D. H. MANGNALL

NEWARK COLLEGE OF ENGINEERING

1881

NCE

NEW JERSEY

CATALOG OF UNDERGRADUATE DAY AND EVENING PROGRAMS

1968 - 1969

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TELEPHONE: Area Code 201, 645-5321.

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Address the President.

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REGISTRATION:
Address the Registrar. Telephone: 645-5150.

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Address Alumni Secretary. Telephone: 645-5441.

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For transcripts and student grades, address the Records Supervisor. Telephone: 645-5139.

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For information on veteran status, address the Veterans' Coordinator. Telephone: 645-5148.

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Address the Administrator. Telephone: 645-5210.

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Address the Director of Physical Plant. Telephone: 645-5151.

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 5:30 P.M. and 8:30 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 5:30 P.M. and 8:30 P.M., Monday through Thursday.

CATALOG OF UNDERGRADUATE DAY AND EVENING PROGRAMS

1968-1969

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

GENERAL INFORMATION

Newark College of Engineering, instituted in 1919, is a development of the Newark Technical School founded in 1881 by the Board of Trade of Newark and civic-minded citizens. The College is a public institution supported by both the City of Newark and the State of New Jersey and is governed by a Board of Trustees appointed by the Governor of the State of New Jersey. The Governor and the Mayor of Newark are ex-officio members.

The College is organized under five divisions: the Day Undergraduate Division, the Evening Undergraduate Division, the Graduate Division, the Division of Technology and the Division of Continuing Engineering Studies. This catalog describes programs leading to the degree of Bachelor of Science offered by the Day and Evening Undergraduate Divisions.

The Graduate Division offers programs leading to the degree of Master of Science in the major engineering fields and to the degree of Doctor of Engineering Science in chemical engineering, electrical engineering, and mechanical engineering. These programs are described in the catalog of the Graduate Division.

The Division of Technology offers a wide variety of courses and certificate programs for training engineering technicians. The Division of Continuing Engineering Studies provides non-credit short courses, conferences, and seminars for up-dating practicing engineers. The offerings of these two divisions are described in a separate catalog.

The College is accredited by the Middle States Association of Colleges and Secondary Schools and by the Engineers' Council for Professional Development.

The College's administrative offices are located at 323 High Street, immediately west of Newark's central business district, convenient to all transportation.

Current enrollment figures show 3866 students in the Undergraduate divisions, 1004 in the Graduate Division, and 1840 in the divisions of Technology and Continuing Engineering Studies.

CONTENTS

COLLEGE CALENDAR: 1968-1969

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

1968

Fall Semester Begins.....September 11

Midpoint of Semester.....November 5

Thanksgiving Holidays.....November 27 to 30, inclusive.

Christmas Holidays .....December 23 to January 4, inclusive

1969

Fall Semester Ends.....January 18

Spring Semester Begins.....January 29

Midpoint of Semester, except for February Freshmen.....March 25

Spring Vacation.....March 31 to April 5, inclusive.

Spring Semester Ends for February Freshmen.....May 20

Registration for Summer Semester —February Freshmen.....May 27

Spring Semester Ends for all students except February Freshmen .....May 27

Summer Semester Begins for February Freshmen.....May 28

Memorial Day Holiday .....May 30

Commencement .....To be announced.

Registration — Undergraduate
Summer Session* ..... June 6

Undergraduate Summer
Session Begins..... June 9

Independence Day Holiday..... July 4

Summer Semester Ends
for February Day and Evening
Freshmen ..... August 19

Undergraduate Summer
Session Ends..... August 28

*The Undergraduate Summer Session Announcement will be available at the Office of the Registrar on or about April 1.

- 1968 -

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- 1969 -

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Professor Metzger
Professor Meyer
Professor Peyser

COMMITTEE ON HONORS PROGRAMS

Professor Reff, *Chairman*

Professor Foster
Professor Grammer
Professor W. Jaffe
Professor Lyngstad
Professor Rose
Professor Schmerzler
Professor Shilman

LIBRARY COMMITTEE

Professor Wenisch, *Chairman*

Professor Cambreleng
Professor Herman
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Professor Misra
Professor Rausen

COMMITTEE ON 1967 "OPEN HOUSE"

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Professor Spitz

HISTORY OF NEWARK COLLEGE OF ENGINEERING

The history of Newark College of Engineering and of its predecessor, the Newark Technical School, closely parallels the technological growth of New Jersey and the nation over the past eighty years. Created originally to meet the demands of Newark's expanding industry in the 1880's, the Technical School and subsequently the College have been in a continuous process of development, as industry has developed, ever since.

During his term as governor of New Jersey, General George B. McClellan became convinced that the path to industrial supremacy lay in a broad system of technical education that would supply a skilled labor force. In 1879 the Civil War general therefore proposed to the legislature that funds be allocated by the State to aid in the establishment of technical schools.

In Newark, New Jersey's leading industrial city, the Board of Trade had been contemplating a technical school since 1875.

Thus, in 1881, the Board of Trade's ambitions were finally realized with the passage of the first successful legislation in the

United States to provide state aid for technical education. The Newark Board was quick to act. Spearheaded by such prominent citizens as inventor Edward Weston, school superintendent William Barringer and former congressman Thomas B. Peddie, the organization launched its campaign to bring the school into reality.

As a result, the Newark Technical School opened its doors on February 9, 1885, with Professor Charles A. Colton as its director. Its aim was to develop men who could eventually assume positions of leadership in Newark's many industries.

By offering its courses during the evening, the new technical school sought to help those who could not otherwise afford to attend. Its students, who usually worked ten hours a day, attended classes five nights a week, where they studied a hard-core curriculum of science and mathematics. At a time when many thought that technical education should consist mainly of manual training, Director Colton, backed by a sympathetic board of trustees, was determined to emphasize for his students training in scientific and technical disciplines.

Of the 106 students who began classes in 1885, only 16 were graduated in 1888. Their subsequent success, however, surpassed the expectations of the founders of the School and bore out the wisdom of Dr. Colton's approach to technical education. Many of the graduates continued their studies in leading colleges, entered various professions and rose to positions of leadership in their communities.

The success of the young School soon caused its modest rented facilities to be overtaxed. Dr. Colton appealed to the citizens of Newark to contribute funds to enable the School to erect its own building. Through the donations of a number of prominent Newarkers the money was quickly raised and in 1897 the Newark Technical School moved into its own somewhat more spacious quarters on High Street on the site of Newark College of Engineering's present campus.

With these expanded facilities, Dr. Colton was able to offer various special courses in addition to the regular curriculum. Jewelry design, architectural drawing and electricity, for example, were set up to meet the special demands of Newark's industries. As new programs were added, the basic technical curriculum was also constantly upgraded to conform to the progress of technology.

In the final years of his administration, Dr. Colton initiated plans for a day college program. But in 1918, exhausted by 34 years of dedicated service, he expressed his wish to retire. He left that year, highly honored by those who had worked with

him through the crucial, formative period of the School's development.

The Board of Trustees carried Dr. Colton's plans forward and in 1919 the State Board of Education authorized the School to grant degrees in engineering. That fall a day college program was begun with a class of 40.

In 1920, Allan R. Cullimore, formerly dean of the College of Engineering at the University of Delaware, became Director of the Newark Technical School and Dean of the College. Dr. Cullimore strongly believed that engineering education should stress an understanding of human relations as well as technical knowledge. To fill this dual requirement, he established a co-operative program with industry, in which students spent alternate periods at the College and in industrial plants. He believed that through such first-hand knowledge of the human-relations aspect of industry, his students would be more mature by the time they graduated and thus better equipped to cope with engineering problems.

As advancing technology increased its demands upon the engineer's knowledge the co-operative plan was dropped in the late 1930's in order to permit students to devote full time to their studies. To compensate for the change, Dr. Cullimore introduced into the curriculum a strong program of professional development, designed not only to make students aware of the "human relations" element in industry but also of their own individual responsibilities as citizens. Dr. Cullimore especially believed that engineers were equipped, through their particular type of education, to make special contributions of service to community, state and nation.

Over the years, the program has become such a strong element of NCE's curriculum that in 1960, on the occasion of the College's 75th anniversary, the motto "Dedicated to Education in Engineering and Citizenship" was established as a permanent statement of the College's governing philosophy.

While the College was developing its day program, the Technical School, continuing to operate at night, had also been growing. In addition, Dr. Cullimore began to realize the need for an evening degree program, and in the late 20's an evening undergraduate program was instituted which today serves over 1,000 students.

While the Newark Technical School is still a legal entity, its function has gradually undergone a metamorphosis into the Division of Technology of the College. This division, today, continues to offer terminal technical programs for the special needs of industry. Advanced conferences for graduate scientists and engineers are given by the Division of Continuing Engineering Studies.

During and after World War II, due first to the federal government's need for the rapid training of thousands of defense workers, and later for the retraining and rehabilitation of returning veterans, NCE became an important center for such help.

To further assist returning veterans, the College established a Testing and Guidance Division in 1943. Working in cooperation with the Veterans Administration, this service gave help to thousands of veterans through 1951, when it was reorganized as the Newark College of Engineering Counseling Center. The Center now provides counseling and guidance to industry, high schools, students of the College and the general public.

Originally open only to residents of Newark, the Technical School began admitting non-residents in 1897. By the late 20's the majority of the students both of the College and the Technical School were non-residents. Although financed by the City of Newark and by the State, the institution was still receiving most of its funds from Newark. Accordingly, the College appealed for more State support. Gradually over the years the amount of support has shifted and today, while the City of Newark still supports the institution, most of the public funds are received from the State.

Today NCE has twelve buildings in use and three more in the planning stages, scheduled for completion by about 1971.

Most of this major expansion has taken place under Dr. Robert W. Van Houten, a graduate of the College, who succeeded Dr. Cullimore as President in 1949. The tremendous growth of the nation's technology since the War has not only necessitated these new facilities, but has also stimulated the College's development in other directions. Thus, the College's graduate program, begun in 1940, has developed during the last few years into one of the largest in engineering in the nation, granting both the master's and doctoral degree and a new post M.S. degree, that of Engineer.

In addition, the Graduate Division works closely with a major adjunct of the College, the privately financed and separately administered Foundation for the Advancement of Graduate Study in Engineering, established in 1959, which coordinates various projects among graduate students and faculty that seek to further the frontiers of science and engineering technology.

Today, Newark College of Engineering has a foremost reputation among its peers throughout the country as it continues to fulfill the wishes of General McClellan and of those dedicated members of the Board of Trade who in the 1880's had the vision and determination to establish a technical school in Newark.

FACILITIES

BUILDINGS

From its original modest building on West Park Street, Newark College of Engineering has now expanded to twelve edifices along High Street, Warren Street, Lock Street, and Bleeker Street in the heart of Newark. The first of the buildings to be erected at the present site was a combination administration and classroom building, designated as Weston Hall in honor of Dr. Edward Weston, one of the founders of the institution, which was torn down in 1958 to be replaced by a new Weston Hall, completed in 1960. The College soon outgrew the facilities of the original building and there was built on adjoining property a four story laboratory building now known as Colton Hall, which contains equipment used in the courses, and also provides classroom, lecture and drafting room space. The continued expansion of the College necessitated the construction of Campbell Hall in 1926 and a five story Campbell Hall annex in 1930.

Still greater work areas were found necessary immediately following the Second World War, and a five story extension to Colton Hall was built which houses departmental offices and laboratories. The expansion of administrative and student facilities also occasioned the purchase of the former Newark Orphan Asylum property at the corner of Bleeker Street. This century old building was rehabilitated and named Eberhardt Hall in honor of Frederick L. Eberhardt, former chairman of the Board of Trustees of the College.

Additional facilities were completed in the Spring of 1958 with the opening of Cullimore Hall, a six story building at the rear of Eberhardt Hall, containing a faculty-staff dining hall and 37 classrooms, as well as other offices and college services. With the completion of the new Weston Hall, a six story building, 15 laboratory areas, an enlarged Library, and a 400-seat lecture hall were added to the College plant.

In 1956, the College also acquired a building situated at 240-250 High Street through the philanthropy of Mr. Martin F. Tiernan, which after extensive remodeling became occupied by the departments of Chemical and Civil Engineering for laboratories, offices, and classrooms. This is the Martin F. Tiernan Laboratory Building.

As one of New Jersey's eight state-supported higher educational institutions, Newark College of Engineering received the sum of $9,631,000 from two bond issues in 1959 and 1964.

