels
ME 225 Advanced Metallurgy
ME 226 Corrosion
ME 229 Light Alloys
ME 301 Thesis

REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN THE DEPARTMENT OF MECHANICAL ENGINEERING

A. For the Master of Science in Mechanical Engineering candidates must select a minimum of fifteen credits from courses within the groups outlined above.

B. For the Master of Science candidates must select a minimum of twelve credits of courses that when grouped will provide an area of major interest.

Courses Offered by the Department of Mechanical Engineering

ME 201 HEAT TRANSFER Professor STAMPER
The theory and practice of heat transfer. Critical examination of the laws of conduction, convection and radiation; dimensional analysis; combined heat transfer; the heat flow differential equation applied to steady and unsteady flow; empirical methods.

Prerequisite: Undergraduate Differential Equations and Applied Heat Power.

3 hours per week — **3 credits**
First Semester — **M, 7-10**

ME 202 ADVANCED THERMODYNAMICS Professor FULLER
Consideration of topics which are hastily treated or intentionally avoided in an undergraduate course in thermodynamics. Basic theory

will be solidified and expanded and emphasis will be placed on the physical implications of the theory.

Prerequisite: Undergraduate Differential Equations, Fluid Mechanics and Heat Power.

3 hours per week — 3 credits
Second Semester — M, 7-10

ME 203 GAS TURBINES — Professor JACOBS

Fundamental considerations in the design and development of the gas turbine power plant for stationary and mobile applications. Detailed study of cycles and components. Analysis and design of compressors, combustion chambers, turbines and turbo-jets.

Prerequisite: Undergraduate courses in Differential Equations and Applied Heat Power.

3 hours per week — 3 credits
First Semester — Th, 7-10

ME 204 INTERNAL COMBUSTION AND AIRCRAFT ENGINES

Professor SCHMERZLER

Basic theory and practice relating to the design and performance of reciprocating internal combustion engines. Analysis of aircraft propellers and performance of aircraft engines at high altitude. Design of centrifugal and turbo superchargers for internal combustion engines.

Prerequisite: Undergraduate courses in Differential Equations and Applied Heat Power.

3 hours per week — 3 credits
Second Semester — Offered 1961-1962 and alternate years — Th, 7-10

ME 205 ADVANCED MACHINE DESIGN — Professor PREDALE

Advanced analysis of threaded members; keyed, splined, and shrink fits when subject to torque; the flywheel as an indeterminate structure; preloaded bearings; surging, presetting and buckling of coiled springs; accurate analysis of impact stresses, and stresses beyond the yield point.

Prerequisite: Undergraduate Differential Equations and Senior Machine Design.

3 hours per week — 3 credits
First Semester — Tu, 7-10

ME 206 MECHANICAL VIBRATIONS — Professor MICHELS

Mathematical analysis of vibrating systems with one or more degrees of freedom; Lagrange's equation of motion; solution of characteristic equations by the method of matrices; Rayleigh-Ritz and Holzer's methods.

Prerequisite: Undergraduate Differential Equations and Kinetics.

3 hours per week — 3 credits
Second Semester — F, 7-10

ME 208 HIGH SPEED MACHINERY Professor PREDALE

This advanced course treats of the requirements introduced by the preponderance of centrifugal and dynamic forces in machine parts at high speed.

Prerequisite: Undergraduate Differential Equations and Senior Machine Design.

3 hours per week — 3 credits
Second Semester — Th, 7-10

ME 210 PHYSICAL METALLURGY OF ALLOY STEELS

Professor BANNON

Study of the effects of alloy additions on the constitution and properties of the iron-carbon system with special emphasis on transformation products and tempering results.

Prerequisite: Undergraduate course in Metallurgy.

3 hours per week — 3 credits
Second Semester — Tu, 7-10

ME 212 DYNAMICS OF COMPRESSIBLE FLUIDS

Professor SMITHBERG

Gas flow theory as applied to one, two and three dimensional study of compressible fluids flowing externally and internally. Subsonic and supersonic flows; shock waves, supersonic wing theory; gas flow through ducts, with friction and heat addition; nozzles; diffusers; viscosity effects in compressible flow.

