NEWARK COLLEGE OF ENGINEERING

1881

NCE

NEW JERSEY

GRADUATE COURSES

1964 1965

JANUARY, 1964

DIRECTORY FOR CORRESPONDENCE

Mailing Address: 323 High Street, Newark, N. J. 07102

Telephone: Area Code 201, 624-2424

Matters of General College Interest:
Address the President.

Admissions:
For information concerning the Master's Degree address the Dean of Admissions. Telephone: Ext. 257; for the Doctoral Program, address the Director, Graduate Division. Telephone: Ext. 359.

Registration:
Address the Registrar. Telephone: Ext. 369.

Alumni Activities:
Address Alumni Secretary. Telephone: Ext. 364.

Financial Matters:
Address the Business Manager. Telephone: Ext. 218.

Special Courses Admission or Program:
For all information concerning special courses programs and admissions, etc., address the Director of Special Courses. Telephone: Ext. 366.

Employment of Seniors and Graduates:
Address the Office of Industrial Relations. Telephone: Ext. 363.

Counseling:
Address the Counseling Center. Telephone: Ext. 263.

Transcripts:
For transcripts and student grades, address the Records Supervisor. Telephone: Ext. 229.

Veterans:
For information on veteran status, address the Veterans' Coordinator. Telephone: Ext. 379.

Research Foundation:
Address the Secretary. Telephone: Ext. 243.

Plant, Equipment, and Utilities:
Address the Plant Engineer. Telephone: Ext. 270.

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 school year. The Registrar's Office and the Finance Office are 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 4:00 P.M., Monday through Friday, while the Registrar's Office and the Finance Office are open between the hours of 6:00 P.M. and 9:00 P.M., Monday through Thursday.

NEWARK COLLEGE OF ENGINEERING

GRADUATE COURSES

1964 1965

The BULLETIN
PUBLISHED BY
THE BOARD OF TRUSTEES
OF SCHOOLS FOR INDUSTRIAL EDUCATION
OF NEWARK, N. J.

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COLLEGE CALENDAR: 1964-65

GRADUATE DIVISION

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

1964

Registration—Fall Semester	In accordance with instructions to be issued.
Fall Semester Begins	September 23
Thanksgiving Holidays	November 25 to 28 inclusive
Christmas Holidays	December 21 to January 2 inclusive

1965

Fall Semester Ends	January 23
Registration—Spring Semester	In accordance with instructions to be issued.
Spring Semester Begins	February 15
Washington's Birthday Holiday	February 22
Spring Vacation	April 12 to 17 inclusive
Memorial Day Holiday	May 31
Spring Semester Ends	June 4
Commencement (tentative)	June 10
Registration—Summer Session*	June 18
Summer Session Begins	June 21
Independence Day Holiday	July 5
Summer Session Ends	August 13

*Summer Session announcement will be available on or about April 1.

NEWARK COLLEGE OF ENGINEERING

NEWARK, NEW JERSEY

Supported by the State of New Jersey and the City of Newark

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Chairman, Department of Industrial and Management Engineering

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January 1, 1964

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* Licensed Professional Engineer.

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† Member, New Jersey Bar.
** Licensed Health Officer, State of New Jersey.

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Professor in Mathematics.

STEVEN M. ZIMMERMAN, B.S., M.S.
Assistant Professor in Management Engineering.

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* Licensed Professional Engineer.

GENERAL INFORMATION

THE GRADUATE DIVISION

Since 1919 Newark College of Engineering has offered courses leading to the degrees of Bachelor of Science in Chemical, Civil, Electrical and Mechanical Engineering. In 1960 the degree of Bachelor of Science in Industrial Engineering was added.

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.

By authorization of the New Jersey State Board of Education, the Board of Trustees of the College is empowered to confer the degrees of Master of Science in Chemical, Civil, Electrical, Management, and Mechanical Engineering. In addition, the Board is further empowered to confer the M.S. degree upon successful candidates who elect to undertake graduate studies with a major emphasis on basic engineering science or mathematics, or who wish to diversify their engineering studies by including two engineering areas.

In 1960 the Board of Trustees was authorized to offer the degree of Doctor of Engineering Science in the Departments of Chemical and Electrical Engineering. Applicants for admission to these programs are presently restricted to students who hold the degree of Master of Science in Chemical Engineering or the degree of Master of Science in Electrical Engineering.

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 — 1963-1964," 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.

COLLEGE LIBRARY

The College Library occupies the third floor of Weston Hall. The reading room has chairs for two hundred students and provides a suitable environment for serious study.

The book collection consists of more than 40,300 volumes, including bound back files of the more important engineering and physical science periodical publications. Numerous unbound runs of essential journals, government bulletins, and booklets add to the

library's informational resources. The current periodical subscription list numbers some five hundred titles and includes the periodical indexes and abstract journals required to locate specific data quickly. Books and magazines are selected with emphasis on the fields of study offered by the College.

The resources of the College Library are supplemented by easy access to other libraries in the community; by means of interlibrary loan relationships with other libraries across the nation; and by the availability of printed material in photocopy and microfilm form.

Memorial gifts from the personal libraries of men formerly associated with the College have been received. Foremost among these gifts are books and periodicals from the collections of former Trustee Dr. Edward Weston and State Senator Roy V. Wright. During the past five years the Society of Plastics Engineers has purchased and presented to the Library approximately 50 current books and several periodical subscriptions in the field of plastics.

FELLOWSHIPS

Through the College and its Research Foundation, fellowships are available to graduate students to enable them to pursue a combined program of research, teaching and study leading to the master's degree. It normally takes two years to earn the degree under the fellowship program, and the fellowships are renewable for the second year. Inquiries and applications should be directed to the Vice-President.

Holders of fellowships who are engaged in part-time teaching under the program of the Research Foundation are required to register for and attend the seminar, G 200: *Seminar on Engineering Education,* which is directed toward analyzing and discussing the fundamentals of college teaching in the field of Engineering. The seminar is also open to all assistants and instructors not directly connected with the Research Foundation program. For a description of the course see page 86.

Howard B. Begg Fellowship

Established in the name of the originator of the NCE Executive Development Conferences, this fellowship provides tuition up to $200 per year for a student registered in the Industrial and Management Engineering Department. A student who has selected management as a career, exhibited potential for management responsibility, and has need of financial assistance, is chosen annually by the Department from among applicants for this fellowship.

IN-SERVICE INSTITUTES

Under the sponsorship of the National Science Foundation and the Newark College of Engineering Research Foundation, courses

are offered to qualified teachers in the High Schools of the City of Newark and other communities enabling them to become familiar with the most recent advances in Chemistry, Mathematics and Physics. These courses are administered by the Graduate Division and the course offered in each field is designed to increase the teacher's knowledge of the field, to familiarize him with the techniques necessary for successful teaching in the field and to provide a foundation for continued and more advanced work in the area of specialization selected. Information on admission and course content may be obtained by communicating with the Director of In-Service Institutes, Newark College of Engineering, Newark, New Jersey 07102.

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 who register for additional courses.

Special Students

1. Students who are not qualified for admission but who 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 Director 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.

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 Director of the Graduate Division.

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 1964-1965

Regular Fees

Tuition (residents of New Jersey)	$22.00	per credit
Tuition (non-residents of New Jersey)	32.00	per credit
Registration Fee (Day)	10.00	per semester
Registration Fee (Evening)	5.00	per semester
General Fee	3.00	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.

A MATRICULATION FEE of $5.00 is required upon acceptance as a candidate for a Master's degree. (See page 25.)

A CANDIDACY FEE of $20.00 is required upon acceptance as a candidate for a Doctor of Engineering Science degree. (See page 36.)

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.

The GENERAL FEE of $3.00 per semester represents the graduate student's share of the cost of student-life facilities services.

A GRADUATION FEE of $25.00 is required of all candidates for degrees. 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 Director 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 Director 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.

Leave of Absence

A student enrolled for a degree program in the Graduate Division who finds it necessary to interrupt his program of studies for any reason should consult his adviser concerning procedures to be followed for "leave of absence."

Refunds

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

If a refund is approved by the Board of Trustees, the percentage of tuition, and laboratory and general 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 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 changes his schedule, he must fill out a set of 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.

If the dropping of a course, or courses, causes the change to be classified as a withdrawal from College, the student should follow the procedures stipulated in the section "Withdrawals from College —General," above.

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 graduate 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.

S — Satisfactory

or

U — Unsatisfactory —

These will be used as final grades for doctoral seminars; or as progress grades for thesis work (masters or doctoral), excepting at the end of the final semester of the thesis work.

W — Withdrawal

TIME AND PLACE OF CLASSES

Room and laboratory assignments will be announced on the bulletin boards of the Graduate Division at the close of registration week. (See page 39.)

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

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.

Each prospective candidate for any degree must file an Application for Candidacy prior to the opening of the spring semester of the year in which the candidate expects to graduate. 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 the Master's 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.

MASTER OF SCIENCE PROGRAMS

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.

The degree of Master of Science (M.S.) in areas of Engineering Science is offered to qualified students whose bachelor's degree is in engineering, mathematics, or the physical sciences. The programs of study are interdisciplinary in emphasis and are designated to meet the interests of the individual student.

Among the areas within the scope of the program are: advanced chemistry; polymer chemistry; theoretical and applied mechanics; theoretical physics; solid state physics; nuclear physics and engineering; computer theory, design, and operation; and advanced engineering mathematics. Other areas may be added as interest indicates.

Required courses within these areas are specified after consultation by the student with the adviser assigned and in accordance with the general outline of requisites indicated under "Requirements for Degrees, Section B" of this catalog. E.Sc. 200 or E.Sc. 300 is required of all students matriculating under this program.

ADMISSIONS

An applicant for admission to a Master's program 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 August 1 to be eligible for the fall semester and by

January 1 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, or by his representative.*

GENERAL REQUIREMENTS FOR DEGREES

Two programs are available to Master's degree students of the Graduate Division. The general requirements for these degrees are given below.