These funds have so far added a Center with dining facilities for 900 students, a bookstore and complete facilities for student organizations; a Physical Education Building with three gymnasiums, a swimming pool, outside tennis courts and a playing field; and a major Academic Building to house the

Department of Electrical Engineering. In addition, an Alumni Center for Continuing Engineering Studies, a gift to the College by the NCE Alumni Association, has also been completed.

NCE's newest building, a major Library-Humanities Center and a maintenance building were dedicated in 1967. Further development during the next five years will include additional classroom and laboratory space, high-rise dormitories for 500 students, a graduate research building, and additional food services.

COUNSELING CENTER

The Counseling Center exists primarily to assist students in two ways: first, to help them understand and deal with problems which may be interfering with their satisfactory scholastic progress; and secondly, to help them plan thoughtful and responsible action regarding their educational and career choices. Noteworthy services of the latter kind are the pre-employment career counseling of seniors and of students who, for any reason, may have to leave the College. These confidential services are free to undergraduate students of the College.

Students may themselves request counseling whenever the Center is open. Students may be referred for counseling by the Dean of Students, the Assistant Dean of Students, and members of the faculty.

The Center is located in especially designed rooms on the third floor of Eberhardt Hall. In addition to experienced professional counselors, its staff includes a trained psychometrist who administers standard psychological and other tests, and scoring and stenographic assistants. Its facilities provide privacy for counseling and for individual or group testing, including the testing of vision and hearing.

The Center dates from 1943, when the first of over 14,000 veterans were counseled for the Veterans Administration. Since 1943, over 30,000 persons and many business and industrial firms have used the services of the Center.

The Center's community services, all by appointment (see inside front cover), include: (a) the educational and career counseling of 11th and 12th grade students, college students and out-of-school adults; (b) the evaluation for business and industry of applicants for employment and of employees for promotion, training, or transfer; (c) educational counseling for the parents of 8th, 9th, and 10th grade students who are too young for career counseling; and (d) individual testing and score reporting for applicants to graduate schools which require the Miller Analogies Test, the Minnesota Engineering Analogies Test, or the

Doppelt Mathematics Reasoning Test. Counseling and testing fees reflect the cost of providing each service.

The Center is open from 9 a.m. to 5 p.m. Monday through Friday, as well as one evening each week (for evening students) and by appointment on occasional Saturday dates.

LIBRARY

The College Library makes available to students a collection of books, periodicals, pamphlets and government documents for use in their course work and as supplemental reading.

Students have access to a book collection consisting of more than 50,000 bound volumes including an up-to-date reference section covering the fields of study offered by the College. Subscriptions to abstract, business and labor services as well as to over 800 periodicals are maintained.

To augment the resources of the College Library, students have the privilege of using other libraries in the area. Among these are the libraries of Newark-Rutgers, the Engineering Societies, the Chemists' Club and the Newark and New York Public libraries.

Country-wide interlibrary loan arrangements, together with the availability of microfilm and copying services, further enrich the material available for research and study.

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.

The Library, which also houses a permanent display of Edward Weston's early electrical equipment and inventions, is open for service on all days when classes are in session, between the hours of 8:30 a.m. and 10:00 p.m. and on Saturdays during the fall and spring semesters from 9:00 a.m. to 4:00 p.m. Holiday and recess period hours are posted on the bulletin board located at the Library entrance.

OBJECTIVES

Newark College of Engineering offers to qualified young men and women the opportunity to follow a course of study leading to the degree of Bachelor of Science in one of six major fields: Chemical, Civil, Electrical, Industrial, or Mechanical Engineering, or in Engineering Science. In each case the curriculum is sufficiently broad to permit a graduate to enter the engineering profession immediately, or to continue his studies in graduate school in engineering, science, or even in some other field.

In this advanced technological age, in which science and engineering have assumed such important roles, an engineering education enables an individual to make significant contributions to society. Because the engineer applies scientific principles and practical judgment to the economic solution of many problems concerned with human welfare, his education must include, in addition to courses in engineering analysis and design, numerous courses in the basic sciences, and in the humanities and social sciences as well. Thus, the total program at Newark College of Engineering provides each student with a liberal education, well-suited to permit him to make important contributions not only toward the solution of specific technical problems, such as those found in rocket or computer circuit design or plastics manufacture, but also toward the solution of such compelling problems of society as are evidenced in transportation, urban redevelopment, or air and water conservation.

Engineering education at Newark College of Engineering is so broadly-based that, while most graduates do remain in the engineering profession, a significant number use their engineering backgrounds as a foundation for professional careers in law, medicine, business, education, science, and other fields.

The undergraduate programs emphasize general engineering principles that may be applied in many specialized functions such as research and development, design, construction, manufacturing, and marketing of products. The College maintains close contact with industry so that its students are made aware of the opportunities available to them after graduation. Students are encouraged to learn about industry through employment during summer vacation periods. The College's placement service assists students in finding employment for the summer and in finding permanent positions after graduation.

With the increasing importance of graduate education for engineers, the College strongly encourages its students to continue their education beyond the bachelor's level. Toward this goal, seniors are given assistance in obtaining financial support for graduate study at the College or at other leading engineering schools.

Although engineering competence is essential for success, character is equally important. The College expects its students to develop a professional attitude with respect to their studies and their personal decorum, and emphasizes qualities of maturity, responsibility, and integrity.

PROFESSIONAL CONDUCT

Every student shall conduct himself with decorum and shall constantly adhere to ethical and professional behavior. All work offered as the student's own must be that 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.

The College feels that the development of a sensitivity on the part of the students regarding the importance of dress and good grooming is a part of the professional discipline which constitutes engineering education. People who are being educated for a profession should be responsible enough to decide their own attire. The only stipulation, insisted upon by the College, is to be neat, tidy, and clean. However, as responsible persons, students will be expected to wear jackets, ties, and suitable accompanying attire for placement interviews and other occasions where business attire is customary.

PROGRAMS

DAY AND EVENING UNDERGRADUATE DIVISIONS

The College offers four-year undergraduate curriculums in Chemical, Civil, Electrical, Industrial and Mechanical Engineering, and in Engineering Science.

Much of the subject matter in the undergraduate programs is common to all of them. These common courses represent the unity among all branches of engineering of basic sciences, mathematics, humanities, and engineering science.

The work of the first two years of the Day Division is designated as the Junior Division. The work of the third and fourth years, concentrated in the selected major field, is known as the Senior Division.

The evening program of Newark College of Engineering is also divided into two sections. The first four years of work come under the heading of the Junior Division (Evening). This division has the same entrance standards and requirements as the day program, and the work taken during the evening hours parallels the subjects studied in the first two years of the undergraduate day division. The program of the Senior Division is approximately four years in length if taken on a full evening schedule, and completion of these courses under the same standards as in the day third and fourth year programs will lead to the bachelor of science degree.

Well-qualified students interested in attending medical school after graduation in engineering may make special arrangements to fulfill medical school admission requirements while completing their engineering degree.

Courses for which less than fifteen students are enrolled may not be given. Students may not register for part of a course.

For information concerning programs consult or write the Dean of Admissions.

HONORS PROGRAM

An Honors Program at Newark College of Engineering has been established in the Day Undergraduate Division in all four years and all five curriculums. Students in the freshman, sophomore, and junior years may participate in Honors courses in Mathematics and in Humanistic Studies with the recommendation of members of the faculty. Aptitude tests and high school records are used as corroborative selective criteria. Such Honors courses, appropriately designated, are described under the offerings of their respective departments. Students in the junior and senior years may participate in programs involving

special course work, summer honors reading and course work, special lectures, and individual course or laboratory work, with the recommendation of members of the faculty. College records are used as corroborative selective criteria. In certain cases, students in the Program may, with the approval of the department concerned, substitute graduate courses for courses in the regular undergraduate curriculum. The Honors Program is guided by a faculty committee and special advisers within each department involved.

GRADUATE DIVISION

Newark College of Engineering offers courses at the graduate level leading to the degree of Master of Science in the fields of Chemical, Civil, Electrical, Industrial and Mechanical Engineering, and in the various Engineering Sciences. A program of courses and the opportunity for research, leading to the degree of Doctor of Engineering Science, are also offered in the fields of Chemical, Electrical and Mechanical Engineering. The College also offers post M.S. programs, leading to the Degree of Engineer, to qualified practicing engineers.

Graduates of accredited institutions who wish to enroll in programs of advanced study may obtain further information by requesting the Division's *Catalog of Graduate Programs*. (See inside front cover.)

Specially qualified seniors at Newark College of Engineering may take courses in the Graduate Division before graduation under certain specified conditions. Information concerning these conditions may be obtained from the Dean of the Graduate Division.

The College encourages well-qualified students to consider full-time graduate study. Fellowship support sponsored by the College, by the Federal government and by industry is available. The College and the Foundation for the Advancement of Graduate Study in Engineering also sponsor a combined program of research, teaching and study leading to the master's degree. Inquiries concerning these programs should be directed to the Graduate Division.

FOUNDATION FOR THE ADVANCEMENT OF GRADUATE STUDY IN ENGINEERING

The Foundation for the Advancement of Graduate Study in Engineering, a privately incorporated and financed organization, serves as a coordinating agency for research activities at the College. One of the Foundation's major objectives is to offer the opportunity for professional development to graduate students and members of the teaching staff by providing for or obtaining support for research activities. The staff of the Foundation assists with the preparation of research proposals,

solicitation of financial support, and administrative details involved in research programs.

COMPUTING CENTER

The Computing Center is an inter-departmental laboratory for the use of students and staff of all divisions of the College. The equipment consists of analog computers and modern high-speed digital computers with remote consoles. The computers are capable of obtaining numerical solutions to a wide range of engineering and scientific problems as well as the processing of data for general business operations.

Instructions in computer programming and operation are given at various times during the school year as an integral part of the college curriculum and also through a number of special courses. Those who have taken these courses may, through their instructors, reserve time on the computer for their problems. The staff of the Center is available for consultation in problems of programming and operation.

DIVISION OF TECHNOLOGY

Individual courses and three year certificate programs are offered for men and women in industry who wish to further their technical, scientific, or mathematical training, but who are not concerned with credits toward a degree. One hundred thirty-five courses in architectural, building construction, civil, chemical, electrical, and plastics technologies, as well as metallurgy, refrigeration and air conditioning, and machine and tool design are offered under the supervision of various departments of the College. These courses are conducted in the evening and on Saturday for twelve-week terms which begin in the fall, winter, and spring. The certificate programs are designed to prepare persons for placement as engineering technicians.

DIVISION OF CONTINUING ENGINEERING STUDIES

The educational programs arranged by this Division are intended to fulfill the requirements of practicing engineers, scientists, and management personnel for information in solving complex engineering problems. Short courses and seminars are offered which illustrate present theory and applications. New information from current research and development is disseminated in lectures, conferences, and symposia presented during the day or in the evening. The Division works closely with professional organizations and industrial groups to meet needs for specialized non-credit training programs. Such requirements may be discussed with staff members of the Division.

CRITERIA FOR GRADUATION

DEGREES

Newark College of Engineering reports to and receives the right to grant degrees from the New Jersey State Board of Higher Education.

Candidates for graduation who satisfactorily complete a regular undergraduate course of study and the examinations required receive the degree of Bachelor of Science (B.S.) in the course pursued.

While passing marks are required as a minimum in all subjects undertaken, barely passing marks alone do not insure graduation.

To be eligible for graduation, a student must attain a grade point average of 2.00 in all the courses listed in this catalog as being required in the third and fourth years of the engineering department in which he desires to earn a Bachelor of Science degree.

The catalog of the Graduate Division states the requirements for the degrees of Master of Science (M.S.), Engineer (Eng.), and Doctor of Engineering Science (Engr. Sc. D.).

Each degree is certified by a diploma bearing the seal and the signatures of officers of this institution.

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.

Candidates for any degree granted by the College shall appear in person upon the appointed commencement day to receive the degree, unless excused by the Faculty.

GRADUATION WITH HONORS

The academic honors of *cum laude, magna cum laude,* and *summa cum laude* are awarded to qualified students at graduation. The honors are given for outstanding academic achievement, as determined by standards set by the College.