Prerequisites: Undergraduate Differential Equations, Fluid Mechanics and Heat Power.

3 hours per week — 3 credits
Second Semester — Th, 7-10

ME 214 ADVANCED HEAT TRANSFER Professor LEVY

Theory and design of high rate heat transfer with emphasis on techniques involved in thermal design of nuclear reactors. Analytical, digital and analog computer methods for transient and steady state high rate heat transfer problems including conduction, convection, radiation and heat generation.

Prerequisite: ME 201 Heat Transfer.

3 hours per week — 3 credits
Second Semester — F, 7-10

ME 215 DYNAMICS OF INCOMPRESSIBLE FLUIDS

Professor SMITHBERG

Incompressible fluid flow theory; hydrodynamics of ideal fluids; incompressible viscous fluid flow; surface and form resistance; dimensional analysis; applications to incompressible fluid flow through pipes, fluid meters, and turbomachinery.

Prerequisites: Undergraduate Differential Equations, Fluid Mechanics and Heat Power.

3 hours per week — 3 credits
First Semester — W, 7-10

ME 216 REFRIGERATION AND AIR CONDITIONING

Professor STAMPER

The theory and design of modern refrigeration and air conditioning systems. Analysis of absorption, steam jet and refinements of vapor compression cycles. The study of cooling towers, spray apparatus, central air conditioning systems, heat pumps and controls and transient problems are implemented by means of design projects.

Prerequisite: Undergraduate Differential Equations, Fluid Mechanics and Applied Power.

3 hours per week — 3 credits
Second Semester — Tu, 7-10

ME 217 BEARINGS AND BEARING LUBRICATION Professor MICHELS

A lecture course on the theoretical and physical aspects of lubrication considering the classical hydrodynamic theory and the solution of Reynold's differental equation for the pressure distribution in journal bearings with and without end leakage.

Prerequisite: Undergraduate Differential Equations and Senior Machine Design.

3 hours per week — 3 credits
First Semester — F, 7-10

ME 218 *(formerly ME 209)* INSTRUMENTATION Professor JACOBS

Theory and design of the primary elements of instrumentation. Design criteria of pressure, temperature and speed measurement elements. Application of instrumentation in the fields of fluid mechanics and combustion. Emphasis on response time and primary instrumentation in automation. Laboratory covering fabrication techniques and testing of various configurations.

Prerequisite: Undergraduate Differential Equations, Fluid Mechanics and Applied Heat Power.

3 hours per week — 3 credits
Second Semester — W, 6:30-10

ME 223 EXPERIMENTAL STRESS ANALYSIS Professor MILLER

A lecture and laboratory course dealing with two and three dimensional stresses and strains; static, dynamic and impact strain measurements with bonded wire strain gages; strain rosettes; brittle coatings for stress analysis; residual stresses and their evaluation; dimensional analysis.

Prerequisite: Undergraduate Differential Equations and Strength of Materials.

3½ hours per week. Laboratory fee $15.00 — 3 credits
First Semester — Th, 6:30-10

ME 224 PHOTOELASTICITY — Professor MILLER

Two dimensional stress analysis, isoclinics and stress trajectories in bending, tension and combined loading. The Lamé-Maxwell equation and the integration of principal stresses along stress trajectories. Three dimensional stress analysis — torsion and centrifugal forces in bars and disks. Frozen stress patterns.

Prerequisite: Undergraduate Differential Equations and Strength of Materials.

3½ hours per week. Laboratory fee $15.00 — 3 credits
Second Semester — M, 6:30-10

ME 225 ADVANCED METALLURGY — Professor BANNON

A combined lecture and laboratory course dealing with multi-metal systems, both ferrous and non-ferrous, the working of metals and the principle of heat-treatment techniques. Laboratory experiments are designed to illustrate the principle points developed. Some original experimentation will be carried out.

Prerequisite: Undergraduate courses in Metallurgy and Metallography.