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 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

This degree will require of the student the following:

1. Graduation from an ECPD and regionally accredited college of engineering.

   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 must be selected to form a correlated group within an area of specialization. The area of specialization must be approved by the Director of the Graduate Division and the courses must receive the approval of the student's adviser. 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 rules govern the submission of grades in candidacy for either the Master of Science in a specified field of Engineering, or the Master of Science degree for students matriculating after June 30, 1951 and regulate the time requirements for such degrees:

1. 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.
2. The Master's degree will be granted only to those students 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.

MATRICULATION

Admission to studies in the Graduate Division does not imply matriculation. If a student wishes to become a candidate for the Master's degree, he must obtain an application for matriculation at the office of the Graduate Division and indicate on the application his fulfillment of these conditions:

1. Satisfactory completion of 15 credits of graduate work.
2. The approval, by signature of his adviser, of the student as a candidate for an advanced degree.
3. Payment of the matriculation fee.

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 nine 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 Director, 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.

DEPARTMENTAL REQUIREMENTS

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 recog-

nized 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.

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

ChE 223 Heat Transfer and Fluid Flow or
ChE 224 Transport Phenomena (3)
ChE 312 Advanced Unit Operations Laboratory (3)
ChE 300 Thesis (6)

and six points selected from the following areas of specialization:

(1) Chemical Engineering Practice:
ChE 207 Electrochemical Engineering
ChE 217 Adsorption
ChE 220 Petroleum Refining
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 224 Transport Phenomena
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 300 Thesis (6)
and six points selected from groups 1 to 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.

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.

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.

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 VIII. Others will be required to take such undergraduate prerequisites as may be needed and some or all of the following basic graduate courses:

Ma 100—Vector and Tensor Analysis
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 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

offerings of the Department have been divided into the following fields of specialization:

I Electric Circuit Design and Synthesis:
EE 229, 248, 252, 253, 256, 273, 274, 276, 339

II Automatic Control and Industrial Electronics:
EE 245, 250, 261, 262, 263, 264, 265, 266, 466, 467

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

IV Communication Theory:
EE 229, 243, 244, 273, 274, 276, 339, 450

V Communication Devices:
EE 242, 246, 247, 250, 268, 269, 270, 339, 448

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

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

VIII Fields and Waves:
EE 222, 223, 246, 247, 424, 447

IX Electronic Systems Reliability:
EE 211, 250, 273, 274, 275, 339, 450, 451

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.

DEPARTMENT OF INDUSTRIAL AND MANAGEMENT ENGINEERING

The Department of Industrial and Management Engineering subscribes to the philosophy that graduate study in this field is applicable to four specialization 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 curriculums 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 recommended objective for the graduates of an engineering curriculum whose careers are in, or moving toward, management in an engineering-scientific oriented enterprise. The degree *Master of Science* is the recommended objective for those holders of B.S. degrees who have majored in Mathematics, Physics, or Chemistry, as well as for those graduates of an engineering curriculum whose

careers are in, and likely to remain in, technical work but who desire a knowledge of a lesser body of the management field. For either degree, the candidate must offer, as prerequisites, EM 110 and EM 111 or their undergraduate equivalents.

For the degree *Master of Science in Management Engineering* the student must include the following fifteen specialization credits:

EM 201 — Advanced Management Engineering (3)
EM 203 — Analytical Engineering Statistics (3)
EM 250 — Introductory Operations Research (3)
EM 300 — Thesis (6)

The nine elective credits may be chosen from those listed in the student's chosen area of managerial activity, from another area of managerial activity, or from courses offered by other departments, depending upon the courses necessary to prepare the student properly for the Thesis.

For the *Master of Science* degree the twelve specialization credits must include:

EM 215 — Design of an Enterprise (3)
EM 216 — Seminar in the Design of an Enterprise (3)

and two other three-credit courses chosen from one area of managerial activity. The twelve elective credits may be chosen from any one area of managerial activity, or from other departments' offerings, provided they comprise an integrated area of knowledge.

Graduate courses in the Department of Industrial and Management Engineering are grouped by areas of managerial activity as follows:

Group I—Management of Research, Design, and Development

EM201 Advanced Management Engineering
EM203 Analytical Engineering Statistics
EM204 Advanced Analytical Engineering Statistics
EM205 Engineering Reliability
EM215 Design of an Enterprise
EM216 Seminar in Design of an Enterprise
EM223 Psychology in Engineering
EM234 Planning and Management of Industrial Research
EM235 Management of Design and Development
EM250 Introductory Operations Research
EM251 Linear Programming
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

EM201 Advanced Management Engineering
EM203 Analytical Engineering Statistics
EM204 Advanced Analytical Engineering Statistics
EM205 Engineering Reliability
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

EM201 Advanced Management Engineering
EM203 Analytical Engineering Statistics
EM204 Advanced Analytical Engineering Statistics
EM212 Personnel Management
EM215 Design of an Enterprise
EM216 Seminar in Design of an Enterprise
EM223 Psychology in Engineering
EM241 Labor and the Law
EM242 Contemporary Collective Bargaining
EM250 Introductory Operations Research
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

EM201 Advanced Management Engineering
EM203 Analytical Engineering Statistics
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.

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 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
ME 219 Mechanics of Viscous Fluids
ME 227 Steam Power Plant Design
ME 228 Steam Turbine Design
ME 232 Statistical Thermodynamics
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 234 Design of Plates and Shells
ME 235 Random Vibrations
ME 301 Thesis

(c) *Behavior of Metals*

ME 210 Engineering Metallurgy of Alloy Steels
ME 225 Advanced Metallurgy
ME 226 Corrosion
ME 229 Light Alloys
ME 233 Principles of Physical Metallurgy
ME 301 Thesis

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

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.

DOCTOR OF ENGINEERING SCIENCE PROGRAMS

The impact of recent advances in science and engineering and the acceleration of research demands, not only for industry and defense but to an equal degree for education, have made doctoral programs mandatory. There is a growing and insistent need for qualified scholars to move into the frontiers of scientific and engineering knowledge and to transmit the consequent advances to the classrooms and laboratories of our institutions of higher learning. Responsive to such requirements, Newark College of Engineering has formulated programs leading to the degree of *Doctor of Engineering Science.* At the present time these programs are restricted to the Departments of Chemical Engineering and Electrical Engineering but their extension to other fields is contemplated for the future.

ADMISSION

An applicant for admission to the doctoral program must submit, in a letter addressed to the Director of the Graduate Division, an outline of his personal and academic background and his reasons for wishing to undertake doctoral studies. The applicant must also submit two transcripts of all previous academic work beyond the secondary school.

The application fee of $5.00 must accompany the letter, in check or money-order, payable to Newark College of Engineering.

Three letters of recommendation are required, one from each of the following:

a. The chairman or advisor of the department of major study in the applicant's undergraduate school;

b. The chairman or advisor of the department of major study in the graduate school that conferred the applicant's master's degree;

c. An employer, or other person, familiar with the applicant's professional work or activity.

When all letters, transcripts, and credentials have been received, the applicant will be notified to make an appointment for an interview with an advisor in his department of major study.

Admission will be predicated on satisfactory evidence of probable success as demonstrated from the information obtained from the applicant's academic background, recommendations, and interviews.

If an applicant wishes to work for a degree in a field other than his previous major field of study and is otherwise qualified, his prospective department of major study can recommend a program,

the satisfactory completion of which would make him eligible for the field of his choice.

An applicant offering transcripts and evidence of degrees from a foreign university must follow the procedure outlined in the preceding paragraph.

REQUIREMENTS FOR DEGREES

The requirements for the degree of *Doctor of Engineering Science* are:

1. Completion of the candidacy requirements;
2. A minimum of twenty-four (24) credits in course work beyond the master's degree;
3. A minimum of one (1) academic year in residence;
4. A minimum of thirty-six (36) credits of original research or design, culminating in a thesis which meets the publication requirements of the College;
5. An oral defense of the research or design before a committee of the Graduate Faculty selected by the department of major study with the concurrence of the Committee on Graduate Studies.

The doctoral 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 doctoral program. Candidates for the degree who desire a special ruling by reason of hardship may submit an appeal directly to the Faculty of the College.

Applications for the doctoral degree should be obtained from the Graduate Division office and filed with the department not later than the close of the first semester of the year in which the degree is expected to be conferred.

CANDIDACY REQUIREMENTS

Admission to the doctoral program does not imply candidacy for a degree. To establish candidacy for the doctoral degree the student must:

1. Within three (3) years after admission to the doctoral program, make application, through the office of the Graduate Division, for a qualifying examination to be administered by his department of major study;
2. Within one (1) year after satisfactorily completing the qualifying examination and prior to initiating his doctoral

research, demonstrate technical reading ability in at least one (1) foreign language useful to his proposed research or design;

3. Pay the candidacy fee of $20.00.

Forms for candidacy application can be obtained from the Graduate Division office.

DEPARTMENT OF CHEMICAL ENGINEERING

The Department of Chemical Engineering recommends as candidates for the degree of *Doctor of Engineering Science in Chemical Engineering* those who have obtained the Master of Science degree in Chemical Engineering from accredited institutions and who fulfill the requirements specified for the doctoral degree. Required courses for the program will include thermodynamics, kinetics, design, advanced chemical engineering problems courses and such additional courses as may be specified by the Department. Research for the degree requires an original research, development or design project, completion of which makes a contribution to available knowledge. Specific requirements as to courses and projects are programmed in consultation with the candidate at the time of admission and will include courses on the 400 level as specified below (page 47).

The qualifying examinations will require competence in Chemical Engineering and related fields. It is expected that the student will be prepared in the following areas, the metes and bounds of which are described by the following courses in this catalog:

1. Materials — ChE 222.
2. Thermodynamics — ChE 211.
3. Kinetics — ChE 212.
4. Heat Transfer and Fluid Flow — ChE 223.
5. Transport Phenomena — ChE 224.
6. Design of Chemical Equipment and Plants — ChE 241.
7. Instrumentation — ChE 225.
8. Advanced Chemical Engineering Problems — ChE 226.
9. A specific unit operations course from the following group:
   (a) Adsorption — ChE 217.
   (b) Petroleum Refining — ChE 220.
   (c) Absorption and Extraction — ChE 227.
   (d) Distillation — ChE 228.
   (e) Catalysis — ChE 246.