GRADES

Grades used in the College and their general significance are as listed below:

GRADE	SIGNIFICANCE
4	Superior
3	Above average
2	Satisfactory

1	Minimum for credit
O	No credit
INC	"Grade deferred"—given in *rare* instance for students who would normally complete work, but because of special circumstances *could* not. If this grade is not removed within the next regular semester, a grade of O will result.
R	Resigned
W	Withdrawn.
S	Satisfactory. (Physical Education only.)
U	Unsatisfactory. (Physical Education only.)

ADMISSIONS

APPLICATION

Candidates for the Freshman Class must submit an application for admission and a certified secondary school record on forms provided by the Office of Admissions. Forms normally employed for that purpose by the secondary school submitting the record may also be used for the scholastic record. A $10.00 application fee must accompany the application.

SCHOLASTIC RECORD

The certified record must include the date of graduation; or if the record is submitted prior to graduation, a certificate of graduation must be submitted before final acceptance can be granted.

Failure on the part of the applicant or the secondary school to provide complete information may delay consideration of the application.

In lieu of a certificate of graduation from an approved secondary school, a candidate may offer a high school equivalency certificate as issued by the New Jersey State Board of Education.

REQUIREMENTS

Engineering requires more than mere technical ability. Graduates of engineering colleges are expected to be well versed not only in mathematics and science but also in English and social studies. The curriculums in accredited engineering colleges are designed with this goal in mind, and experience has proved that applicants for admission need an all-inclusive secondary school background.

Candidates for admission must submit a minimum of 16 secondary school units:

Ten are required:

English	4 units
College preparatory mathematics, including algebra, geometry, and trigonometry	4 units
Physics	1 unit
Chemistry	1 unit

The remaining 6 may be submitted from among the following as indicated:

Foreign Language	2 to 5 units
Social Studies	1 to 5 units
Science and Mathematics in addition to required units	1 to 3 units
Any other subject having a value of one full unit	1 unit

In selecting applicants for admission from among those who meet the entrance requirements listed above, preference will be given to those who submit two or more units in one foreign language.

Candidates should plan to take the Scholastic Aptitude Test of the College Entrance Examination Board, the entrance examination required of all applicants, in December or January of their senior year. In addition, day freshmen candidates are encouraged to take achievement tests in Mathematics (Level 1) and either Physics or Chemistry. These achievement tests may be required of candidates who might be handicapped by their submitting only the results of the Scholastic Aptitude Test. Applications and information on fees and dates of examinations can be obtained from the College Entrance Examination Board, Box 592, Princeton, New Jersey.

Since increasing enrollments are causing existing facilities to be used to the utmost, legal residents of the State of New Jersey will be given preference in acceptance. A limited number of non-residents of New Jersey may be accepted for admission.

The College requires a student to carry 12 or more credits to be classified as a full-time student.

ADMISSION BY TRANSFER

Students who have pursued studies at accredited colleges or universities offering comparable programs and who have demonstrated by their previous records that they are capable of doing academic work of the high caliber which would enable them to earn a degree at Newark College of Engineering may be admitted with advanced standing. Credit may be given for completed courses that are equivalent to those in the curriculum for which the applicant is accepted, and in which he has earned final grades higher than the lowest passing grade.

Candidates who have previously attended another institution giving courses above the secondary school level must comply with all the regulations set forth for candidates for the first year class, including the scores earned on the Scholastic Aptitude Test of the College Entrance Examination Board and, in addition, submit official transcripts and statements of honorable dismissal from all institutions which they have previously attended.

SPECIAL STUDENTS

NON-MATRICULATED STUDENTS

Although the College usually recommends a program of studies leading to a degree, applicants who fulfill all the admission requirements may, with the approval of the Admissions Office, choose courses without following a degree program. Official transcripts of record for non-matriculated students will list subjects completed, grades earned, and the credits which will be granted if the student matriculates.

AUDITOR

Permission to enroll as an auditor may be granted by the Admissions Office to mature students who can demonstrate that they are qualified to take and profit from the courses for which

they desire to register. Auditors receive no grade or academic credit but may receive a statement of their attendance in the course.

ENROLLMENT

Those who wish to be considered for enrollment as Special Students may receive instructions as to the procedure to be followed by writing to the Office of Admissions.

Special Students approved for enrollment will be permitted to register for courses in which there is still room available after all degree candidates have completed their registration.

PRE-COLLEGE GUIDANCE

Since students of Newark College of Engineering are in the main graduates of secondary schools located in the northeastern part of New Jersey, personal communication with those likely to be candidates for admission is readily maintained. Members of the Admissions Staff make scheduled visits to all the schools in the area and in addition make every effort to accept invitations to participate in guidance programs or to talk informally with groups of students. A class characteristics study of the most recently admitted class and a follow-up report of their graduates already enrolled are sent annually to the high schools concerned.

High school and junior high school students are encouraged to visit the Admissions Office for an interview or to be escorted on tours of the buildings. Members of Alpha Phi Omega, national college service fraternity, act as guides for these tours. Arrangements can be made for guided tours or interviews by telephoning the Admissions Office, Area Code 201, 645-5140.

The Counseling Center also participates in pre-college guidance. For details, refer to the section "Facilities."

INTERVIEWS

An interview may be required of any candidate to assist in determining his probable fitness to do engineering college work. The date and time of the interview will be arranged by the Dean of Admissions.

EXPENSES

TUITION AND FEES

Day Division

As a public institution receiving support from the State of New Jersey and the City of Newark, and having no general endowment funds, it is incumbent upon Newark College of Engineering to establish its tuition and fees at a level which will maintain the proper relationship between the responsibilities of the State, the City, and the direct beneficiary, the student.

To preserve the equities of all interested parties, it is necessary for the College to adjust its tuition charges from time to time as educational costs become affected by changing economic conditions.

	Charges per Semester	
	New Jersey Residents	*Non-Residents*
Tuition*	$200.00	$400.00
Regular Fees		
Registration	10.00	10.00
General Fee	25.00	25.00
Total Tuition and Regular Fees per Semester	$235.00	$435.00

*Tuition includes charges for services other than instruction, such as library, publications, counseling, placement, etc., but does not cover the breakage or loss of College property. The General Fee provides funds for the support of student activities, health services, and other non-academic facilities and services.

Tuition charges are somewhat higher for special programs of study differing from those shown in this catalog.

APPLICATION, MATRICULATION AND SPECIAL FEES

Day Division

ADMISSION APPLICATION FEE

Each candidate for admission to the College must pay an APPLICATION FEE of $10.00 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 College. This fee covers service which is necessary to evaluate applications for admission.

READMISSION APPLICATION FEE

Any applicant for readmission to Newark College of Engineering must pay a READMISSION APPLICATION FEE of $10.00 at the time the Application for Readmission form is submitted. (See section "Readmission," page 40.) This fee is not returnable, regardless of whether or not the student is readmitted to the College. This fee covers service which is necessary to evaluate applications for readmission.

MATRICULATION FEE

All students entering the College for the first time as candidates for a degree are charged a MATRICULATION FEE of $5.00.

LATE REGISTRATION FEE

Registration is required for each semester. A LATE REGISTRATION FEE of $10.00 is required of those who register late.

PHYSICAL EXAMINATION FEE

A fee of $10.00 is charged if, at the discretion of the College, it seems advisable for the student to be given a physical examination.

LABORATORY FEE

Students registering for the professional work of any semester in the Chemical Engineering Department are charged a special LABORATORY FEE of $10.00 a semester if residents of New Jersey, or $20.00 a semester if non-residents.

SCHEDULE CHANGE FEE

A SCHEDULE CHANGE FEE of $3.00 is charged when a student requests a schedule change for reasons other than those beyond his control.

CHANGE OF GRADE FEE

A fee of $1.00 is charged for the removal of a grade of "INC."

SPECIAL EXAMINATION FEE

For special examinations, taken at times other than those regularly scheduled, a fee of $5.00 is charged.

GRADUATION FEE

A GRADUATION FEE of $25.00 is required of all candidates for the Bachelor's degree; and a graduation fee of $25.00 for advanced degrees. The graduation fee includes cost of rental of academic dress.

INSURANCE

Health and accident insurance is made available to full time day students at a reasonable cost. See page 49.

EXPENDITURES FOR BOOKS

Students are advised to defer expenditures for books until the official list of textbooks has been posted at the College Bookstore.

For the first semester of the freshman year, books cost approximately $85.00 with an additional $75.00 covering the cost of a slide rule, drawing instruments and general supplies, including gym clothing, for that semester. Books and supplies for the second semester of the freshman year will cost approximately $70.00.

PROPERTY LOSS

The College is not responsible for loss of property by fire or theft in its buildings and grounds.

EVENING DIVISION

Information concerning expenses for the Evening Division will be found on pages 75-77.

PROCEDURES

REGISTRATION

Prospective students will be informed of registration procedures by the Registrar, after the latter has received certification of acceptance from the Dean of Admissions.

Students entering the College for the first time are required to submit a *completed physical examination form* prior to August 1 for September admissions and January 1 for February admissions. The form will be furnished by the Registrar. Each examination form will be reviewed by the College physician.

Currently enrolled students will be informed of registration procedures (during July for the Fall Semester and during January for the Spring Semester) by the Registrar.

Former students (not currently enrolled), after being readmitted by the Dean of Students, will be informed of registration procedures by the Registrar.

Failure to complete registration by the close of the registration period will make the student subject to payment of a late fee. (See page 39.)

STUDENT IDENTIFICATION CARD

The Registrar will issue an identification card to each student. This I-D card must be presented when requested by authorized personnel of the College. Failure to do so will subject the student to disciplinary action.

COURSES AT RUTGERS-NEWARK COLLEGE OF ARTS AND SCIENCES

Newark College of Engineering and Rutgers-Newark College of Arts and Sciences, desiring to offer the broadest opportunities to their undergraduate students, have agreed to an exchange of student enrollment in courses at each institution under certain conditions. A student at Newark College of Engineering, wishing to enroll in a course at Rutgers-Newark College of Arts and Sciences, should consult the Dean of Engineering.

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 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.

After the first two weeks of the semester any change of program will be considered a withdrawal from a course (or from the College) and the student should follow the procedures stipulated in the section "Withdrawals and Refunds."

READMISSION

Students of any of the groups listed below who wish to re-

sume their studies at the College must apply for readmission:

1. Students who withdraw from the College during any semester and wish to return for the next or any succeeding semester,
2. Former students who have not been in attendance for one or more semesters, and
3. Students who have been dismissed for academic reasons.

Students who have been dismissed for academic reasons are not eligible for readmission until one semester has elapsed since the time of their dismissal. The results of a recent series of aptitude tests (which can be arranged at no cost to the applicant) must be on file at the Counseling Center. This is mandatory for both Day and Evening students.

To initiate readmission, students must obtain an Application for Readmission at the offices of either the Dean of Students or Registrar and then complete and submit this form with the required readmission application fee of $10.00 to the Dean of Students. Deadline dates for the receipt of applications for readmissions are as follows:

For the Fall Semester ..... August 1
For the Spring Semester ..... December 20
For the Summer Session ..... May 1

Applicants will be informed of their readmission status by the Dean of Students. Those who are advised of acceptance for readmission will be sent registration instructions by the Registrar.

TRANSCRIPT OF GRADES

A semester grade record is issued to the student by the Registrar at the end of each semester. Students who wish to have a Transcript of Record issued on their behalf must submit a request in writing to the Records Supervisor. Transcript requests must be accompanied by a payment fee of $1.00 for each copy. Grades are discussed fully in the section "Criteria for Graduation."

WITHDRAWALS AND REFUNDS

WITHDRAWAL PROCEDURE

Registration for a course places a definite responsibility upon the student to carry the course through to conclusion and to receive the grade he has earned. However, it is recognized that in exceptional cases it may be impossible for the student to continue in attendance. If a student wishes to withdraw from a course, or courses, or from college, he should notify the Dean of Students in writing, using a form to be obtained from his office or from the Registrar.

A student may resign from any subject during the first eight weeks of the term, or equivalent, and receive an "R" in any subject from which he resigns. After the first eight weeks, or equivalent, when an instructor has reason to believe that a student is no longer in attendance and if the student's class

standing at the time of last attendance is 2 or better, the instructor will report a grade of "W"; if below a 2, the instructor will report a grade of "O," except that if the withdrawal comes within the last four weeks, or equivalent, of the semester, the student will be given the grade earned as of the end of the semester.

Should a student be forced to withdraw due to causes beyond his control, the matter should be promptly referred to the Dean of Students for consideration.

The receipt of the notice by the Dean of Students will be considered as the date of the withdrawal.