3½ hours per week — 3 credits
First Semester — W, 6:30-10

ME 226 CORROSION — Mr. WEISMAN

General nature and theories of corrosion; influence of manufacturing methods and composition of metals; laboratory test methods; protection against various forms of corrosion; lecture material supplemented by selected laboratory tests.

Prerequisite: B.S. in science, engineering or closely allied field.

3½ hours per week. Laboratory fee $15.00 — 3 credits
Repeated Each Semester — W, 6:30-10

ME 227 STEAM POWER PLANT DESIGN — Professor POLANER

Advanced analysis of vapor power cycles including economic considerations; evaluation of performance characteristics of turbines, pumps, boilers, heaters, condensers and auxiliaries; calculations included in the design of important components; adaptation to special conditions of service.

Prerequisite: Undergraduate Applied Heat Power.

3 hours per week — 3 credits
First Semester — Tu, 7-10

ME 228 STEAM TURBINE DESIGN — Mr. BENCZE

Mechanical and thermal considerations underlying the use of steam in turbines of various types; calculations involved in turbine design; evaluation of performance characteristics; adaptation to special conditions of service.

Prerequisite: Undergraduate Applied Heat Power and Fluid Mechanics.

3 hours per week — 3 credits
Second Semester — F, 7-10

ME 229 LIGHT ALLOYS — Professor SCHNEIDER

A combined lecture and laboratory course dealing with aluminum and magnesium alloys. Laboratory experiments are so designed as to bring out the points discussed in the lectures.

Prerequisite: Undergraduate courses in Metallurgy and Metallography.

3½ hours per week. Laboratory fee $15.00 — 3 credits
First Semester — Offered 1961-1962 and alternate years — Th, 6:30-10

ME 230 DYNAMICS OF MACHINERY — Professor MILLER

An advanced treatment of mechanical elements, linkages, cams, gears and miscellaneous mechanisms; dynamic consideration, including inertia and gyroscopic effects commonly encountered in the design of automatic machinery and control mechanisms; impulse loads and transient conditions of motion; mechanical computing devices, multicylinder balancing, and governor control will be among the topics examined.

Prerequisite: Undergraduate Differential Equations and Senior Machine Design.

3 hours per week — 3 credits
Second Semester — W, 7-10

ME 301 THESIS — Department Faculty

A written report involving experimental research, original analysis, design or development in the field of Mechanical Engineering. Discussions of the analytical and experimental solution of the assigned projects and a review of current literature will be held in the form of a seminar.

Prerequisite: Departmental Approval.

Hours to be arranged — 6 credits
First and Second Semester

With the permission of the department, preparation for thesis may be scheduled over one to four consecutive terms. Credit will be limited, however, to the six credits indicated for the subject. The charges for each term will be: Registration Fee—$5.00; Thesis—$5.00; Tuition—$66.00. If use of laboratory facilities or equipment is necessary, a $25.00 deposit must be maintained.

COURSES OFFERED BY THE DEPARTMENT OF CHEMISTRY

Chem 348 SANITARY BIOLOGY AND CHEMISTRY
Professors BAUDER and RAM

A lecture and laboratory course covering the chemistry and bacteriology of water and sewage. Types and distribution of bacteria in water, sewage and certain foodstuffs such as milk and shellfish are examined and studied in relation to problems of sanitation and public health. Chemical treatment and purification methods are included. *Note: This course is not available for graduate credit to students who have completed Chem 48, or the equivalent.*

Prerequisite: An undergraduate course in chemistry.

3 hours per week. Laboratory fee $15.00. 6 credits
First and Second Semesters Offered 1960-1961 and alternate years F, 7-10

COURSES OFFERED BY THE DIVISION OF HUMANITIES

Hu 80 FOREIGN LANGUAGES FOR ENGINEERS To be announced

A course directed towards the reading of scientific and technical literature in the original languages. The language offered in any year will depend on student requests and registration. Either German, French or Russian will be considered. Where necessary and on sufficient registration two sections will be offered, one for those with some previous knowledge of the language and another for beginners.