Registration for thesis and research will require as prerequisites:

1. Such courses as may be specified by the Department;
2. Satisfactory completion of the Qualifying Examination;

3. Demonstration of proficiency in technical reading of one or more appropriate foreign languages.

Should the 36 credits be completed before the submission of the final copy of the thesis and its acceptance by the Department, it will be necessary for the student to register for additional thesis and research credit, or, if this registration be waived, at the discretion of the Department and the Committee on Doctoral Studies, the student will be required to maintain his candidacy status by payment of the registration fee for each semester intervening between such submission and acceptance, with a maximum extension to not more than seven years from the date of entrance to the doctoral program. The oral thesis examination will be given only after the acceptance of the completed thesis.

DEPARTMENT OF ELECTRICAL ENGINEERING

The program for the degree of *Doctor of Engineering Science in Electrical Engineering* is intended for superior electrical engineering students with a Master's degree in Electrical Engineering who have a broad background in engineering, mathematics and physics and who wish to do advanced work in the areas of electrical engineering research or design. Students with too narrow a specialization in the bachelor's or master's programs will be required to broaden this background before becoming eligible as candidates for the Doctoral degree.

Specifically, the prospective candidate should have courses, as prerequisites for advanced study, equivalent to MA 273, Ordinary Differential Equations; MA 256, Functions of a Complex Variable; EE 120, Fundamentals of Electromagnetic Waves; EE 140, Electronic Circuits; and EE 150, Circuit Analysis. At least 50% of the undergraduate course work should have been in Physical Science or allied fields and the work on the M.S. level should indicate a major in Electrical Engineering and a minor in either mathematics or physics, or both.

Course requirements for the Doctoral Program will be specified in consultation with the student, and the research for the degree will require an original research or design project, completion of which will contribute to the available knowledge in the field of the project. This project will include courses on the 400 level as specified below. (See pages 61 ff.)

The qualifying examination will require competence in the following fields:

1. Mathematics: Differential Equations and Vector Analysis; Transformation or Operational Calculus; Advanced Calculus; Complex Variables; Elements of Probability and Stochastic Processes.
2. Engineering Physics: Undergraduate physics, including kinetics, kinematics and thermodynamics. Advanced topics in Classical and Modern Physics. Also included are engineering applications to branches of engineering other than electrical.
3. General electrical engineering: Undergraduate electrical engineering and elementary graduate study in circuits, fields, and electronics.
4. A specialized area of electrical engineering. This field must be indicated to the Department Chairman within six weeks before the date of the qualifying examination. This section of the examination will entail a critical evaluation of the area specified in order to determine ability to conduct research requiring such knowledge and to apply this knowledge to broader and more general problems.

Registration for thesis and research will require as prerequisites:

1. Such courses as may be specified by the Department;
2. Satisfactory completion of the Qualifying Examination;
3. Demonstration of proficiency in technical reading of one or more appropriate foreign languages.

Should the 36 credits be completed before the submission of the final copy of the thesis and its acceptance by the Department, it will be necessary for the student to register for additional thesis and research credit, or, if this registration be waived, at the discretion of the Department and the Committee on Doctoral Studies, the student will be required to maintain his candidacy status by payment of the registration fee for each semester intervening between such submission and acceptance, with a maximum extension to not more than seven years from the date of entrance to the doctoral program. The oral thesis examination will be given only after the acceptance of the completed thesis.

COURSE OFFERINGS

CLASSIFICATION OF 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 6:30 p. m. and end at 9:30 p. m. 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.

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.

Three 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. Two, *Radioisotopes Laboratory* (Phys 223), also offered by the Department of Physics, and three, *Technology of Nuclear Materials* (ChE 252), offered by the Department of Chemical Engineering, deal 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.* Other courses in this Area will be added and the student should check the course offerings in the several Departments for these courses.

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.

COURSES OFFERED BY THE DEPARTMENT OF CHEMICAL ENGINEERING

ChE 201 ADVANCED ORGANIC CHEMISTRY Dr. SNYDER

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 1965-1966 and alternate years — W, 6:30-9:30

ChE 206 PHYSICAL ORGANIC CHEMISTRY Dr. SNYDER

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 1964-1965 and alternate years — Tu, 6:30-9:30

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, 6:30-9:30

ChE 211 CHEMICAL ENGINEERING THERMODYNAMICS Dr. JOFFE

The fundamental principles of thermodynamics are developed quantitatively to include thermodynamic functions and their relations. Applications are discussed with particular attention to generalized methods. Methods are developed for the treatment of gaseous mixtures, liquid solutions, and vapor-liquid equilibria. The thermodynamics of chemical equilibria is considered. Statistical thermodynamics is discussed briefly.

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

3 hours per week — 3 credits
First Semester — Th, 6:30-9:30

ChE 212 KINETICS OF REACTIONS Dr. JOFFE

The theory of absolute reaction rates is discussed. The kinetics of homogeneous reactions is studied, and applications are made to batch and flow processes. Uncatalyzed heterogeneous reactions are considered. Considerable attention is devoted in this course to reactor design.

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

3 hours per week — 3 credits
Second Semester — Th, 6:30-9:30

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 1965-1966 and alternate years — M, 6:30-9:30

ChE 218 INDUSTRIAL SYNTHESIS Dr. KREPS

A seminar course dealing with industrial methods of chemical syn-

thesis: unit processes, synthesis of specific types of compounds, both organic and inorganic. Topics discussed will include the physico-chemical and economic backgrounds of specific processes chosen according to the students' interests.

Prerequisite: Previous training satisfactory to the Department.

3 hours per week — 3 credits
Second Semester — Offered 1964-1965 and alternate years — M, 6:30-9:30

ChE 220 PETROLEUM REFINING — Dr. WEINSTEIN

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 1965-1966 and alternate years — Tu, 6:30-9:30

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 — W, 6:30-9:30

ChE 223 HEAT TRANSFER AND FLUID FLOW

Drs. SALAMONE and MCCORMICK

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
Repeated Each Semester — M, 6:30-9:30

ChE 224 TRANSPORT PHENOMENA — Dr. ANDERSEN

An advanced treatment of molecular and turbulent momentum, energy, and mass transport. Emphasis is on the mathematical description of physical mechanisms.

Prerequisite: B.S. in Ch.E. or M.E.; a course in differential equations or advanced mathematics for engineers.

3 hours per week — 3 credits
First Semester — M, 6:30-9:30

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, 6:30-9:30

ChE 226 ADVANCED CHEMICAL ENGINEERING PROBLEMS — Dr. MCCORMICK

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 department.

3 hours lecture per week — 3 credits
Second Semester — Offered 1965-1966 and alternate years — Tu, 6:30-9:30

ChE 227 ABSORPTION AND EXTRACTION — Dr. MCCORMICK

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, 6:30-9:30

ChE 228 DISTILLATION — Dr. MCCORMICK

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, 6:30-9:30

ChE 230 EXTRACTIVE METALLURGY — Adjunct 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 department.

3 hours lecture per week — 3 credits
Second Semester — Offered 1965-1966 and alternate years — F, 6:30-9:30

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 ten students each semester.

Prerequisite: Unit Operations or equivalent.

1 hour conference
4 hours design per week. Laboratory fee $5.00; Laboratory deposit $25.00 — 3 credits
Second 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 ten students each semester.

Prerequisite: Unit Operations or equivalent.

1 hour conference
4 hours Design per week — 3 credits
First Semester — Hours by arrangement

ChE 243 CHEMICAL ENGINEERING COMMUNICATIONS
Now given as Hu 200, for description of which see page 79.

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 1964-1965 and alternate years — M, 6:30-9:30

ChE 246 CATALYSIS Dr. KREPS
Background theory, reaction kinetics, reactor design, and application of homogeneous and heterogeneous catalytic processes; commercial preparation and evaluation of catalysts.

Prerequisite: Training satisfactory to the Department.

3 hours per week — 3 credits
Second Semester — Offered 1965-1966 and alternate years — M, 6:30-9:30

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 1965-1966 and alternate years — M, 6:30-9:30

ChE 249 ADVANCED ORGANIC CHEMISTRY LABORATORY

To be announced

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 1965-1966 and alternate years — Tu and Th, 6:30-9:30

ChE 250 ADVANCED ORGANIC CHEMISTRY LABORATORY

To be announced

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 — 3 credits
Second Semester — Offered 1964-1965 and alternate years — M and W, 6:30-9:30

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 — 3 credits
Second Semester — Offered 1965-1966 and alternate years — Th, 6:30-9:30

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 — 3 credits
First Semester — Offered 1965-1966 and alternate years — M, 6:30-9:30

ChE 255 PLASTICS ENGINEERING — Dr. MILLER

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 — 3 credits
Second Semester — W, 6:30-9:30

ChE 300 M.S. 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. Approval to register must be obtained from thesis adviser.

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, 6-9

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 — Tu, 6-9

ChE 314 ADVANCED CHEMICAL PRINCIPLES — Dr. 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 1965-1966 and alternate years — Th, 6:30-9:30

ChE 400 DOCTORAL THESIS AND RESEARCH Department Faculty

Required of all candidates for the degree of Doctor of Engineering Science in Chemical Engineering.

A minimum of thirty-six (36) credits is required. The student must register for at least six (6) credits of thesis per semester; registration for additional credits may be permitted beyond the six, with the approval of the advisor, to a maximum of twelve (12) credits per semester.

Hours to be arranged — Credits as designated

Fees: Registration Fee—$5.00 per semester; Thesis Fee—$5.00 per semester; Tuition Fees—$22.00 per credit per semester; Laboratory Deposit—$25.00 per semester, or such additional amount as may be necessary to provide laboratory facilities and equipment.

ChE 401 DOCTORAL SEMINAR Department Faculty

A seminar in which faculty or others will present summaries of advanced topics suitable for research. In the course students and faculty will discuss research procedures, thesis organization and content. Research students will present their own problems and research progress for discussion and criticism.