Students withdrawing from a course, or courses, or from college, should adhere strictly to the general regulations as stated above.

WITHDRAWALS FROM COLLEGE—SELECTIVE SERVICE

Any 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. If his induction occurs after the middle of a semester, certain options are available to the student, and he is advised to confer with the Dean of Students concerning particulars. 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

Students who withdraw from College of their own accord will receive a refund based upon the following schedule, provided that a signed withdrawal application has been received by the Dean of Students. The date of withdrawal will be the date upon which the application has been received by the Office of the Dean of Students. Refunds will not be granted for withdrawal applications received after the fifth week, except in cases of military induction as is explained elsewhere in this catalog. Applications for withdrawal may be obtained from the Registrar or from the Office of the Dean of Students.

REFUNDS

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

The percentage of tuition and general fee refunded will be based on the following table:

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

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

SCHOLARSHIPS, AWARDS AND STUDENT AID

SCHOLARSHIPS AND AWARDS

Through the years the College has received applications from students who have shown a definite need for financial assistance in meeting their college expenses. For such needy young men who also possess the ability to carry on engineering study satisfactorily, certain scholarships are available.

Most of the following scholarships are available to full time students registered in the Day Division. It is expected that since evening students will be engaged during the day in income-producing occupations, there will be few cases where scholarship assistance is actually required.

Aaron Lippman Freshman Scholarship

A scholarship of $440 is awarded annually to an incoming first year student by Mr. Aaron Lippman of Aaron Lippman and Company, Newark, N. J.

Alcoa Foundation Scholarships

Four scholarships of $250 a year have been established by the Aluminum Company of America for junior and senior students who stand high scholastically in their class and show a potential of becoming successful engineers in their particular field.

Alumni Scholarships

The NCE Alumni Association annually awards nine $100 scholarships to incoming freshmen. The awards are determined on the basis of ability, need, and at the recommendation of the Director of Admissions.

American Institute of Chemical Engineers Loan Fund

New Jersey Section of A.I.Ch.E. has established an annual fund to provide financial aid to chemical engineering juniors and seniors. Fifty percent of the grant must be repaid after graduation.

American Society of Tool Engineers Scholarship

Northern New Jersey Chapter 14 of the American Society For Tool & Manufacturing Engineering will award two scholarships of $150 each to two students of sound scholastic ability who have a need for financial assistance and who are majoring in mechanical engineering.

J. T. Baker Chemical Company Scholarsihp

A two-year award is presented to an incoming junior chemical engineering undergraduate for his junior and senior years. The scholarship holder will also be offered

a summer position at the company's Phillipsburg plant. The applicant must be a U.S. citizen.

BOARD OF TRUSTEES SCHOLARSHIPS

A limited number of scholarships in the amount of $100 each are made available each fall and spring semester by the College Board of Trustees.

BLONDER-TONGUE FOUNDATION AWARD

A scholarship of $250 has been established for award to a senior in electrical engineering in recognition of high scholastic attainment and the demonstration of outstanding potential in the fields of radio and television (electronics).

BOY SCOUT SCHOLARSHIPS

The Board of Trustees has granted two scholarships, the recipients of which are to be chosen from scouts in Newark, Belleville and Irvington by the Robert Treat Council of Boy Scouts of America.

JAMES FRANCIS COCHRANE SCHOLARSHIP FUND

A four year scholarship is awarded in memory of James Francis Cochrane, alumnus. The award, based upon an endowed fund established by his mother, Mrs. Josephine M. Cochrane, is made to a graduate of East Orange High School or Clifford J. Scott High School. If a qualified candidate cannot be found from these two institutions, the Dean of Students may select a candidate from another New Jersey high school.

ESSEX ELECTRICAL LEAGUE SCHOLARSHIP

The Essex Electrical League annually awards a $500 scholarship to a third year electrical engineering undergraduate for his senior year. To be qualified, a student must be a resident of Essex County, N.J. and demonstrate both high scholarship and financial need.

EVA COHN SCHOLARSHIPS

By the will of Eva Cohn a few scholarships are available for worthy and capable students in financial need.

COLTON MEMORIAL SCHOLARSHIP

A Colton Memorial Scholarship, established in memory of Dr. Charles A. Colton, first director of the Newark Technical School, is awarded each year by the Scholarship Fund Trustees of the Newark College of Engineering Alumni Association, in the amount of $400, to a member of the Freshman class. Applicants will be considered on the basis of high school record, College Board scores, and need.

Communication Systems, Inc. Scholarship

This scholarship will be awarded annually to an electrical engineering undergraduate entering his junior or senior year. The award is made by Communication Systems, Inc. of Paramus, N. J.

Allan R. Cullimore Memorial Scholarship

A scholarship in memory of the late Dr. Allan R. Cullimore, former president of the College, is awarded annually by the Scholarship Fund Trustees of the Newark College of Engineering Alumni Association. This scholarship, in the amount of $400, will be awarded to the junior class member having the highest grade-point average in the class during the first six semesters at NCE.

John Christopher Denman Scholarship Fund

This fund has been established to provide a scholarship for an evening school student who wishes to take professional work at NCE.

Essex County Engineering Society Scholarships

The Society will provide one or more scholarships in the amount of $200.00 annually, divided equally between two successive semesters. The student must have maintained a satisfactory academic record through one or more years at NCE and must need financial assistance.

Other things being equal, the son or daughter of a professional engineer will be given preference. The student must be willing to take such tests as may be requested by the college committee appointed to select the recipient. The recipient will automatically become the nominee for the same award for the next year unless he no longer requires financial assistance, in which case the award will be made to another qualified student. The final selection of each candidate will be made by a committee of the faculty of the college.

Solomon Fishman Memorial Scholarship

The Solomon Fishman Memorial Scholarship is awarded annually to a third year student by the Essex County Society of Professional Engineers in memory of the late Professor Solomon Fishman of the NCE Faculty.

C. Homer Flynn Memorial Scholarship

A scholarship of $500 per year is awarded annually by the Federation of Societies of Paint Technology to a senior undergraduate interested in chemical engineering relating to paint and protective coatings technology. Preference will be given to the son or daughter of a person associated with the industry.

FOLEY MACHINERY ENGINEERING SCHOLARSHIP

The Foley Machinery Engineering Scholarship of $500 is awarded annually to a male undergraduate in Civil, Electrical, or Mechanical Engineering for the junior year. The award winner must be a resident of one of the 13 northern counties of New Jersey and will be selected on the basis of promise in his field of engineering, leadership, character, personal and academic achievement, and financial need.

GENERAL MOTORS CORPORATION SCHOLARSHIPS

One General Motors Corporation Scholarship to Newark College of Engineering is awarded each year to an entering freshman. The amount of the award is flexible, depending upon the need of the individual for financial assistance, and ranges from an honorary award of $200 up to $2000 per year. The scholarship is renewable for four years providing the recipient maintains a high academic record.

HERBERT P. GLEASON SCHOLARSHIPS

By the will of Herbert P. Gleason several scholarships are available from time to time for young men of character and ability.

THE IRVINGTON OPTIMIST CLUB SCHOLARSHIP

The Optimist Club of Irvington offers annually a $350 scholarship at Newark College of Engineering to a senior boy in one of the high schools in Irvington, New Jersey.

A committee of school personnel determines the winner and an alternate on the basis of need, scholarship, College Board scores, marks, especially in English, mathematics, and science, personality ratings, and extra curricular activities. The winner must already have been accepted at Newark College of Engineering and determination made that he will definitely attend Newark College of Engineering.

JERSEY CENTRAL POWER AND LIGHT COMPANY SCHOLARSHIPS

Jersey Central Power and Light Company and the New Jersey Power and Light Company annually award two scholarships to students who will be members of the senior class. The awards are made on the basis of academic achievement and need.

JUNIOR ACHIEVEMENT SCHOLARSHIP

The college Board of Trustees annually awards a scholarship of $200.00 to be used to pay part of the first

year's tuition expenses for a Junior Achiever. Candidates are selected by the National Scholarship Committee of Junior Achievement.

Odon S. Knight Memorial Award

Each year a scholarship is awarded by the North Jersey Section, American Institute of Chemical Engineers to a senior chemical engineering student. The award will be announced upon completion of the student's junior year. The recipient must be of outstanding scholarship, good character, and in need of financial assistance.

Materials Handling Prize

The Silent Hoist and Crane Company Materials Handling Award is presented annually for the best papers on the subject of materials handling. The award is made from proceeds from a trust established by the Wunsch Foundation, Inc., of Brooklyn.

Robert M. Perkins Scholarship

An annual scholarship, established by the A.P. Smith Manufacturing Company in honor of Robert M. Perkins, is awarded to a candidate for admission to NCE or to an undergraduate of NCE who is either an employee, a former employee, or the child of an employee or former employee of the A.P. Smith Manufacturing Company or of Linker Machines, Inc. If no qualified candidate is available, the award may be given to a student of NCE not so qualified.

New Jersey Society of Professional Engineers Scholarship Awards

Each year the New Jersey Society of Professional Engineers awards one or more scholarships to regular daytime students who are in the last year of candidacy for the Bachelor's Degree in a curriculum accredited by the Engineers Council for Professional Development. Students of Newark College of Engineering and three other engineering colleges in New Jersey are eligible for consideration. Each scholarship is in the amount of $500.00 with final selection determined by the scholarship committee of the college.

Nopco Chemical Company Scholarships

Nopco Chemical Company annually makes two scholarships available to Chemical Engineering juniors for their senior year. The recipients are usually selected by the Chemical Engineering Department on the basis of academic achievement and need.

HENRY J. RUESCH SCHOLARSHIP FUND

A scholarship fund established in memory of Henry J. Ruesch, Class of 1891, to provide financial assistance to a day undergraduate who has demonstrated good academic progress. The scholarship will be retained by the recipient until graduation, provided he continues to qualify academically and has continued to maintain acceptable standards of professional conduct.

JOHN A. SCHIECK MEMORIAL FUND

By the will of Caroline D. Schieck, a scholarship fund has been established in the name of her brother, John A. Schieck. From time to time several scholarships will be available from this fund.

WILLIAM L. SCHOONOVER SCHOLARSHIPS

By the will of William L. Schoonover several scholarships are available from time to time for worthy and capable students in financial need.

ARTHUR SILVERMAN SCHOLARSHIP

Arthur Silverman, Class of 1939, makes available to NCE a yearly scholarship covering tuition and fees which is awarded to a student upon the recommendation of the scholarship committee.

UNIROYAL FOUNDATION SCHOLARSHIPS

Funds for a limited number of annual scholarships have been granted to Newark College of Engineering to assist junior and senior year students of proven ability who lack personal financial resources.

WESTERN ELECTRIC FUND SCHOLARSHIPS

These scholarships are awarded annually by the Western Electric Co., Inc. to third and fourth year students who exhibit high academic performance. Awards are made by the scholarship committee and cover tuition, books, and fees.

STUDENT AID

The College participates in the National Defense Student Loan Program of the Federal Government whereby full-time students at the College may secure loans to meet the cost of attending the College and make repayment after graduation or leaving the College.

The College also administers several loan funds from which loans may be made to a limited number of students. These funds include the Continental Electric Company Student Loan Fund, the Sanford L. Kahn Loan Fund, Morris County Association of Professional Engineers and Land Surveyors Loan Fund, Newark College of Engineering Scholarship Fund, the Abraham Rothschild Loan Fund, the David Steinman Foundation Loan Fund, Senior Loan Fund, the Mechanical Engineers' Loan Fund, the Molina Loan Fund, the N. J. Section of the American Institute of Chemical Engineers, the Professional Engineers Society of Union County, N. J., and the John S. Judd Loan Fund.

Some part time positions in the college during hours when classes are not in session, or in the evening or during holiday periods, are also available to students who can qualify for such positions. Students interested in obtaining such part-time positions should consult the Dean of Students and the College Placement Office.

Applications for any form of student aid should be made to the Dean of Students.

HEALTH AND ACCIDENT INSURANCE

Health and accident insurance protection is available at low rates to all day students on a group basis. Coverage extends 24 hours per day throughout the 12 month period or until a student ceases to be enrolled as a day undergraduate.

Subscription to the insurance coverage is voluntary, although each student is required at registration to submit a statement declaring whether or not he desires to enroll in the Student Medical Reimbursement Insurance Plan.

DISABLED VETERANS

Public Law 87-815 provides educational assistance for veterans who sustained a 30% minimum service-connected disability in peacetime military duty. All such veterans have until October 15, 1971 to file for benefits with the Veterans Administration.