4 hours each week No graduate credit
First and Second Semesters Tu, 7-9; F, 7-9

Hu 200 TECHNICAL PUBLICATION AND EDITING Dr. ESTRIN

A seminar dealing with the production and editing of technical writing on the professional level and problems of publication from both the writer's and the editor's point of view. Students will be assisted indvidually with their writing — either work already in progress or new work. Representative editors and publishers of technical books and periodicals will visit the seminar as lecturers and consultants. Students from any department of the Graduate Division will be accepted after consultation with the instructor.

3 hours per week 3 credits
Repeated Each Semester M, 7-10

COURSES OFFERED BY THE DEPARTMENT OF MATHEMATICS

Ma 220 MODERN ALGEBRA AND SEMINAR ON APPLICATIONS
Dr. FOSTER

The course involves the development of mathematical concepts requisite for study of the applications of modern algebra to engineering and science. The course begins with elementary number theory and Boolean Algebra. Special emphasis is placed on matrices and their applications derived from material in current engineering research journals. Other topics in the field will be discussed in accordance with the interest of the students.

Prerequisite: Undergraduate Calculus and preparation satisfactory to the Department of Mathematics.

3 hours per week — 3 credits
Repeated Each Semester — Th, 7-10

Ma 251 ADVANCED CALCULUS I — Dr. ZATZKIS

Advanced mathematical methods useful in the analysis of engineering problems. The course will cover a number of selected topics from the following list: Infinite series, elliptic integrals, elliptic functions, Gamma functions, Beta functions, Laplace Transforms, partial differentiation.

Prerequisite: Differential and Integral Calculus.

3 hours per week — 3 credits
First Semester — M, 7-10 1st semester
Repeated Each Semester — Tu, 7-10 2nd semester

Ma 252 ADVANCED CALCULUS II — Dr. ZATZKIS

Companion course to Ma 251, but independent of it. Subject matter included: advanced topics in vector analysis, elements of tensor analysis, calculus of variations with applications to analytical dynamics, determinants and matrices, Jacobian functional determinants, calculus of finite difference equations, application of conformal mapping to boundary value problems. The choice of specialized topics will be determined by the interest of the students.

Prerequisite: Differential and Integral Calculus.

3 hours per week — 3 credits
Second Semester — M, 7-10

Ma 255 FOURIER SERIES AND ORTHOGONAL FUNCTIONS
Dr. ZATSKIS

The course deals primarily with Fourier Series and their applications to boundary value problems of physics, but it also considers the more general theory of orthogonal sets of functions, and deals briefly with Bessel functions, Legendre polynomials and applications.

Prerequisite: One year of Calculus.

3 hours per week — 3 credits
First Semester — W, 7-10

Ma 256 FUNCTIONS OF A COMPLEX VARIABLE Dr. FOSTER
This course contains a substantial introduction to the theory of functions of a complex variable, with emphasis on those parts which are most useful in applications. The applications include the uses of the theory of residues and contour integrals in the evaluation of real integrals.

Prerequisite: Differential and Integral Calculus.

3 hours per week — 3 credits
Second Semester — W, 7-10

Ma 261 MATHEMATICAL STATISTICS Professor BARKAN
This course develops the fundamental notions of statistics necessary for the analysis of numerical data. Special attention is given to the problem of determining when statistical methods are appropriate. Case histories of the proper and improper use of statistics are considered.

Prerequisite: Differential and Integral Calculus.

3 hours per week — 3 credits
First Semester — Tu, 7-10

Ma 262 STATISTICAL INFERENCE Professor BARKAN
This course considers inferences about populations based on samples, design of experiments, elementary decision theory, minimax principle.

Prerequisite: Differential and Integral Calculus.

3 hours per week — 3 credits
Second Semester — Tu, 7-10

Ma 273 DIFFERENTIAL EQUATIONS I Dr. KOREN
Ordinary differential equations with applications to engineering problems. The course is intended to be primarily useful—questions of existence are omitted.

Prerequisite: Differential and Integral Calculus.

3 hours per week — 3 credits
Repeated Each Semester — Th, 7-10 1st semester
Tu, 7-10 2nd semester

Ma 274 DIFFERENTIAL EQUATIONS II Dr. KOREN
A companion course to Ma 273, dealing with partial differential equations, with emphasis on those of physics and their solutions by means of Fourier series, Bessel functions, and Legendre polynomials.