Hours to be arranged — No credit

Required of all doctoral candidates registered for ChE 400 unless requirement is waived, in writing, by thesis adviser. Open to all students registered for ChE 300. A seminar fee of $22.00 per semester is required of all doctoral candidate participants.

COURSES OFFERED BY THE DEPARTMENT OF CIVIL ENGINEERING

CE 201 CIVIL ENGINEERING PROJECTS I Department Faculty

Extensive investigation, analysis, or design of civil engineering problems not covered by regular graduate course work.

A student who has done an exceptional quality of work in either CE 201 or CE 202 may, upon his own initiative and with the approval of his adviser, substitute the work of either course as the equivalent of the first three credits for a Master's Thesis, CE 301.

Prerequisites: Sufficient experience and/or graduate course work to support the project, and permission of the Department faculty.

Hours to be arranged — 3 credits
Either semester

CE 202 CIVIL ENGINEERING PROJECTS II Department Faculty
A continuation of CE 201.

Hours to be arranged 3 credits
Either semester

CE 211 SANITARY ENGINEERING (Water Treatment Plants)
Professor METZGER

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 1964-1965 and alternate years Tu, 6:30-9:30

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

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 1964-1965 and alternate years Tu, 6:30-9:30

CE 213 SANITARY ENGINEERING (Waste Disposal Works)
Professor METZGER

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 3 credits
First Semester Offered 1965-1966 and alternate years Tu, 6:30-9:30

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

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 3 credits
Second Semester Offered 1965-1966 and alternate years Tu, 6:30-9:30

CE 215 SANITARY CHEMISTRY
Also given as Chem 201, for a description of which see page 77.

CE 216 SANITARY MICROBIOLOGY
Also given as Chem 200, for a description of which see page 77.

CE 219 RADIOISOTOPES LABORATORY
Also given as Phys 223, for a description of which see page 84.

CE 233 ADVANCED STRENGTH OF MATERIALS
Also given as Phys 209, for a description of which see page 82.

CE 234 THEORY OF ELASTICITY
Also given as Phys 206, for a description of which see page 82.

CE 237 ADVANCED REINFORCED CONCRETE DESIGN
Professor MANGASARIAN

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 "ultimate strength" 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 — 3 credits
First Semester — Offered 1964-1965 and alternate years — Th, 6:30-9:30

CE 238 PRESTRESSED CONCRETE DESIGN Professor MANGASARIAN

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 — 3 credits
Second Semester — Offered 1964-1965 and alternate years — Th, 6:30-9:30

CE 245 HYDRAULIC ENGINEERING I Professor ROBBINS

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 1964-1965 and alternate years — M, 6:30-9:30

CE 246 HYDRAULIC ENGINEERING II Professor ROBBINS

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 1964-1965 and alternate years — M, 6:30-9:30

CE 251 SOIL MECHANICS I — To be announced

A review of basic soil properties and applied mineralogy. Advanced study of flow nets, stress distribution, and consolidation. Laboratory techniques of consolidation testing.

Prerequisite: Undergraduate course in soil mechanics or equivalent experience.

3 hours per week. Laboratory fee $5.00 — 3 credits
First Semester — Offered 1964-1965 and alternate years — M, 6:30 9:30

CE 252 SOIL MECHANICS II — To be announced

A study of the most recent advances in the field of shear strength of soils and associated practical problems. Laboratory techniques of triaxial shear testing.

Prerequisite: CE 251 or permission of instructor.

3 hours per week. Laboratory fee $5.00 — 3 credits
Second Semester — Offered 1964-1965 and alternate years — M, 6:30-9:30

CE 253 FOUNDATION ENGINEERING I — Dr. RAAMOT

Fundamentals of applied soil mechanics, criteria for the design of foundations and earth structures, selection of foundation types.

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

3 hours per week — 3 credits
First Semester — Offered 1965-1966 and alternate years — M, 6:30-9:30

CE 254 FOUNDATION ENGINEERING II — Dr. RAAMOT

Problems in the design of foundations and earth structures, including structural design of foundation elements.

Prerequisite: CE 253, or Permission of the Instructor.

3 hours per week — 3 credits
Second Semester — Offered 1965-1966 and alternate years — M, 6:30-9:30

CE 261 URBAN AND REGIONAL PLANNING — To be announced

This course will cover the socio-economic and engineering aspects of planning for population growth and optimum land use, applied in a broad and comprehensive way. Design methods, case studies, and group workshop problems will be included.

3 hours per week — 3 credits
First Semester — Offered 1964-1965 and alternate years — F, 6:30-9:30

CE 262 URBAN TRANSPORTATION PLANNING — To be announced

Basic urban transportation studies will include travel characteristics and trends, origin-destination surveys, inventory, use studies, parking studies, and transit surveys. Application will be made of transportation, economic, and land use data in estimating future travel.

3 hours per week — 3 credits
Second Semester — Offered 1964-1965 and alternate years — F, 6:30-9:30

CE 301 MASTER'S 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 — 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

CE 333 STRUCTURAL THEORY — Dr. LEHMAN

Structural analysis as related to design is presented with emphasis on the physical-intuitive approach. Methods of broad scope and wide range of application are studied. Numerical techniques are oriented to digital computers.

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

3 hours per week — 6 credits
First and Second Semesters — Offered 1964-1965 and alternate years — Tu, 6:30-9:30

CE 334 STRUCTURAL DESIGN

Broad aspects of the design philosophy are introduced, including topics on feasibility determination, decision making, and optimization. The use of the computer is explored for the programming of a general class of structural design problems and the design of highly indeterminant structures.

Prerequisite: CE 333.

3 hours per week — 6 credits
First and Second Semesters — Offered 1965-1966 and alternate years — Tu, 6:30-9:30

COURSES OFFERED BY THE DEPARTMENT OF ELECTRICAL ENGINEERING

EE 120 FUNDAMENTALS OF ELECTROMAGNETIC WAVES — To be announced

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.

Prerequisite: Ma 100 or equivalent.

3 hours per week — 3 credits
Repeated Each Semester — F, 6:30-9:30

EE 140 ELECTRONIC CIRCUITS — To be announced

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, 6:30-9:30

EE 150 CIRCUIT ANALYSIS — To be announced

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, 6:30-9:30

EE 201 MASTER'S PROJECT — Department Faculty

An extensive paper involving design, construction and analysis, or theoretical investigation, will be required of all candidates for the Master's degree who do not take EE 301, Master's Thesis. The paper must be initiated in an EE course, with the knowledge and approval of the instructor in such course, at the start of the course. Students must make substantial progress toward completion of the project 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 adviser.

A student who has submitted a report in EE 201 deemed by the adviser to be of exceptional quality may, upon the initiative of the adviser, be allowed to extend the Master's Project, EE 201, into a Master's Thesis, EE 301.

Prerequisite: Matriculation for a M.S. Degree and substantial progress in writing an extensive paper in the designated EE course.

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

If the use of laboratory facilities or equipment is necessary, a $25.00 deposit must be maintained.

EE 207 ELECTROCHEMICAL ENGINEERING — Dr. MANTELL

Also given as ChE 207, for a description of which see page 41.

EE 211 TRANSISTOR PHYSICS — Professor TOWFIK

Also given as Phys 211, for a description of which see page 83.

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 1964-1965 and alternate years — F, 6:30-9:30

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 1964-1965 and alternate years — F, 6:30-9:30

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 1964-1965 and alternate years — M, 6:30-9:30

EE 218 SYMMETRICAL COMPONENTS

Adjunct Professor 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 1965-1966 and alternate years — Th, 6:30-9:30

EE 222 ELECTROMAGNETIC RADIATION Dr. REFF

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

Prerequisite: EE 120 and Ma 274 or equivalent.

3 hours per week — 3 credits
Second Semester — Offered 1965-1966 and alternate years — Th, 6:30-9:30

EE 223 MICROWAVE TRANSMISSION

Adjunct Professor 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 and Ma 274 or equivalent.

3 hours per week — 3 credits
First Semester — Offered 1964-1965 and alternate years — Th, 6:30-9:30

EE 229 ADVANCED TRANSIENTS Adjunct Professor CARLAT

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 and Ma 256 or equivalent.

3 hours per week — 3 credits
Second Semester — M, 6:30-9:30

EE 242 RADIO-FREQUENCY COMMUNICATIONS
Adjunct Professor 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 1965-1966 and alternate years — Tu, 6:30-9:30

EE 243 MODULATION THEORY — Dr. PANTER

This course covers fundamental principles of modulation theory and modulation systems which are commonly used in the design of communication systems. The modulation systems are treated on a unified basis consistent with modern information theory, an approach which provides useful tools in evaluating their performance. The discussions of information theory are limited to basic concepts especially applicable to communication systems with a view to developing quantitative criteria by which the performance of these systems can be measured. Modulation systems are discussed from the point of view of bandwidth occupancy, threshold effects, signal to noise ratio, distortion, interchannel crosstalk and other phenomena.

Prerequisites: EE 140 or equivalent.

3 hours per week — 3 credits
First Semester — Offered 1965-1966 and alternate years — M, 6:30-9:30

EE 244 COMMUNICATIONS SYSTEMS DESIGN — Dr. PANTER

This course covers communication systems design; the design and performance evaluation of multichannel communication systems, such as line of sight, tropospheric communication systems, and satellite communication systems. Specifically, such topics as propagation characteristics, diversity, and multihop systems are discussed. The factors affecting the performance of communication systems are discussed in some detail, such as intermodulation noise, thermal noise, and equalization of baseband noise in multichannel FM radio systems; communication systems using earth satellites are covered in great detail including space communication.

Prerequisite: EE 242 or EE 243.

3 hours per week — 3 credits
Second Semester — Offered 1965-1966 and alternate years — M, 6:30-9:30

EE 245 INDUSTRIAL ELECTRONICS — Professor ANDERSON

Fundamental principles including thermistors, varistors, switching

circuits; R. F. heating, electronic control (motor, welding and photo-electric); power rectifiers and inverters; X-ray applications; electrostatic precipitation.

Prerequisite: EE 140 or equivalent.