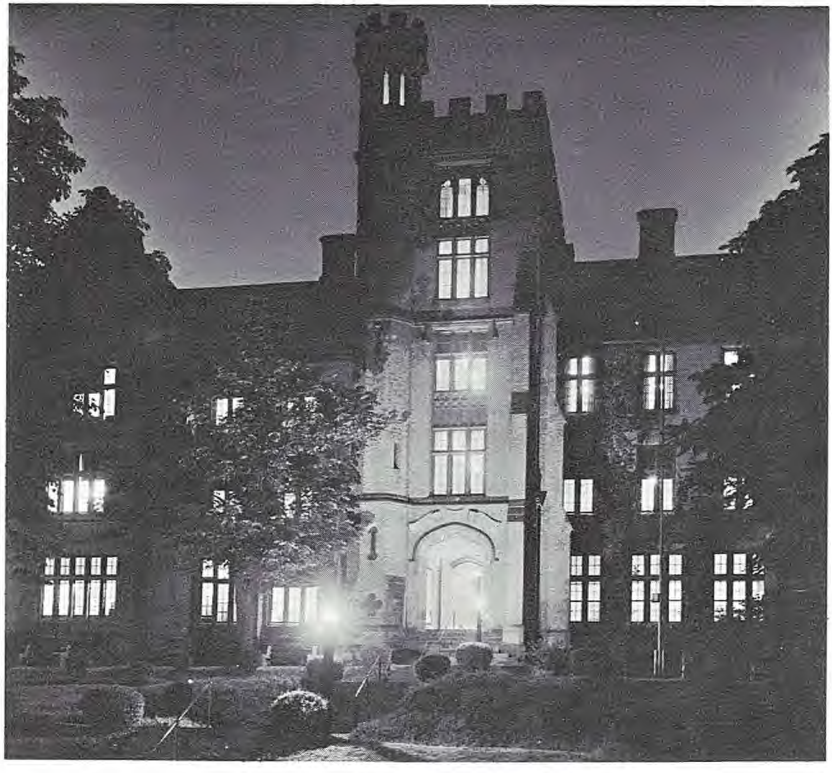
PUBLIC LAW 358

In order to be eligible for educational benefits under Public Law 358, it is necessary for a veteran to have served on active duty for more than 180 days, any part of which must have been after January 31, 1955. This 181-day period, however, may not include training time spent in a Reserve or National Guard

program. The deadline date for completing training is eight years subsequent to discharge; this time cannot be extended. Veterans who qualify under the above conditions should file an application form with the Veterans Administration.

WAR ORPHANS ACT

Public Law 634 provides education and training at higher institutions to all children of servicemen who died as a result of a disability or disease incurred in line of duty during World War I, II, or the Korean War. Also eligible are children of living veterans who were permanently or totally disabled as a result of service-connected conditions. Any applicant or student between the ages of 18 and 23 who believes he is eligible under this bill should contact the Veterans Administration Regional Office, Newark, New Jersey.



PLACEMENT

RELATIONS WITH INDUSTRY

The aims and purposes of the college program are directed toward properly preparing the student for his place in industry. Under the guidance and supervision of the professional departments he has been trained in the fundamentals of engineering principles. He has further received instruction in the human relations problems of industry in the courses of the Department of Industrial Relations. It is the function of the Placement Office to culminate that training by helping place the individual student in the type of work for which he has demonstrated interest and ability.

PROFESSIONAL DEVELOPMENT PROGRAM

The Professional Development Program is intended to supply the opportunity for qualified students to take on the challenge of more advanced work assignments offered through a cooperative plan with industry for the summer months.

Each year a number of industrial firms and governmental agencies are solicited for the purpose of identifying a list of selected pre-engineering positions demanding students of above average academic achievement.

The program is open to sophomore and junior students in the Day Division who achieve a minimum G.P.A. of 3.00. The students so qualified will receive priority placement in the job opportunities made available through this program. A student who meets the requirements of high academic excellence and who achieves satisfactory job progress reports from industry will receive a certificate of distinction at the conclusion of the year's program. Furthermore, those students who successfully maintain this class rank for the sophomore and junior academic years and attain satisfactory work performance records in industry for two summers will receive a special citation on their diplomas at graduation in recognition of this outstanding achievement.

PLACEMENT

Modern industry, with its activity in research, design, development, production, sales, and management, recognizes academic achievement as only one of its criteria for selection. The criteria for advancement, in addition to the academic, are initiative, industry, and leadership. It is for this reason that the Placement Office coordinates its efforts with the Counseling Center and the professional departments with the single aim of making the recruiting period as efficient as possible for both the students and corporate representatives. The College maintains

membership in the Middle Atlantic Placement Association and the Metropolitan New York College Placement Officers Association through its Director of Placement.

Each candidate for graduation is provided with a printed schedule of company recruiting dates, and arrangements may be made through the Placement Office for interviews with representatives of approximately 400 companies who regularly recruit at the College. An up-to-date Relations With Industry file of company information is available to make the students' preparation a thorough one. Prior to the interviewing period, an orientation program is held to enable the student to make maximum use of his contact time with industrial representatives.

Recognizing the importance of the placement interview, both to the student and company representative, the College has made available modern and comfortable interviewing facilities. Upon his arrival at the College, the corporate recruiter receives a schedule of student interviews and an Interview Data Sheet for each student on his schedule. In addition, the Placement Office maintains on file the personally written resume of each student, his transcript of grades, and Employer Evaluation Forms from the Professional Development Program.

The Office maintains a computer-assisted listing of all job openings received for candidates for graduation as well as for alumni.

The Placement Office is open during business hours throughout the year, and two evenings each week during the academic year, primarily for the convenience of evening students.

The Placement Office provides information on part-time off-campus employment for students throughout the year. Part-time positions in the various areas of the College are listed with the office of the Dean of Students. Assistance in obtaining summer employment is available to all undergraduate and graduate students. Since the best interest of the student requires unqualified attention to his course of study, the Placement Office supervises such placements and feels that outside activity should be limited to the ability of the individual student.

STUDENT LIFE

Student life, through its guidance, counseling, and extracurricular programs, plays an important role in preparing NCE students for their eventual careers in industry, education and government. Membership in the College's various clubs and athletic organizations, in professional and honor societies, and in student government councils provides excellent training for eventual participation in similar activities beyond college. The guidance resources of NCE provide additional aids for students in academic, vocational and personal decision-making.

GUIDANCE AND COUNSELING

The guidance and counseling services of the College are coordinated by the Dean of Student's office and are available to all students through the office of the Dean of Students and the Counseling Center. During their Orientation Program, freshmen learn about the engineering education they will be offered. At this time the Counseling Center administers a comprehensive battery of tests, and the freshmen are introduced to the total counseling and guidance program. As freshmen, they utilize the services of the office of the Dean of Students for problems of a vocational, academic, social or personal nature. When they become upperclassmen, a faculty adviser is assigned to each student. When a problem requires intensive counseling, the students are referred to the Counseling Center. The Counseling Center also provides valuable pre-employment counseling for all seniors.

STUDENT GOVERNMENT

A Student Council, acting with the Director of Student Activities as the adviser, constitutes the basic form of student government. This group is composed of officers who are elected by the student body and of representatives from various special-interest areas. The Council also coordinates the overall Student Activity Program. The freshman, sophomore, junior, and senior classes are organized further to meet the needs of these student groups.

SOCIAL ACTIVITIES

Social gatherings range from dinner meetings and lectures conducted by student professional societies to class or fraternity-sponsored dances and outings. In all cases, the group sponsoring a social event is responsible for the conduct of those attending, including that of members and guests. Further, each student is expected always to conduct himself on the basis of high professional standards.

Thirteen social fraternities offer the student desiring this type of affiliation a choice of the fraternity in which he may wish to

participate. Representatives of these fraternities to the Interfraternity Council coordinate various unified programs of the group.

SPECIAL INTEREST ORGANIZATIONS

The development of individual interests is fostered by the opportunity for participation in a number of organizations. Those students wishing to develop spiritually may participate in Christian Fellowship, Newman Club, Campus Christian Foundation, Shalom, or YMCA activities. In addition, there are club activities in physical recreation, such as outing, rod and gun, yachting and golf. The Audio, Bridge, Chess, Dance, Motor, Photo and Radio Clubs, and a number of others, offer additional opportunities for students with special interests.

COEDUCATIONAL ACTIVITIES

The coeds of the College participate actively in student government, clubs and social organizations, and in professional and honor societies. Sigma Chi Epsilon, a College sorority open to all coeds, promotes social and intellectual activities of special significance to women students including a charter affiliation with the Society of Women Engineers.

STUDENT PUBLICATIONS

A newspaper, *The Vector,* is operated and published entirely by student staff members. There is a yearbook, *Nucleus,* published by each Senior class. *Log NCE,* the handbook for freshmen, as well as professional, departmental, and other publications, are also edited by students.

HONOR SOCIETIES

Freshmen who rank in the upper 20 percent of their class are considered for membership in Phi Eta Sigma, national scholarship society for freshmen. The College is also among the leading engineering colleges of the United States having a chapter of Tau Beta Pi, the honorary engineering society. Membership in this distinguished organization is open, by election, to junior and senior students of high scholarship and exemplary character, of unselfish activity and breadth of interest in technical and nontechnical fields.

There are also several other national honor societies. Omicron Delta Kappa, leadership society, recognizes students on the basis of character and specific eligibility in scholarship and extracurricular activity. Faculty and alumni members are chosen for similar qualities. Four national honor societies are associated with particular professional departments, all of them open only to juniors and seniors: Omega Chi Epsilon, Chemical Engineer-

ing; Pi Tau Sigma, Mechanical Engineering; Eta Kappa Nu, Electrical Engineering; Chi Epsilon, Civil Engineering; and Alpha Pi Mu, Industrial Engineering.

The Arnold Air Society is the honor society of the Air Force Reserve Officers Training Corps. Its purpose is to further the mission, tradition, and concept of the Air Force as a means of defense, to promote American citizenship, and to create a closer and more efficient relationship among the students. Membership is limited to advanced students who qualify academically, show an interest in the Air Force ROTC program, and are considered favorably in voting sessions of the active members of the squadron.

PROFESSIONAL SOCIETIES

National professional engineering societies sponsor student branches at the College. The societies represented are the American Chemical Society, American Institute of Chemical Engineers, American Society of Civil Engineers, American Institute of Industrial Engineers, American Society of Mechanical Engineers, Institute of Electrical and Electronics Engineers, Society for the Advancement of Management, and Society of Automotive Engineers.