Prerequisite: Ordinary Differential Equations.

3 hours per week — 3 credits
Second Semester — Th, 7-10

COURSES OFFERED BY THE DEPARTMENT OF PHYSICS

Phys 202 HISTORY OF THE PHYSICAL SCIENCES Dr. ORENS
An outline of the development of science and technology from pre-

history to the present. The role of science and technology in history, their contribution to the evolution of human institutions and impact on philosophical inquiry are examined, analyzed, and applied for the development of an historical perspective towards a more comprehensive understanding of their meaning and function in the structure of contemporary civilization.

Prerequisite: Bachelor's degree in science, engineering, or closely allied fields. Required of all students.

3 hours per week — 3 credits
Repeated Each Semester — W, 7-10 1st semester
Tu, 7-10 2nd semester

Phys 206 THEORY OF ELASTICITY — Professor WILLIAMS

The Theory of Elasticity is studied as a basis for both advanced stress analysis and for a critical examination of elementary stress analysis.

Prerequisite: Differential Equations.

3 hours per week — 3 credits
Second Semester — M, 7-10

Phys 208 ADVANCED MECHANICS — Dr. REFF

A study of particle dynamics with special emphasis on problems dealing with vibration and central forces; the dynamics of a rigid body; gyroscopic motion. Lagrange's and Hamilton's equations will be applied to simple problems in physics and engineering.

Prerequisite: Undergraduate Mechanics.

3 hours per week — 3 credits
First Semester — F, 7-10

Phys. 209 ADVANCED STRENGTH OF MATERIALS

Professor RAMBERG

Some of the topics beyond the scope of elementary Strength of Materials are studied with particular emphasis on the assumptions and bases of the derivations and on applications to actual problems.

Prerequisite: Undergraduate Strength of Materials.

3 hours per week — 3 credits
First Semester — M, 7-10

Phys 211 TRANSISTOR PHYSICS — Professor TOWFIK

An introduction to modern physical theories with special emphasis on the free electron and band theory of metals, followed by a study of semiconductors, particularly conductivity, Fermi-Dirac statistics, Hall effect, mobility and crystal imperfections and concluding with the theory of p-n junctions and p-n-p transistors.

Prerequisite: Degree in engineering, science or closely allied field.

3 hours lecture per week — 3 credits
First Semester — Tu, 7-10

Phys 220 MODERN PHYSICS Dr. HOFFMANN

Wave and particle nature of light, matter, and energy; experimental determination of the values of important physical constants; particle beams in electric and magnetic fields; the special theory of relativity; assemblies of particles, wave-particle experiments leading to quantum concepts and wave mechanics; the Schroedinger equation applied to simple problems; atomic structure and spectra; molecules; binding and energy bands in solids; electrical, thermal, and magnetic properties of solids.

Prerequisite: Differential Equations.

3 hours per week — 3 credits
First Semester — Tu, 7-10

Phys 221 NUCLEAR PHYSICS Dr. HOFFMANN

A brief introduction to atomic physics gives insight into the vector model of the atom, the Pauli principle and electron spin. The remainder of the course is concerned with the constitution of the nucleus, isotopes, natural radioactivity and the laws of radioactive transformations, induced nuclear disintegration, induced radioactivity, alpha, beta, gamma decay, nuclear reactions and forces, and nuclear structure.

Prerequisite: Phys 220—Modern Physics.

3 hours per week — 3 credits
Second Semester — Tu, 7-10

Phys 222 ELEMENTS OF NUCLEAR ENGINEERING Dr. MALAKER

The production, detection and interaction of neutrons with matter in a nuclear reactor; nuclear fission; discussion of various types of reactors; reactor theory, including the slowing-down of neutrons, the multiplication factor, diffusion theory, Fermi age, criticality factor and critical reactor dimensions; a brief consideration of radiation shielding and reactor instrumentation and control.

Prerequisite: Phys 220—Modern Physics.

3 hours per week — 3 credits
First Semester — M, 7-10