3 hours per week — 3 credits
First Semester — Offered 1964-1965 and alternate years — M, 6:30-9:30

EE 246 MICROWAVE ELECTRONIC SYSTEMS

Adjunct Professor PRESS

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 1964-1965 and alternate years — Tu, 6:30-9:30

EE 247 TRAVELING WAVE TUBES AND PARAMETRIC AMPLIFIERS

Dr. LOUISELL

Basic principles of traveling-wave tubes, space charge waves, backward wave oscillators, parametric amplifiers and frequency converters. Manley-Rowe relations. The parametric amplifier principle is applied to electron beams (space charge wave and cyclotron wave versions), semi-conductor p-n junction diodes and ferrites.

Prerequisite: EE 120 or equivalent and permission of the Department.

3 hours per week — 3 credits
First Semester — Offered 1965-1966 and alternate years — M, 6:30-9:30

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, 6:30-9:30

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 oscillators.

Prerequisites: EE 140 and EE 150 or equivalent.

3 hours per week — 3 credits
Repeated each semester — Th, 6:30-9:30

EE 252 NETWORK SYNTHESIS — Adjunct Professor CARLAT

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 and Ma 256 or equivalent.

3 hours per week — 3 credits
First Semester — Tu, 6:30-9:30

EE 253 ELECTRIC FILTER DESIGN — Dr. 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 1965-1966 and alternate years — Th, 6:30-9:30

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 1965-1966 and alternate years — Tu, 6:30-9:30

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 1965-1966 and alternate years — Tu, 6:30-9:30

EE 256 ADVANCED NETWORK ANALYSIS — Adjunct Professor SABTO-AGAMI

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 and Ma 220 or equivalent.

3 hours per week — 3 credits
Second Semester — Tu, 6:30-9:30

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 1964-1965 and alternate years — M, 6:30-9:30

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 1965-1966 and alternate years — M, 6:30-9:30

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, 6:30-9:30

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 1965-1966 and alternate years — Th, 6:30-9:30

EE 265 NONLINEAR SERVOMECHANISMS Dr. RUSSELL
Nonlinearities 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 — 3 credits
Second Semester — Offered 1965-1966 and alternate years — Th, 6:30-9:30

EE 266 SERVOMECHANISMS LABORATORY Dr. 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 — 3 credits
Second Semester — Tu, 6:30-10

EE 268 TRANSDUCERS AND ACOUSTICS Professor ROSE

Generation, propagation, and detection of sound and sonic waves in gaseous and fluid media. Transducers for generation and detection of these waves are studied through analogues which reduce the mechanical properties to electric circuitry.

Prerequisite: EE 150 or equivalent.

3 hours per week — 3 credits
First Semester — Offered 1965-1966 and alternate years — W, 6:30-9:30

EE 270 TRANSDUCERS AND ACOUSTICS LABORATORY

Professor ROSE

Lecture and laboratory study of transducers for the generation and detection of sound with emphasis on gaseous media. Sensitivity, amplitude-frequency response, and directional characteristics are examined.

Prerequisite: EE 268 plus electronics laboratory experience.

3 hours per week — 3 credits
Second Semester — Offered 1965-1966 and alternate years — W, 6:30-9:30

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 — 3 credits
First Semester — Offered 1965-1966 and alternate years — F, 6:30-9:30

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 1965-1966 and alternate years — F, 6:30-9:30

EE 273 RANDOM PROCESSES IN ELECTRICAL COMMUNICATION
Adjunct Professor 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 1965-1966 and alternate years — W, 6:30-9:30

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.

3 credits
First Semester — Offered 1964-1965 and alternate years — W, 6:30-9:30

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, 6:30-9:30

EE 276 INFORMATION THEORY Adjunct Professor 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, communication 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 — 3 credits
Second Semester — Offered 1965-1966 and alternate years — W, 6:30-9:30

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 — 3 credits
First Semester — Tu, 6:30-9:30

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 — 3 credits
Second Semester — Tu, 6:30-9:30

EE 301 MASTER'S THESIS Department Faculty
Projects involving design, construction, experimental or theoretical investigation may be approved by the graduate adviser 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. The completed work in the form of a written thesis should be of a calibre sufficient to warrant publication in a technical journal.

Prerequisite: 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 339 FEEDBACK AMPLIFIERS Dr. ZAMBUTO
A course in the analysis and synthesis of electronic feedback systems. Elementary feedback review. Mathematical definition of feedback parameters. Transistors as feedback elements. Analysis and design criteria. Mathematical analysis of impedance, admittance, noise and distortion in feedback networks. Fractionated and external feedback gain. Non-linear feedback systems. Transients in f.b. circuits. Stability and physical realizability. Stability criteria and their mathematical foundations, critique and extension. Active impedance synthesis. Bode theorum and analysis criteria. Corrective networks. Amplifier design.

Prerequisites: EE 140, EE 150 and Ma 256 or equivalents.

3 hours per week — 6 credits
First and Second Semesters — Offered 1965-1966 and alternate years — F, 6:30-9:30

EE 400 DOCTORAL THESIS AND RESEARCH — Department Faculty

Required of all candidates for the degree of Doctor of Engineering Science in Electrical Engineering.

A minimum of thirty-six (36) credits is required. The student must register for at least six (6) credits of thesis per semester; registration for additional credits may be permitted beyond the six, with the approval of the advisor, to a maximum of twelve (12) credits per semester.

Hours to be arranged — Credits as designated

Fees: Registration Fee—$5.00 per semester; Thesis Fee—$5.00 per semester: Tuition Fees—$22.00 per credit per semester; Laboratory Deposit—$25.00 per semester, or such additional amount as may be necessary to provide laboratory facilities and equipment.

EE 401 DOCTORAL SEMINAR — Department Faculty

A seminar in which faculty or others will present summaries of advanced topics suitable for research. In the course students and faculty will discuss research procedures, thesis organization and content. Research students will present their own problems and research progress for discussion and criticism.

Hours to be arranged — No credit

Required of all doctoral candidates registered for EE 400 unless requirement is waived, in writing, by thesis adviser. Open to all students registered for EE 301. A seminar fee of $22.00 per semester is required of all doctoral candidate participants.

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 1964-1965 and alternate years — Th

EE 448 MASERS AND LASERS — Dr. ZAMBUTO

This course discusses the mechanism of maser operation and selected topics in maser design, modulation and application. A survey and review of the physical and mathematical background is also presented. Included are elementary maser theory, operators, eigenvalues, spectra, state functions, Schroedinger's equation, and solutions; perturbations - entropy and non-equilibrium systems; interaction of radiation and

matter; population inversion methods, maser states in ammonia, and the ammonia maser; maser levels in paramagnets; three level solid state and gas masers; and noise.

Prerequisites: EE 120 and EE 140 or equivalents.

Corequisites: Phys 220 and Ma 274.

3 hours per week — First and Second Semesters — Offered 1964-1965 and alternate years — 3 credits — F, 6:30-9:30

EE 449 ELEMENTS OF THE QUANTUM THEORY OF RADIATION — Dr. LOUISELL

The course includes a review of quantum mechanics using the Dirac nonrelativistic formulation. The harmonic oscillator is treated by means of operator techniques. The electromagnetic radiation field is quantized and examples are given of the quantized field interacting with matter. Quantum statistics are presented using the density operator. Applications include quantum noise in masers, attenuators and parametric amplifiers.

Prerequisite: Phys 230 or equivalent.

3 hours per week — Second Semester — 3 credits — M, 6:30-9:30

EE 450 SEMINAR ON RELIABILITY PROBLEMS IN ELECTRONICS — Dr. MISRA

The course deals with study of factors causing instability and reliability failure in electronic equipment and components. Particularly, study will be made of problems in dielectrics, including distribution of potentials and electric fields. Transistors will be studied from the point of view of beta stability and leakage current problems including conditions prevailing under different reverse bias conditions. For electron tubes cathodic failure mechanism will be studied along with the effect of emission current densities on life. Problems of current interest to the members of the class will be investigated. Throughout this seminar, emphasis will be placed on engineering approach but basic statistics required for sampling will also be covered. Different types of accelerated life testing problems and physical principles underlying these will be critically studied.

Prerequisites: EE 120, EE 140 or equivalents.

3 hours per week — Second Semester — 3 credits — W, 6:30-9:30

EE 451 SEMINAR ON RELIABILITY — Dr. MISRA

A more detailed study of active elements will be made in terms of stability of different parameters as a function of stress levels and time. Applications of reliability principles to the study of circuits and systems will be undertaken, including the role of localized and overall feedback systems and dependence on components. Problems

of current interest to members of the class will be investigated.

Prerequisite: EE 450 or equivalent.

3 hours per week — 3 credits
First Semester — W, 6:30-9:30

EE 466 SEMINAR ON MODERN CONTROL THEORY Dr. PADALINO

Selected topics in modern control theory, adaptive control systems, and optimal control theory using state representation are covered.

Prerequisites: EE 263 and permission of the Department.

Hours to be arranged — 3 credits
First Semester — Offered 1964-1965 and alternate years

EE 467 SEMINAR ON STATISTICAL DESIGN OF LINEAR SERVOMECHANISMS Dr. RUSSELL

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 1964-1965 and alternate years — W

COURSES OFFERED BY THE DEPARTMENT OF INDUSTRIAL AND MANAGEMENT ENGINEERING

EM 110 PRODUCTION MANAGEMENT I

Professors GORDAN and ZIMMERMAN

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 — Th, 6:30-9:30 First Semester
F, 6:30-9:30 Second Semester

EM 111 PRODUCTION MANAGEMENT II

Professors LAVERDA and WOLF

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, 6:30-9:30 First Semester
Th, 6:30-9:30 Second Semester

EM 201 ADVANCED MANAGEMENT ENGINEERING
Professor SIZELOVE

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

Prerequisite: Undergrad. Industrial Management, or EM 110.

3 hours per week — 3 credits
Repeated each semester — M, 6:30-9:30 First Semester
W, 6:30-9:30 Second Semester

EM 203 ANALYTICAL ENGINEERING STATISTICS
Professors SIZELOVE, MIHALASKY, and GORDAN

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, 6:30-9:30 First Semester
M, 6:30-9:30 Second 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.