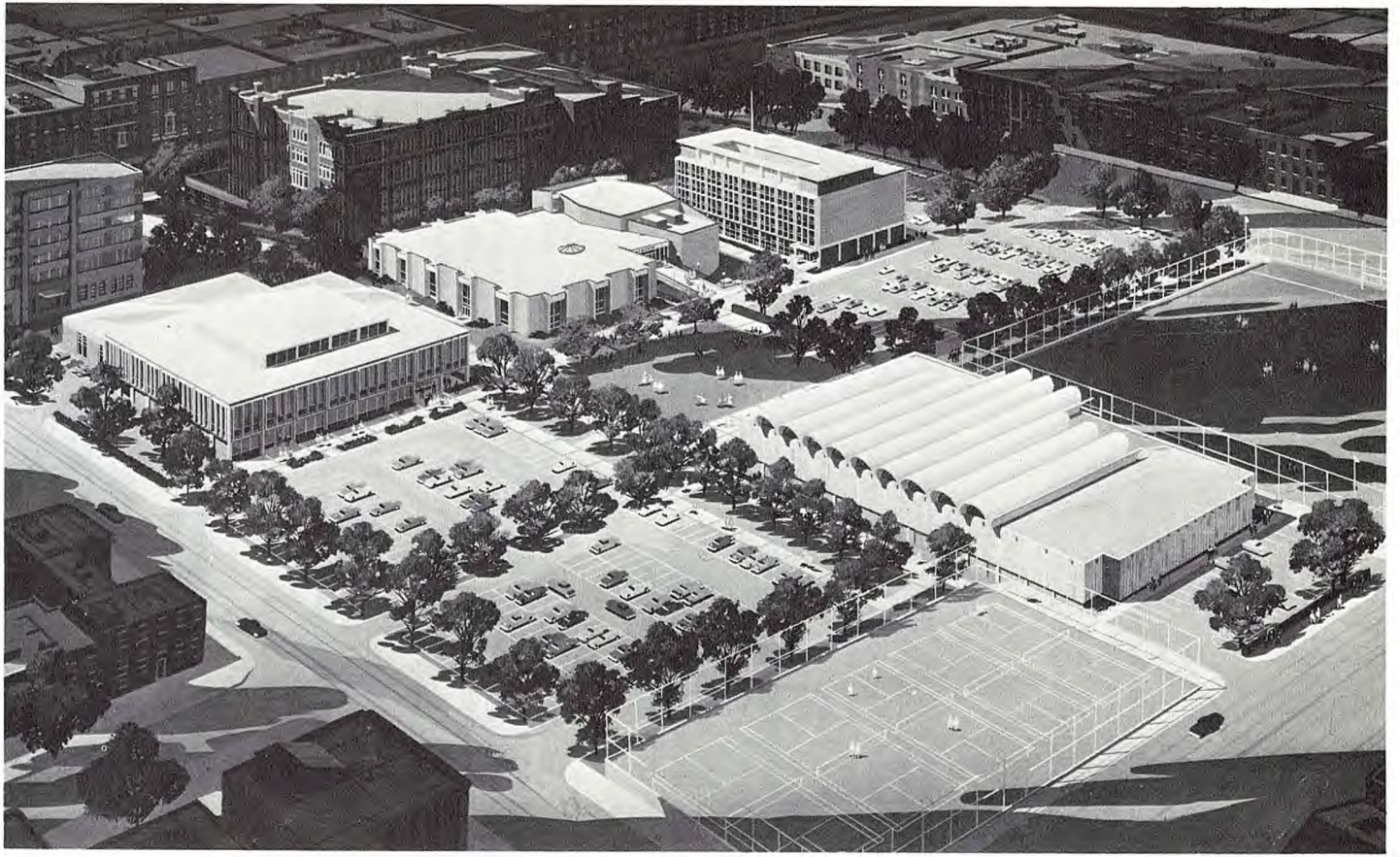
The faculty encourages student participation in the activities of the student branches of these societies as an important phase of their engineering education.

ATHLETICS

The Director of Health, Physical Education, and Athletics, assisted by the joint Student-Faculty Athletic Committee and the Student Athletic Association directs an extensive and varied program in athletic activities which reflects the interests and capabilities of the engineering student and provides him with opportunities for participation.

Intercollegiate competition is usually provided in soccer, basketball, baseball, bowling, tennis, golf, fencing, riflery, and judo. On the intramural level, competition is college-wide in the form of tournaments in basketball, bowling, softball, table tennis, volleyball, and badminton.

Students are encouraged to participate in a wide range of activities on a purely amateur basis. Interested members of the faculty participate in the capacity of coach or adviser.



ARTIST'S RENDERING OF EXPANDED NCE CAMPUS.

CURRICULUMS

DAY DIVISION

The First Year is common to all curriculums. The Second and subsequent years require a selection of one of the six curriculums. Much of the Second Year is common, but one or two courses differ for each curriculum.

All curriculums are undergoing extensive revision. For this reason, complete course requirements for graduation are listed for each class. The College reserves the right to make further changes in course requirements for the years following the 1968-69 academic year, although few changes are contemplated.

Students taking the Aerospace Studies Option will take the listed courses *in addition to* regular courses in the first three years, and *in lieu of* indicated courses in the Fourth Year.

Humanities and Social Science electives are described beginning on pages 109 and 121, respectively. Technical electives are listed at the end of each curriculum and are described under the department which offers the course.

The numbers following the course title represent, in order, lecture-recitation hours per week, laboratory hours per week, and credits for the semester. The method of calculating credits has been changed to reflect greater emphasis on work performed outside the classroom.

Class of 1969

FIRST YEAR (1965-66)

Chem 15, 16; EG 1, 2; Eng 11, 12; Math 11, 12; Phys 1, 2; IR 31; 2 Physical Ed.

Class of 1970

FIRST YEAR (1966-67)

Chem 15, 16; EG 1, 2; Eng 11, 12; Math 11, 12; Phys 1, 2; IR 31, 34; 2 Physical Ed.

Class of 1971

FIRST YEAR (1967-68)

Chem 15, 16; EG 1, 2; Eng 11, 12; Math 11, 12; Phys 1, 21; IR 31; 2 Physical Ed.

Class of 1972

FIRST YEAR (1968-69)

1st Semester		2nd Semester	
Chem 15—General Chemistry	4-2-5	Chem 16—Chem. of Materials	3-2-4
EG 1—Engrg. Graphics	1-2-2	EG 2—Int. to Engrg. Design	1-2-2
Eng 11—Literature & Comp.*	3-0-3	Hist 11—Dev. of Mod. World I*	3-0-3
Math 11—Calculus I	4-0-4	Math 12—Calculus II	4-0-4
Phys 1—Physics I	3-2-4	Phys 21—Physics II	3-2-4
Physical Education	0-1-0	Physical Education	0-1-0
Orientation	1-0-0		
Aerospace Studies Option			
AS 11—World Mil. Systems I	1-1-1	AS 12—World Mil. Systems II	1-1-1

*Paired courses. Half of the students will take these in reverse order.

CHEMICAL ENGINEERING: B.S. (Ch.E.)

Class of 1969

FIRST YEAR (1965-66). See page 57.

SECOND YEAR (1966-67)

Chem 25, 28; ChE 27; Hist 21, 22; IR 34; Math 21, 22, 90; Mech 7, 8; Phys 3, 4.

THIRD YEAR (1967-68)

Chem 31, 32, 33, 34; ChE 45, 46, 63, 64; Eng 31, 32; IE 23; IR 27 or AS 31, IR 25 or AS 32; Math 31 or 33.

FOURTH YEAR (1968-69)

1st Semester		2nd Semester	
Chem 43—Phys. Chem. Lab.*	0-6-3	ChE 69—Chem. Engrg. Lab.*	0-6-3
ChE 49—Reaction Kinetics	3-0-3	ChE 70—Proc. & Plant Design	3-0-3
ChE 65—Transport Oper. III	3-0-3	ChE 74—Proc. Dyn. & Control	2-2-3
IR 41—Management Practices	3-0-3	IR 42—Contemporary Issues	3-0-3
Elective (Human.)	3-0-3	Elective (Human.)	3-0-3
Elective (Tech.)	3-0-3	Elective (Tech.)	3-0-3

Aerospace Studies Option (In lieu of IR 41 and IR 42.)

AS 41—Professional Off. I	3-1-3	AS 42—Professional Off. II	3-1-3

Class of 1970

FIRST YEAR (1966-67). See page 57.

SECOND YEAR (1967-68)

Chem 25, 28; ChE 27; Hist 21, 22; Math 21, 22, 90; Mech 7, 8; Phys 3, 4.

THIRD YEAR (1968-69)

Chem 31—Physical Chem. I	3-0-3	Chem 32—Physical Chem. II	3-0-3
Chem 33—Organic Chemistry I	3-3-4	Chem 34—Organic Chemistry II	3-3-4
ChE 45—Ch.E. Thermodynamics I	3-0-3	ChE 46—Ch.E. Thermodynamics II	3-0-3
ChE 63—Transport Oper. I	3-0-3	ChE 64—Transport Oper. II	3-0-3
Eng 31—M. of Western Lit. I	3-0-3	Eng 32—M. of Western Lit. II	3-0-3
Math 31—Int. to Part. Diff. Eq.	3-0-3	SS 20—Economics	3-0-3
or			
Math 33—Probability & Statis.	3-0-3		

Aerospace Studies Option

AS 31—Gr. & Dev. Aero. Pow. I	3-1-3	AS 32—Gr. & Dev. Aero. Pow.	3-1-3

FOURTH YEAR (1969-70)

Chem 43—Phys. Chem. Lab.*	0-6-3	ChE 69—Chem. Engrg. Lab.*	0-6-3
ChE 49—Reaction Kinetics	3-0-3	ChE 70—Proc. & Plant Design	3-0-3
ChE 65—Transport Oper. III	3-0-3	ChE 74—Proc. Dyn. & Control	2-2-3
IR 41—Management Practices	3-0-3	IR 42—Contemporary Issues	3-0-3
Elective (Human.)	3-0-3	Elective (Human.)	3-0-3
Elective (Tech.)	3-0-3	Elective (Tech.)	3-0-3

Aerospace Studies Option (In lieu of IR 41 and IR 42.)

AS 41	Professional Off. I	3-1-3	AS 42	Professional Off. II	3-1-3

*Paired courses. Half of the students will take these in reverse order.

Class of 1971

FIRST YEAR (1967-68). See page 57.

SECOND YEAR (1968-69)

1st Semester		2nd Semester	
ChE 27—Chem. Engrg. Problems	3-0-3	Chem 31—Physical Chem. I	3-0-3
Math 21—Calculus III	4-0-4	Hist 11—Dev. of Mod. World I*	3-0-3
Math 90—Computer Programg.*	2-2-3	Math 22—Differential Equa.	4-0-4
Mech 10—Statics & Dynamics	4-0-4	Phys 31—Physics III	4-2-5
SS 20—Economics**	3-0-3	Elective (Soc. Sci.)**	3-0-3
Aerospace Studies Option			
AS 21—World Mil. Systems III	1-1-1	AS 22—World Mil. Systems IV	1-1-1

THIRD YEAR (1969-70)

Chem 32—Physical Chem. II	3-0-3	Chem 34—Organic Chemistry II	3-3-4
Chem 33—Organic Chemistry I	3-3-4	Chem 43—Physical Chem. Lab.*	0-6-3
ChE 63—Transport Oper. I	3-0-3	ChE 45—Ch.E. Thermodynamics I	3-0-3
Eng 31—M. of Western Lit. I	3-0-3	ChE 64—Transport Oper. II	3-0-3
Math 31—Int. to Part. Diff. Eq.*	3-0-3	Eng 32—M. of Western Lit. II	3-0-3
or			
Math 33—Probability & Statis.*	3-0-3		
Aerospace Studies Option			
AS 31—Gr. & Dev. Aero. Pow. I	3-1-3	AS 32—Gr. & Dev. Aero. Pow. II	3-1-3

FOURTH YEAR (1970-71)

ChE 46—Ch.E. Thermodynamics II	3-0-3	ChE 69—Chemical Engrg. Lab.*	0-6-3
ChE 49—Reaction Kinetics	3-0-3	ChE 70—Proc. & Plant Design	3-0-3
ChE 65—Transport Oper. III	3-0-3	ChE 74—Proc. Dyn. & Control	2-2-3
IR 41—Management Practices	3-0-3	IR 42—Contemporary Issues	3-0-3
Elective (Human.)	3-0-3	Elective (Human.)	3-0-3
Elective (Tech.)*	3-0-3	Elective (Tech.)	3-0-3
Aerospace Studies Option (In lieu of IR 41 and IR 42.)			
AS 41—Professional Off. I	3-1-3	AS 42—Professional Off. II	3-1-3

Class of 1972

FIRST YEAR (1968-69). See page 57.

SECOND YEAR (1969-70)

ChE 27—Chem. Engrg. Problems	3-0-3	Chem 31—Physical Chem. I	3-0-3
Math 21—Calculus III	4-0-4	Hist 22—Dev. of Mod. World II*	3-0-3
Math 90—Computer Programg.*	2-2-3	Math 22—Differential Equa.	4-0-4
Mech 10—Statics & Dynamics	4-0-4	Phys 31—Physics III	4-2-5
SS 20—Economics**	3-0-3	Elective (Soc. Sci.)**	3-0-3
Aerospace Studies Option			
AS 21—World Mil. Systems III	1-1-1	AS 22—World Mil. Systems IV	1-1-1

* ** Paired courses. Half of the students will take these in reverse order.