3 credits
Second Semester — Offered 1964-1965 and alternate years — W, 6.30-9:30

EM 205 ENGINEERING RELIABILITY — Professor MIHALASKY

A study of the fundamental concepts underlying modern reliability, with application to practical industrial problems. The course will treat statistical concepts, reliability through design, reliability through testing, analysis of reliability data, and the organization and management of a reliability program.

Prerequisite: Bachelor's degree in science or engineering.

3 hours per week — 3 credits
First Semester — Offered 1964-1965 and alternate years — Tu, 6:30-9:30

EM 212 PERSONNEL MANAGEMENT
Professors GORDAN and 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 1965-1966 and alternate years — F, 6:30-9:30

EM 213 PRODUCTION ENGINEERING Adjunct Professor 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 1964-1965 and alternate years — M, 6:30-9:30

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 management and control, tool control, routing, scheduling, dispatching. Also treated are control mechanisms and systems.

Prerequisite: EM 110 or Undergraduate Industrial Management.

3 hours per week — 3 credits
First Semester — Th, 6:30-9:30

EM 215 DESIGN OF AN ENTERPRISE

Dr. JAFFE and Professor RIGASSIO

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 110 and 111.

3 hours per week — 3 credits
First Semester — M, 6:30-9:30

EM 216 SEMINAR IN THE DESIGN OF AN ENTERPRISE

Dr. JAFFE and Professor RIGASSIO

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, 6:30-9:30

EM 217 PRODUCTION ENGINEERING ESTIMATING

Adjunct Professor 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 1965-1966 and alternate years — M, 6:30-9:30

EM 218 MANAGEMENT OF SMALL INDUSTRIAL PLANTS

To be announced

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 110 and EM 111 or equivalent.

3 hours per week — 3 credits
Second Semester — M, 6:30-9:30

EM 223 PSYCHOLOGY IN ENGINEERING — Dr. JOHNSON

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, 6:30-9:30

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, 6:30-9:30

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, 6:30-9:30

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, Taft-Hartley Act, and the Landrum-Griffin Act.

Prerequisite: Bachelor's degree in science or engineering.

3 hours per week — 3 credits
First Semester — Th, 6:30-9:30

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, 6:30-9:30

EM 250 INTRODUCTORY OPERATIONS RESEARCH

Professor GOLDSTEIN

This course treats 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 program-

ming. 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 — Th, 6:30-9:30

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, 6:30-9:30

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 typical large and small scale computers.

Prerequisite: Permission of the Department. Bachelor's degree in science or engineering.

3 hours per week — 3 credits
Second Semester — Tu, 6:30-9:30

EM 260 FINANCE OF INDUSTRIAL ENTERPRISE — Professor LAVERDA

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 1965-1966 and alternate years — Tu, 6:30-9:30

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 110 and 111 or equivalent.

3 hours per week — 3 credits
Second Semester — Tu, 6:30-9:30

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 1965-1966 and alternate years — W, 6:30-9:30

EM 273 ADVANCED PERSONNEL MANAGEMENT — Professor CAMBRELENG

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 1965-1966 and alternate years — F, 6:30-9:30

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 110.

3 hours per week — 3 credits
Second Semester — Offered 1964-1965 and alternate years — F, 6:30-9:30

EM 276 THE SCIENTIFIC SELECTION OF PERSONNEL — Dr. JOHNSON

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, 6:30-9:30

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 1964-1965 and alternate years — F, 6:30-9:30

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 as well as marketing problems treated by managerial science and operations research methods. 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 — Tu, 6:30-9:30

EM 292 SALES ENGINEERING MANAGEMENT

Adjunct Professor ROUNDY

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, 6:30-9:30

EM 293 MANAGERIAL ECONOMICS — 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 110 and EM 111 or equivalent.

3 hours per week — 3 credits
First Semester — Tu, 6:30-9:30

EM 300 MASTER'S THESIS — Department Faculty

All candidates for the degree of 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.

COURSES OFFERED BY THE DEPARTMENT OF MECHANICAL ENGINEERING

ME 201 HEAT TRANSFER — Professor STAMPER

A study of heat transfer by conduction, convection, radiation, and during phase change. Analytical and numerical solutions to steady and unsteady state conduction; boundary layer theory and applications to convective heat transfer; analogy between fluid flow and heat transfer; basic laws of radiation and applications; and combined heat transfer mechanisms are covered.

Prerequisites: Undergraduate courses in Heat Transfer, Fluid Mechanics, and Ma 100 or equivalent.

3 hours per week — 3 credits
First Semester — M, 6:30-9:30

ME 202 ADVANCED THERMODYNAMICS — Dr. HSIEH

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 one year of Thermodynamics.

3 hours per week — 3 credits
First Semester — M, 6:30-9:30

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, Fluid Mechanics, and one year of Thermodynamics.

3 hours per week — 3 credits
First Semester — Th, 6:30-9:30

ME 205 ADVANCED MACHINE DESIGN Professor PREDALE

Advanced methods of analysis based on the principle of virtual displacements and related energy theorems are developed and applied to a variety of problems. Typical applications include stability problems of columns, beam-columns, shafts, and plates; determinate and indeterminate problems of shafts, frameworks, rings, and spoked flywheels; and dynamic analysis of mechanisms.

Prerequisite: Undergraduate Differential Equations, Senior Machine Design, and Ma 100 or equivalent.

3 hours per week — 3 credits
First Semester — Tu, 6:30-9:30

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: Kinetics and Ma 251 or equivalent.

3 hours per week — 3 credits
Second Semester — F, 6:30-9:30

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: Senior Machine Design and Ma 100 or equivalent.

3 hours per week — 3 credits
Second Semester — M, 6:30-9:30

ME 210 ENGINEERING 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 courses in Metallurgy, Metallography, and Mechanics of Deformable Bodies.

3 hours per week — 3 credits
Second Semester — Tu, 6:30-9:30

ME 212 DYNAMICS OF COMPRESSIBLE FLUIDS Dr. 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 Ma 100 or equivalent.

3 hours per week — 3 credits
Second Semester — Th, 6:30-9:30

ME 214 ADVANCED HEAT TRANSFER Professor LEVY
Theory of high rate heat transfer with emphasis on techniques involved in thermal design of complex systems. Anayltical, 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 — W, 6:30-9:30

ME 215 DYNAMICS OF INCOMPRESSIBLE FLUIDS Dr. 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, Ma 100 or equivalent, and one year of Thermodynamics.

3 hours per week — 3 credits
First Semester — Th, 6:30-9:30

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 one year of Thermodynamics.

3 hours per week — 3 credits
Second Semester — Tu, 6:30-9:30

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 differential 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, 6:30-9:30

ME 218 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 one year of Thermodynamics.

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

ME 219 MECHANICS OF VISCOUS FLUIDS — Professor URAM

A study of the properties and behavior of real fluids in laminar and turbulent motion. Mathematical and empirical laws and methods currently used are developed and discussed in the light of applications to flows in ducts, boundary layers over surfaces and bodies, in fluid machinery, etc. Convective heat transfer applications and compressibility effects are also included.

Prerequisite: ME 215.

3 hours per week — 3 credits
Second Semester — W, 6:30-9:30

ME 223 EXPERIMENTAL STRESS ANALYSIS — Professor MILLER

A lecture and laboratory course dealing with experimental methods of analyzing stress and strain distributions. Static, dynamic, and residual stress distributions are examined utilizing brittle lacquers, strain gages, and related instrumentation. Current developments in theory and technique are applied to the solution of special problems.

Prerequisite: Undergraduate Differential Equations and Mechanics of Deformable Bodies.

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

ME 224 PHOTOELASTICITY — Professor MILLER

A lecture and laboratory course dealing with the use of polarized light for the solution of problems of stress analysis. Related theory and recent experimental techniques utilizing the polariscope as well as photoelastic coatings will be applied to the solution of industrial problems. Frozen stress methods are considered in applications involving three-dimensional stress distributions. The utilization of rectangular and circular photoelastic strain gages is also considered.

Prerequisite: Undergraduate Differential Equations and Mechanics of Deformable Bodies.

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, and Mechanics of Deformable Bodies.

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

ME 226 CORROSION Adjunct Professor 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 — M, 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 Fluid Mechanics and one year of Thermodynamics.

3 hours per week — 3 credits
First Semester — Tu, 6:30-9:30

ME 228 STEAM TURBINE DESIGN Adjunct Professor 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 Fluid Mechanics and one year of Thermodynamics.

3 hours per week — 3 credits
Second Semester — M, 6:30-9:30

ME 229 LIGHT ALLOYS Professor SCHNEIDER

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

Prerequisite: Undergraduate courses in Metallurgy, Metallography, and Mechanics of Deformable Bodies.

3½ hours per week. Laboratory fee $15.00 — 3 credits
First Semester — Offered 1965-1966 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, multi-cylinder balancing, and governor control will be among the topics examined.

Prerequisite: Undergraduate Differential Equations, Senior Machine Design, and Ma 100 or equivalent.

3 hours per week — 3 credits
Second Semester — Th, 6:30-9:30

ME 232 STATISTICAL THERMODYNAMICS Dr. HSIEH

An introduction to kinetic theory of gases and statistical mechanics. Topics include Maxwellian distribution; transport phenomena; elements of quantum mechanics; Maxwell-Boltzmann, Bose-Einstein, and Fermi-Dirac statistics; partition functions and their relations to thermodynamic functions; and applications to gaseous, liquid, and solid states. Fluctuations and irreversible processes are also discussed.

Prerequisite: Undergraduate courses in Differential Equations and one year of Thermodynamics.

3 hours per week — 3 credits
Second Semester — Tu, 6:30-9:30

ME 233 PRINCIPLES OF PHYSICAL METALLURGY Professor PEARCE

A consideration of advanced concepts of structure-dependent phenomena in metal systems that are only briefly discussed in undergraduate courses in metallurgy. Topics to be covered include crystal structure and imperfections, phase rule and free energy, solid state diffusion, recovery and recrystalization mechanisms, and X-ray analysis techniques.

Prerequisite: Undergraduate Metallurgy, Metallography, one year of Thermodynamics, and Differential Equations.

3 hours per week — 3 credits
First Semester — F, 6:30-9:30

ME 234 DESIGN OF PLATES AND SHELLS Professor WILSON

A study of plates and shells oriented toward mechanical engineering design which covers solutions for typical loading and boundary conditions by analytical and numerical methods, including digital computer techniques, sandwich construction, plate and shell interfaces, and thermal stresses.

Prerequisite: Mechanics of Deformable Bodies and Ma 100 or equivalent.

3 hours per week — 3 credits
Second Semester — F, 6:30-9:30

ME 235 RANDOM VIBRATIONS — Professor WILSON

An extension of classical vibration theory to problems of random excitation which includes analysis of vibration response utilizing the mobility and impedance of mechanical components, spectral density representations and analog computer methods; and structural damping and design for shock and random loading.

Prerequisite: Undergraduate courses in Mechanics of Deformable Bodies, Mechanical Vibrations, and Ma 100 or equivalent.

3 hours per week — 3 credits
First Semester — F, 6:30-9:30

ME 301 MASTER'S 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 200 SANITARY MICROBIOLOGY — Dr. RAM

A lecture and laboratory course providing an introduction to the biological aspects of water, sewage, and food. Basic principles of microbiology, characteristics and control of bacteria and disease, are included with applications to public health problems. Bacteriological examinations of water, sewage, and milk are made.

Prerequisite: An undergraduate course in chemistry and some knowledge of the subject matter of Chem 201.

3 hours per week. Laboratory fee $15.00. — 3 credits
First Semester — Offered 1965-1966 and alternate years — F, 6:30-9:30

Chem 201 SANITARY CHEMISTRY — Dr. RAM

A lecture and laboratory course providing an introduction to the chemistry of water, sewage, and food. Principles of physical, organic, quantitative, and colloid chemistry applicable to the treatment processes in sanitary engineering are included. Laboratory determinations are made for data used in the design, operation, and analysis of treatment processes.

Prerequisite: An undergraduate course in chemistry.

3 hours per week. Laboratory fee $15.00. — 3 credits
Second Semester — Offered 1965-1966 and alternate years — F, 6:30-9:30

Chem 210 RADIOISOTOPES THEORY AND APPLICATION
Professor FITZGERALD

A study of the theory and principles involved in the application of radioisotopes. It includes the nuclear physics, instrumentation, legal, and safety aspects of radioisotope utilization, calculations involved in designing a tracer experiment, as well as a study of specific application of radioisotopes to industrial problems.

Prerequisite: Modern physics.

3 hours per week — 3 credits
First Semester — Tu, 6:30-9:30

Chem 211 RADIOISOTOPES LABORATORY Professor FITZGERALD
Also given as Phys 223, for a description of which see page 84.

Chem 220 ADVANCED INORGANIC CHEMISTRY Professor CAGNATI
A course in the theory and application of inorganic chemistry. Chemical theory is applied, insofar as it is applicable, to the prediction and elucidation of the properties and behavior of inorganic compounds.

Prerequisite: One year of physical chemistry.

3 hours per week — 3 credits
First Semester — F, 6:30-9:30

Chem 221 STRUCTURAL INORGANIC CHEMISTRY
Professor CAGNATI

The course examines the principles applied in determining the structure of inorganic compounds. The utilization of chemical and physical experimental methods of structure determination is studied from the standpoint of their application to industrial problems.

Prerequisite: Chem 220.

3 hours per week — 3 credits
Second Semester — F, 6:30-9:30

Chem 222 RADIATION CHEMISTRY Professor CAGNATI
An examination of the fundamental mechanisms of radiolytic action in the gaseous, liquid, and solid states. Emphasis is on the effect of radiation on engineering materials.

Prerequisite: Undergraduate physical and organic chemistry, or equivalent.

3 hours per week — 3 credits
Second Semester — Th, 6:30-9:30

Chem 223 SOLID STATE CHEMISTRY Professor CAGNATI
The study of solids from the structural and energetics standpoint and the concomitant chemical changes induced by various environmental factors.

Prerequisite: Physical chemistry.

3 hours per week — 3 credits
First Semester — Th, 6:30-9:30

Chem 240 POLYMERIZATION KINETICS AND PROPERTIES OF POLYMER SOLUTIONS Dr. KWEI

This course deals principally with preparation of the several types of polymers, with the kinetics of polymerization, and with those properties of polymer solutions useful in characterizing molecular size and shape.

Prerequisites: Organic and physical chemistry.

3 hours per week — 3 credits
First Semester — Tu, 6:30-9:30

Chem 241 POLYMER PROPERTIES Professor WENISCH

Forces between polymer molecules and their relation to crystal structure are considered, and the fundamentals of rheology and viscoelastic properties of polymers are presented. Polymer crosslinking, reinforcement, and aging are considered from a chemical viewpoint.

Prerequisite: Chem 240.

3 hours per week — 3 credits
Second Semester — Tu, 6:30-9:30

ESc 200 or ESc 300 M.S. THESIS Designated Faculty

The thesis work will be carried on under the supervision of a designated member of the faculty. Required of all students matriculated for the Master of Science degree in the areas of basic Engineering Science.

Hours to be arranged — ESc 200: 3 credits
First and Second Semester — ESc 300: 6 credits

COURSES OFFERED BY THE DEPARTMENT OF ENGLISH AND HUMANISTIC STUDIES

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 knowledge of the language, another for beginners.

4 hours each week — No graduate credit
First and Second Semesters — Tu, 6:30-8:30; F, 6:30-8:30

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. 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, 6:30-9:30

COURSES OFFERED BY THE DEPARTMENT OF MATHEMATICS

Ma 100 VECTOR AND TENSOR ANALYSIS — Dr. ZATZKIS

Introduction to vector and tensor analysis, including a survey of curvilinear coordinates, with applications to matrix algebra, problems in dynamics, electromagnetic theory, fluid dynamics, and potential theory.

Prerequisite: Differential and integral calculus.

3 hours per week — 3 credits
Repeated Each Semester — Th, 6:30-9:30

Ma 211 INTRODUCTION TO NUMERICAL ANALYSIS

Professor LIONE

The purpose of this course is to acquaint the student with the principles, methods, and procedures for obtaining numerical solutions to problems arising in applied mathematics. Emphasis is placed on the methods which are easily adapted to digital computers, since most engineers and scientists will have these available.

Prerequisite: Differential and integral calculus.

3 hours per week — 3 credits
First Semester — W, 6:30-9:30

Ma 220 MATRIX THEORY — Dr. FOSTER

The course involves the development of mathematical concepts requisite for study of the applications of matrix theory to engineering. Topics considered include matrix inversion, linear dependence, characteristic roots, and vector spaces.

Prerequisite: Undergraduate calculus and preparation satisfactory to the Department.

3 hours per week — 3 credits
First Semester — M, 6:30-9:30

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: Elementary differential equations and preparation satisfactory to the Department.

3 hours per week — 3 credits
First Semester — M, 6:30-9:30

Ma 252 ADVANCED CALCULUS II — Dr. ZATZKIS

A continuation of Ma 251. Subject matter included: Advanced topics in vector analysis, elements of tensor analysis, calculus of variations with applications to analytical dynamics, matrices, calculus of finite differences, applications of conformal mapping to boundary value

problems. The choice of specialized topics will be determined by the interest of the students.

Prerequisite: Ma 251 or equivalent.

3 hours per week — 3 credits
Second Semester — M, 6:30-9:30

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
Repeated Each Semester — W, 6:30-9:30

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, 6:30-9:30

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, 6:30-9:30

Ma 273 DIFFERENTIAL EQUATIONS I — Dr. KOREN

Advanced topics in ordinary differential equations with applications to engineering problems.

Prerequisite: Undergraduate Differential Equations.

3 hours per week — 3 credits
Repeated Each Semester — Section 1: Tu, 6:30-9:30 First Semester
Section 2: Th, 6:30-9:30 First Semester
Tu, 6:30-9:30 Second 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: Ma 273 or equivalent.

3 hours per week — 3 credits
Second Semester — Th, 6:30-9:30

ESc 200 or ESc 300 M. S. THESIS Designated Faculty
The thesis work will be carried on under the supervision of a designated member of the faculty. Required of all students matriculated for the Master of Science degree in the areas of basic Engineering Science.

Hours to be arranged
First and Second Semester

ESc 200: 3 credits
ESc 300: 6 credits

COURSES OFFERED BY THE DEPARTMENT OF PHYSICS AND MECHANICS

Phys 202 HISTORY OF THE PHYSICAL SCIENCES Dr. SAGURTON
An outline of the development of science and technology from prehistory 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
Repeated Each Semester

3 credits
W, 6:30-9:30 First Semester
Tu, 6:30-9:30 Second 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
Second Semester

3 credits
M, 6:30-9:30

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: Mechanics of Deformable Bodies.

3 hours per week
First Semester

3 credits
M, 6:30-9:30

Phys 210 THEORETICAL PHYSICS Dr. NEIDHARDT
Included are concepts of theoretical physics, mathematical methods of solution of problems, gravitational and electromagnetic fields; problems in fluid-flow and heat-flow fields; waves in various media; and the solution of the wave equation, initial value, and boundary value problems.

Prerequisite: Undergraduate general physics and mathematics.

3 hours per week
Repeated Each Semester

3 credits
W, 6:30-9:30 First Semester
Tu, 6:30-9:30 Second Semester

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
First Semester

3 credits
F, 6:30-9:30

Phys 212 DYNAMICS OF A PARTICLE Professor KUHARETZ

A study of particle dynamics using the methods of LaGrange and Hamilton; applications to electrodynamics and high-speed particles; Hamilton-Jacobi theory, wave theory, and the solution of the wave equation.

Prerequisite: Undergraduate analytical or engineering mechanics.