THIRD YEAR (1970-71)

1st Semester		2nd Semester	
Chem 32—Physical Chem. II	3-0-3	Chem 34—Organic Chemistry II	3-3-4
Chem 33—Organic Chemistry I	3-3-4	Chem 43—Physical Chem. Lab.*	0-6-3
Chem 63—Transport Oper. I	3-0-3	ChE 45—Ch.E. Thermodynamics I	3-0-3
Eng 31—M. of Western Lit. I	3-0-3	ChE 64—Transport Oper. II	3-0-3
Math 31—Int. to Part. Dif. Eq.*	3-0-3	Eng 32—M. of Western Lit. II	3-0-3
or			
Math 33—Probability & Statis.*	3-0-3		
Aerospace Studies Option			
AS 31—Gr. & Dev. Aero. Pow. I	3-1-3	AS 31—Gr. & Dev. Aero. Pow. II	3-1-3

FOURTH YEAR (1971-72)

ChE 46—Ch.E. Thermodynamics II	3-0-3	ChE 69—Chemical Engrg. Lab.*	0-6-3
ChE 49—Reaction Kinetics	3-0-3	ChE 70—Proc. & Plant Design	3-0-3
ChE 65—Transport Oper. III	3-0-3	ChE 74—Proc. Dyn. & Control	2-2-3
IR 41—Management Practices	3-0-3	IR 42—Contemporary Issues	3-0-3
Elective (Human.)	3-0-3	Elective (Human.)	3-0-3
Elective (Tech.)*	3-0-3	Elective (Tech.)	3-0-3
Aerospace Studies Option (In lieu of IR 41 and IR 42.)			
AS 41—Professional Off. I	3-1-3	AS 42—Professional Off. II	3-1-3

*Paired courses. Half of the students will take these in reverse order.

TECHNICAL ELECTIVES

Courses other than those listed (including selected courses offered by the Graduate Division) may be substituted, provided that the student can meet the prerequisites and if Department approval has been granted.

Chem 102—Adv. Organic Chem. I	3-0-3	Chem 120—Adv. Inorganic Chem.	3-0-3
Chem 140—Intro. to Polymers	3-0-3	Chem 151—Biochemistry	3-0-3
ChE 73—Math. Methods in Ch.E.	3-0-3	ChE 75—Statis. Thermodynam.	3-0-3
ChE 79—Chem. Process Anal.	3-0-3	ChE 78—Chem. Reactor Design	3-0-3
ChE 91H—Research & Ind. Study	3-0-3	ChE 80—Math. Modeling in Ch.E.	3-0-3
EE 91—Electronics & Instr.	3-0-3	ChE 92H—Research & Ind. Study	3-0-3
ME 54—Compressible Flow	3-0-3	Math 33—Probability & Statis.	3-0-3
Phys 7—Nuclear Engrg.	3-0-3	Math 35—Vector Analysis	3-0-3
		ME 14—Metallurgy	3-0-3
		Phys 9—Nuclear Engrg. Lab.	3-0-3

CIVIL ENGINEERING: B.S. (C.E.)

Class of 1969

FIRST YEAR (1965-66). See page 57.

SECOND YEAR (1966-67)

Chem 25; CE 3; Hist 21, 22; IR 34; Math 21, 22, 90; Mech 7, 8; Phys 3, 4.

THIRD YEAR (1967-68)

CE 23, 27, 41, 42; EE 93; Eng 31, 32; IE 23, 97; IR 27 or AS 31, IR 25 or AS 32; ME 41; 2 TE.

FOURTH YEAR (1968-69)

1st Semester		2nd Semester	
CE 18—Soil Mech. & Found.	3-3-4	CE 29—Structures II	3-3-4
Eng 41—Engrg. Report Writing†	2-0-2	IR 42—Contemporary Issues	3-0-3
IR 41—Management Practices	3-0-3	Elective (Human.)	3-0-3
Elective (Human.)	3-0-3	Electives (Tech.)	6-0-6
Electives (Tech.)	6-0-6		

Aerospace Studies Option (In lieu of IR 41 and IR 42.)

AS 41—Professional Off. I	3-1-3	AS 42—Professional Off. II	3-1-3

† To be taken either semester.

Class of 1970

FIRST YEAR (1966-67). See page 57.

SECOND YEAR (1967-68)

Chem 25; CE 3; Hist 21, 22; Math 21, 22, 90; Mech 7, 8; Phys 3, 4.

THIRD YEAR (1968-69)

CE 23—Str. of Materials	2-2-3	CE 26—Structures I#	3-3-4
CE 41—Fluid Mechanics I	4-0-4	EE 94—Elec. Engrg. Prin.	3-0-3
Eng 31—M. of Western Lit. I	3-0-3	Eng 32—M. of Western Lit. II	3-0-3
SS 20—Economics	3-0-3	IE 97—Enterprise Mgt.	3-0-3
Elective (Tech.)	3-0-3	ME 61—Thermodynamics	3-0-3
		Elective (Tech.)	3-0-3

Aerospace Studies Option

AS 31—Gr. & Dev. Aero. Pow. I	3-1-3	AS 32—Gr. & Dev. Aero. Pow. II	3-1-3

FOURTH YEAR (1969-70)

CE 18—Soil Mech. & Found.	3-3-4	CE 29—Structures II	3-3-4
Eng 41—Engrg. Report Writing†	2-0-2	IR 42—Contemporary Issues	3-0-3
IR 41—Management Practices	3-0-3	Elective (Human.)	3-0-3
Elective (Human.)	3-0-3	Electives (Tech.)	6-0-6
Electives (Tech.)	6-0-6		

Aerospace Studies Option (In lieu of IR 41 and IR 42.)

AS 41—Professional Off. I	3-1-3	AS 42—Professional Off. II	3-1-3

† To be taken either semester.

Half of the Junior sections will take CE 18 in the 2nd semester of the Junior year and CE 26 in the 1st semester of the Senior year. The other sections will take these two courses in the order shown.

Class of 1971

FIRST YEAR (1967-68). See page 57.

SECOND YEAR (1968-69)

1st Semester		2nd Semester	
Hist 11—Dev. of Mod. World I***	3-0-3	CE 3—Surveying*	3-3-4
Math 21—Calculus III	4-0-4	Math 22—Differential Equa.	4-0-4
Phys 31—Physics III*	4-2-5	Math 90—Computer Programg.***	2-2-3
SS 20—Economics**	3-0-3	Mech 10—Statics & Dynamics	4-0-4
		Elective (Soc. Sci.)**	3-0-3
Aerospace Studies Option			
AS 21—World Mil. Systems III	1-1-1	AS 22—World Mil. Systems IV	1-1-1

THIRD YEAR (1969-70)

CE 24—Str. of Materials	4-3-5	CE 26—Structures I#	3-3-4
CE 41—Fluid Mechanics I	4-0-4	EE 94—Elec. Engrg. Prin.	3-0-3
Eng 31—M. of Western Lit. I	3-0-3	Eng 32—M. of Western Lit. II	3-0-3
IE 97—Enterprise Mgt.	3-0-3	ME 61—Thermodynamics	3-0-3
Elective (Tech.)	3-0-3	Elective (Tech.)	3-0-3
Aerospace Studies Option			
AS 31—Gr. & Dev. Aero. Pow. I	3-1-3	AS 32—Gr. & Dev. Aero. Pow. II	3-1-3

FOURTH YEAR (1970-71)

CE 18—Soil Mech. & Found.	3-3-4	CE 29—Structures II	3-3-4
Eng 41—Engrg. Report Writing†	2-0-2	IR 42—Contemporary Issues	3-0-3
IR 41—Management Practices	3-0-3	Elective (Human.)	3-0-3
Elective (Human.)	3-0-3	Electives (Tech.)	6-0-6
Electives (Tech.)	6-0-6		
Aerospace Studies Option (In lieu of IR 41 and IR 42.)			
AS 41—Professional Off. I	3-1-3	AS 42—Professional Off. II	3-1-3

† To be taken either semester.

Class of 1972

FIRST YEAR (1968-69). See page 57.

SECOND YEAR (1969-70)

Hist 22—Dev. of Mod. World II**	3-0-3	CE 3—Surveying*	3-3-4
Math 21—Calculus III	4-0-4	Math 22—Differential Equa.	4-0-4
Phys 31—Physics III*	4-2-5	Math 90—Computer Programg.**	2-2-3
SS 20—Economics***	3-0-3	Mech 10—Statics & Dynamics	4-0-4
		Elective (Soc. Sci.)***	3-0-3
Aerospace Studies Option			
AS 21—World Mil. Systems III	1-1-1	AS 22—World Mil. Systems IV	1-1-1

*, **, *** Paired courses. Half of the students will take these in reverse order.

THIRD YEAR (1970-71)

CE 24—Str. of Materials	4-3-5	CE 26—Structures I#	3-3-4
CE 41—Fluid Mechanics I	4-0-4	EE 94—Elec. Engrg. Prin.	3-0-3
Eng 31—M. of Western Lit. I	3-0-3	Eng 32—M. of Western Lit. II	3-0-3
IE 97—Enterprise Mgt.	3-0-3	ME 61—Thermodynamics	3-0-3
Elective (Tech.)	3-0-3	Elective (Tech.)	3-0-3
Aerospace Studies Option			
AS 31—Gr. & Dev. Aero. Pow. I	3-1-3	AS 32—Gr. & Dev. Aero. Pow. II	3-1-3

See footnote on page 61.

FOURTH YEAR (1971-72)

1st Semester		2nd Semester	
CE 18—Soil Mech. & Found.	3-3-4	CE 29—Structures II	3-3-4
Eng 41—Engrg. Report Writing†	2-0-2	IR 42—Contemporary Issues	3-0-3
IR 41—Management Practices	3-0-3	Elective (Human.)	3-0-3
Elective (Human.)	3-0-3	Electives (Tech.)	6-0-6
Electives (Tech.)	6-0-6		

Aerospace Studies Option (In lieu of IR 41 and IR 42.)

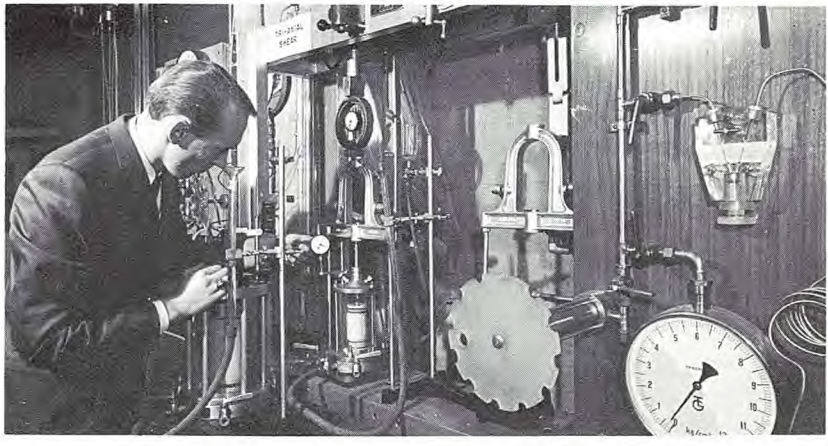
AS 41—Professional Off. I	3-1-3	AS 42—Professional Off. II	3-1-3

† To be taken either semester.

TECHNICAL ELECTIVES

A total of six technical electives is required for graduation. Other undergraduate or 100-level graduate courses of 3 credits each may be elected with the approval of the student's adviser. Courses indicated by an asterisk (*) are available to seniors only.

CE 5—Advanced Surveying	3-0-3	CE 6—Aerial Photo Interpr.	3-0-3
CE 7—Geomet. Des. for Hwys.	3-0-3	CE 17—Engineering Geology	3-0-3
CE 17—Engineering Geology	3-0-3	CE 32—Construction Mgt. II*	3-0-3
CE 31—Construction Mgt. I*	3-0-3	CE 45—Fluid Mechanics II	3-0-3
CE 47—Hydr. & San. Engrg. I	3-0-3	CE 48—Hydr. & San. Engrg. II	3-0-3
CE 51—Urban Planning	3-0-3	CE 52—Transportation Engrg.	3-0-3
CE 63—Num. Meth. Engrg. Anal. I*	3-0-3	CE 64—Num. Meth. Engrg. Anal. II*	3-0-3
CE 71—Civil Engrg. Proj. I*	3-0-3	CE 72—Civil Engrg. Proj. II*	3-0-3
CE 102—Environmental Chem.*	3-0-3	IE 99—Mgt. & Control of Const.	3-0-3
CE 109—Adv. Str. of Mater.*	3-0-3		
IE 98—Bas. Acctg. Constr. Mgt.	3-0-3		



ELECTRICAL ENGINEERING: B.S. (E.E.)

Class of 1969

FIRST YEAR (1965-66). See page 57.

SECOND YEAR (1966-67)

Chem 25; EE 10; Hist 21, 22; IE 23; IR 34; Math 21, 22, 90; Mech 7, 8; Phys 3, 4.