3 hours per week
First Semester

3 credits
F, 6:30-9:30

Phys 213 DYNAMICS OF A RIGID BODY Professor WILLIAMS

The kinematics and kinetics of rigid bodies, Euler equations of motion, inertia tensor, principal axes, transformation theory, Euler's angles, gyroscopic motion, and the symmetric top are covered.

Prerequisite: Undergraduate analytical or engineering mechanics.

3 hours per week
Second Semester

3 credits
F, 6:30-9:30

Phys 214 SOLID STATE PHYSICS Professor TOWFIK

A study of crystals and x-ray diffraction; thermal dielectric and ferroelectric properties of solids; diamagnetic, paramagnetic and ferromagnetic phenomena; and superconductivity.

Prerequisite: Undergraduate degree in engineering, the engineering sciences, or physics.

3 hours per week
Second Semester

3 credits
F, 6:30-9:30

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, 6:30-9:30

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, 6:30-9:30

Phys 222 ELEMENTS OF NUCLEAR ENGINEERING — Dr. ANDERSEN

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: Bachelor's degree in Engineering or Physics and the consent of the instructor.

3 hours per week — 3 credits
Second Semester — M, 6:30-9:30

Phys 223 RADIOISOTOPES LABORATORY

Professors FITZGERALD and SHUKUR

The objective of the course is to establish a foundation in the field of radioisotopes for research and industry. It encompasses the study of counting systems: Geiger-Muller, scintillation, proportional, and fast and slow neutron counters. Application of these systems permits determination of nuclear processes: alpha decay, beta emission, gamma ray spectroscopy and neutron flux distribution. Isotopes of relatively short half-lives are prepared by activation experiments using a five-curie Pu-Be source in a neutron howitzer. These, and additional long-lived isotopes, are used to determine their nuclear properties. Area surveying and decontamination methods, using portable detection and monitoring equipment, acquaint the student with the theory and practices of radiological safety.

Laboratory Fee: $25.00 — 3 credits
Repeated each semester — Th, 6:30-10

Phys 224 NUCLEAR ENGINEERING LABORATORY

Professor SHUKUR

Basic experiments in nuclear physics, and experiments with a subcritical assembly are performed to determine and measure neutron flux, slowing down of neutrons, relaxation length, reflector savings factor, buckling, diffusion length, migration area, albedo of water for thermal neutrons, thermal utilization in uranium water lattice, and temperature coefficient of multiplication factor.

Prerequisite: Undergraduate course in nuclear engineering or Phys 222.

3½ hours per week — 3 credits
Repeated each semester — W, 6:30-10

Phys 230 QUANTUM MECHANICS — Dr. REFF

Included are the Schroedinger equation, the free particle, the linear harmonic oscillator, one-dimensional potential barrier probems, three-dimensional problems including the rotator, the oscillator, the hydrogen atom, time-independent, and time-dependent perturbation theory.

Prerequisite: Phys 210 or Phys 220.

3 hours per week — 3 credits
Second Semester — W, 6:30-9:30

Mech 252 THEORY OF PLATES AND SHELLS — Professor CIESLA

A study of the differential equations governing the stresses and deformation of plates and shells, strain energy methods, shells with and without bending, and the general theory of cylindrical shells with axially symmetric loads.

Prerequisite: Ma 100 or equivalent, and theory of deformable bodies.

3 hours per week — 3 credits
Second Semester — M, 6:30-9:30

Mech 254 THEORY OF ELASTIC STABILITY — Professor NIELSEN

A study is made of the critical load and buckling configuration of bars with axial and lateral loads, non-uniform cross-sections, thin plates, and shells. Both strain-energy and differential equation methods are discussed. The methods developed are applied to numerical problems.

Prerequisite: Ma 100 or equivalent, and theory of deformable bodies.

3 hours per week — 3 credits
Second Semester — Tu, 6:30-9:30

Mech 256 HYDRODYNAMICS — Professor GRANIK

Dynamics of ideal fluids are treated by methods of singularities and separation of variables. Two dimensional flows are analyzed by the

methods of complex variables. Blasius theorem is used to compute pressure distribution, forces, and moments on submerged bodies.

Prerequisite: Ma 100 or equivalent.

3 hours per week — 3 credits
Second Semester — W, 6:30-9:30

ESc 200 or ESc 300 M. S. THESIS — Designated Faculty
The thesis work will be carried on under the supervision of a designated member of the faculty. Required of all students matriculated for the Master of Science degree in the areas of basic Engineering Science.

Hours to be arranged — ESc 200: 3 credits
First and Second Semester — ESc 300: 6 credits

COURSES SPONSORED BY THE NEWARK COLLEGE OF ENGINEERING RESEARCH FOUNDATION

G 200 SEMINAR ON ENGINEERING EDUCATION — Selected Faculty
Orientation, profile of the engineering student, the student and the learning process, history of engineering education, workshop on teaching methods, visual aids, test construction and validity, evaluation of student performance, psychology of the teacher, the teacher in student guidance, engineering and teaching ethics, professional advancement, student research.

Cr. 2 — Hours to be arranged

IN-SERVICE INSTITUTES FOR HIGH SCHOOL TEACHERS

G 101 MATHEMATICS INSTITUTE — Professor BARKAN
A survey of the topics recommended by the Mathematical Association of America, with attention given to the unifying ideas of sets, variables, functions and relations.

W, 6:30-9
Cr. 3,3 — Both Semesters

G 102 PHYSICS INSTITUTE — Dr. REFF
Examination of the relationships of physics to modern philosophy, other areas of science, and the impact of physics on technology.

W, 6:30-9
Cr. 3,3 — Both Semesters

G 103 CHEMISTRY INSTITUTE — Professor BRADLEY
Emphasis on the value of mathematical calculations in physics and chemistry, with attention given to the texts of the Chemical Bond Approach Committee.

M, 6:30-9
Cr. 3,3 — Both Semesters

G 104 P.S.S.C. INSTITUTE Dr. HOFFMANN

A thorough study of the printed materials and films, construction and use of laboratory materials, and the philosophy of the Physical Science Study Committee approach to the study of high school physics.

Th, 6:30-10

Cr. 3,3 Both Semesters

G 105 ANALYTICAL CHEMISTRY INSTITUTE Professor BISHOP

A study of the newer methods of analysis which have been developed and the application of instrumental methods to chemical analyses.

Th, 6-10

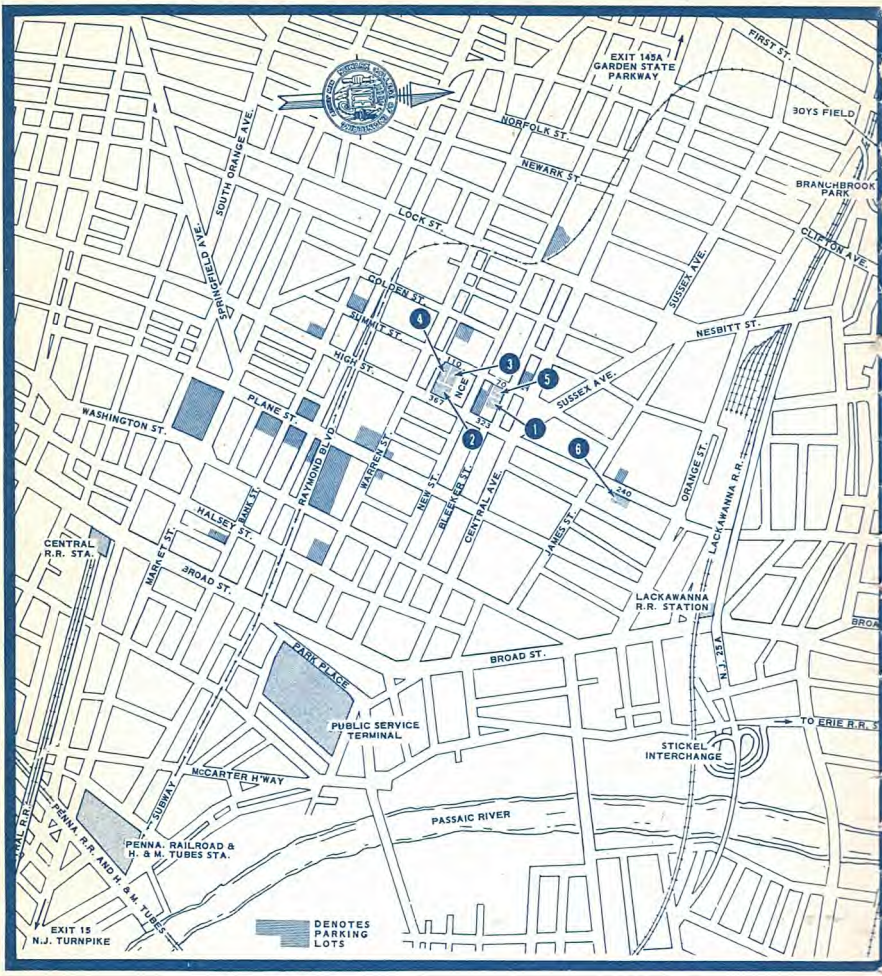
Cr. 3,3 Both Semesters

G 106 APPLIED MATHEMATICS AND MODERN ALGEBRA INSTITUTES Drs. FOSTER and KOREN

A course in applied mathematics in the first semester with selected topics from advanced calculus, differential equations, and vector analysis, with material on invariance of vector physical laws, electricity, and electro-mechanical analogues. A course in modern algebra in the second semester with attention to elementary concepts of modern algebra; all material in the outline for modern algebra recommended by Commission on Mathematics of the College Entrance Examination Board.

Tu, 6:30-9

Cr. 3,3 Both Semesters



1 EBERHARDT HALL — 323 HIGH STREET
(ADMISSIONS AND ADMINISTRATIVE OFFICES)
E BUILDING

2 WESTON HALL — 367 HIGH STREET
W BUILDING

3 CAMPBELL HALL — 110 SUMMIT STREET
C BUILDING

4 COLTON HALL — 17 SUMMIT PLACE
L BUILDING

5 CULLIMORE HALL — 70 SUMMIT STREET
M BUILDING

6 TIERNAN HALL — 240 HIGH STREET
T BUILDING

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