THIRD YEAR (1967-68)

EE 20, 25, 31, 40, 42, 60; Eng 31, 32; IR 27 or AS 31, IR 25 or AS 32; Math 32, 35; ME 41.

FOURTH YEAR (1968-69)

1st Semester		2nd Semester	
EE 22—Transmission Circ.	4-0-3	EE 80—Adv. Measurements	2-3-3
EE 44—Active Circuits II	3-3-4	EE 86—Elec. Engrg. Project	0-3-2
IR 41—Management Practices	3-0-3	IR 42—Contemporary Issues	3-0-3
Elective (E.E.)	3-0-3	Elective (E.E.)	3-0-3
Elective (Human.)	3-0-3	Elective (Human.)	3-0-3
Elective (Tech.)	3-0-3	Elective (Tech.)	3-0-3

Aerospace Studies Option (In lieu of IR 41 and IR 42.)

AS 41—Professional Off. I	3-1-3	AS 42—Professional Off. II	3-1-3

Class of 1970

FIRST YEAR (1966-67). See page 57.

SECOND YEAR (1967-68)

Chem 25; EE 10; Hist 21, 22; IE 23; Math 21, 22, 90; Mech 7, 8; Phys 3, 4.

THIRD YEAR (1968-69)

1st Semester		2nd Semester	
EE 20—Passive Circuits	4-0-4	EE 27—Electromag. Fields II	3-0-3
EE 26—Electromag. Fields I	4-0-4	EE 30—Magnetic Circuits	3-3-4
EE 42—Active Circuits I	4-3-5	EE 44—Active Circuits II	3-3-4
Eng 31—M. of Western Lit. I	3-0-3	Eng 32—M. of Western Lit. II	3-0-3
Math 32—Funct. of a Compl. Var.	3-0-3	ME 61—Thermodynamics	3-0-3
Aerospace Studies Option			
AS 31—Gr. & Dev. Aero. Pow. I	3-1-3	AS 32—Gr. & Dev. Aero. Pow. II	3-1-3

FOURTH YEAR (1969-70)

EE 51—Communications Syst.	3-3-4	EE 86—Elec. Engrg. Project	1-3-3
IR 41—Management Practices	3-0-3	IR 42—Contemporary Issues	3-0-3
Elective (E.E.)	3-1-3	Elective (E.E.)	3-0-3
Elective (Human.)	3-0-3	Elective (E.E. Syst.)	3-0-3
Elective (Tech.)	3-0-3	Elective (Human.)	3-0-3
		Elective (Tech.)	3-0-3

Aerospace Studies Option (In lieu of IR 41 and IR 42.)

AS 41—Professional Off. I	3-1-3	AS 42—Professional Off. II	3-1-3

Class of 1971

FIRST YEAR (1967-68). See page 57.

SECOND YEAR (1968-69)

1st Semester		2nd Semester	
EE 11—Elec. Engrg. I	3-2-4	EE 12—Elec. Engrg. II	3-0-3
Hist 11—Dev. of Mod. World I*	3-0-3	Math 22—Differential Equa.	4-0-4
Math 21—Calculus III	4-0-4	Math 90—Computer Programg.*	2-2-3
Phys 31—Physics III	4-2-5	Mech 10—Statics & Dynamics	4-0-4
SS 20—Economics**	3-0-3	Elective (Soc. Sci.)**	3-0-3
Aerospace Studies Option			
AS 21—World Mil. Systems III	1-1-1	AS 22—World Mil. Systems IV	1-1-1

THIRD YEAR (1969-70)

EE 23—Passive Networks	4-0-4	EE 27—Electromag. Fields II	3-0-3
EE 26—Electromag. Fields I	4-0-4	EE 30—Magnetic Circuits	3-3-4
EE 42—Active Circuits I	3-3-4	EE 44—Active Circuits II	3-3-4
Eng 31—M. of Western Lit. I	3-0-3	Eng 32—M. of Western Lit. II	3-0-3
Math 32—Funct. of a Compl. Var.	3-0-3	ME 61—Thermodynamics	3-0-3
Aerospace Studies Option			
AS 31—Gr. & Dev. Aero. Pow. I	3-1-3	AS 32—Gr. & Dev. Aero. Pow. II	3-1-3

FOURTH YEAR (1970-71)

IR 41—Management Practices	3-0-3	IR 42—Contemporary Issues	3-0-3
Elective (E.E.)	3-0-3	Elective (E.E.)	3-0-3
Elective (E.E. Syst. I)	3-3-4	Elective (E.E. Syst. II)	3-0-3
Elective (Human.)	3-0-3	Elective (Human.)	3-0-3
Elective (Tech.)	3-0-3	Elective (Tech.)	3-0-3
Aerospace Studies Option (In lieu of IR 41 and IR 42.)			
AS 41—Professional Off. I	3-1-3	AS 42—Professional Off. II	3-1-3

Class of 1972

FIRST YEAR (1968-69). See page 57.

SECOND YEAR (1969-70)

EE 11—Elec. Engrg.	3-2-4	EE 12—Elec. Engrg. II	3-0-3
Hist 22—Dev. of Mod. World II*	3-0-3	Math 22—Differential Equa.	4-0-4
Math 21—Calculus III	4-0-4	Math 90—Computer Programg.*	2-2-3
Phys 31—Physics III	4-2-5	Mech 10—Statics & Dynamics	4-0-4
SS 20—Economics **	3-0-3	Elective (Soc. Sci.)**	3-0-3
Aerospace Studies Option			
AS 21—World Mil. Systems III	1-1-1	AS 22—World Mil. Systems IV	1-1-1

*, ** Paired courses. Half of the students will take these in reverse order.

THIRD YEAR (1970-71)

EE 23—Passive Networks	4-0-4	EE 27—Electromag. Fields II	3-0-3
EE 26—Electromag. Fields I	4-0-4	EE 30—Magnetic Circuits	3-3-4
EE 42—Active Circuits I	3-3-4	EE 44—Active Circuits II	3-3-4
Eng 31—M. of Western Lit. I	3-0-3	Eng 32—M. of Western Lit. II	3-0-3
Math 32—Funct. of a Compl. Var.	3-0-3	ME 61—Thermodynamics	3-0-3
Aerospace Studies Option			
AS 31—Gr. & Dev. Aero. Pow. I	3-1-3	AS 32—Gr. & Dev. Aero. Pow. II	3-1-3

FOURTH YEAR (1971-72)

1st Semester		2nd Semester	
IR 41—Management Practices	3-0-3	EE 86—Elec. Engrg. Project	1-3-3
Elective (E.E.)	3-0-3	IR 42—Contemporary Issues	3-0-3
Elective (E.E. Syst. I)	3-3-4	Elective (E.E.)	3-0-3
Elective (Human.)	3-0-3	Elective (E.E. Syst. II)	3-0-3
Elective (Tech.)	3-0-3	Elective (Human.)	3-0-3
		Elective (Tech.)	3-0-3

Aerospace Studies Option (In lieu of IR 41 and IR 42.)

AS 41—Professional Off. I	3-1-3	AS 42—Professional Off. II	3-1-3

ELECTRICAL ENGINEERING ELECTIVES

With adviser's approval, certain graduate courses may be elected by superior students.

EE 69—Power System Anal.	3-0-3	EE 31—Transducers	3-1-3
EE 70—Transistor Circuits	3-0-3	EE 64—Electrokinetics II	3-3-4
EE 73—Electronic Devices	3-0-3	EE 71—Control Systems	3-1-3
EE 77—Reliability Problems	3-0-3	EE 72—Feedback Amplifiers	3-1-3
EE 78—Information Trans.	3-0-3	EE 74—Analog Computation	3-1-3
EE 79—Pulse Techniques	3-0-3	EE 75—Dig. Computer Circ.	3-1-3
EE 81—Network Synthesis	3-0-3	EE 76—Microwaves	3-1-3

TECHNICAL ELECTIVES

Students must elect one course in the 1st Semester and a second course in the 2nd Semester. Other courses may be chosen as technical electives with department approval. With adviser's approval, certain graduate courses may be elected by superior students. Courses indicated by an asterisk (*) are available to evening students only.

Math 32—Funct. of a Compl. Var.*	3-0-3	Chem 111—Radioisotopes Lab.	0-3-3
Math 111—Intro. to Num. Anal.	3-0-3	Chem 120—Adv. Inorganic Chem.	3-0-3
Math 145—Advanced Calculus I	3-0-3	IE 91—Enterprise Mgt.	3-0-3
Math 177—Random Proc. for EE's	3-0-3	Math 31—Int. to Part. Diff. Eq.	3-0-3
Phys 7—Nuclear Engineering	3-0-3	Math 32—Funct. of a Compl. Var.*	3-0-3
Phys 8—Semiconductor Phys.	3-0-3	Math 33—Prob. & Statis.	3-0-3
Phys 41—Modern Physics	3-0-3	Math 146—Advanced Calculus II	3-0-3
Phys 43—Optics	3-0-3	ME 62—Energy Analysis	3-0-3
		Phys 6—Engineering Physics	3-0-3
		Phys 8—Semiconductor Phys.	3-0-3
		Phys 9—Nuclear Engrg. Lab.	0-3-3
		Phys 42—Quantum Mechanics	3-0-3

ENGINEERING SCIENCE: B.S. (E.S.)

FIRST YEAR

The courses required in the First Year are listed on page 57.

SECOND YEAR

The Second Year of one of the five Engineering curriculums most appropriate for the work proposed in the Third and Fourth Years should be selected.

THIRD AND FOURTH YEARS

The following courses are required of all students in Engineering Science; in addition, each student will elect courses to complete the requirements for graduation.

Eng 31 and 32	(Third Year)
IR 41 and 42	(Fourth Year)
Two courses in humanities electives	(Fourth Year)
Four courses in engineering, including one course in thermodynamics	(Totaling at least 12 credits)
Two courses in mathematics	(Totaling at least 6 credits)
Two courses in physics or physical chemistry	(Totaling at least 6 credits)

OVER-ALL DEGREE REQUIREMENTS

A field of specialization totaling at least 24 credits must be completed. The field may include courses in more than one department, but it must represent a coherent and logical occupational objective. The 24 credits may include any of the Third and Fourth Year general requirements.

A minimum of 136 credits is required for the degree of Bachelor of Science in Engineering Science. Individual courses of study must be approved by the Committee on the Undergraduate Engineering Science Program.

The Aerospace Studies option is available to students enrolled in the Engineering Science program.

INDUSTRIAL ENGINEERING: B.S. (I.E.)

Class of 1969

FIRST YEAR (1965-66). See page 57.

SECOND YEAR (1966-67)

Chem 25; Hist 21, 22; IE 23, 24, 25; IR 34; Math 21, 22, 90; Mech 7, 8; Phys 3, 4.

THIRD YEAR (1967-68)

Eng 31, 32; IE 37, 38, 46, 47, 96; IR 27 or AS 31, IR 25 or AS 32; Math 33, 34; ME 39, 41, 75.

FOURTH YEAR (1968-69)

1st Semester		2nd Semester	
EE 94—Electrical Engrg.	3-0-3	IE 40—Management Science II	2-2-3
IE 39—Management Science I	2-2-3	IE 44—Systems Design II	2-2-3
IE 43—Systems Design I	2-2-3	IR 42—Contemporary Issues	3-0-3
IR 41—Management Practices	3-0-3	Elective (Human.)	3-0-3
Elective (Human.)	3-0-3	Elective (Tech.)	3-0-3
Elective (Tech.)	3-0-3	Elective (Tech.)	3-0-3

Aerospace Studies Option (In lieu of IR 41 and IR 42.)

AS 41—Professional Off. I	3-1-3	AS 42—Professional Off. II	3-1-3

Class of 1970

FIRST YEAR (1966-67). See page 57.

SECOND YEAR (1967-68)

Chem 25; Hist 21, 22; IE 23, 24, 25; IR 34; Math 21, 22, 90; Mech 7, 8; Phys 3, 4.

THIRD YEAR (1968-69)

Eng 31—M. of World Lit. I	3-0-3	Eng 32—M. of World Lit. II	3-0-3
IE 33—Engrg. Cost Anal.	4-2-5	IE 31—Applied Statistics	3-0-3
IE 37—Work Design I	2-2-3	IE 38—Work Analysis II	2-2-3
Math 33—Probability & Statis.	3-0-3	Math 34—Math for Mgt. Sci.	3-0-3
		ME 65—Mechanical Engrg.	5-0-5

Aerospace Studies Option

AS 31—Gr. & Dev. Aero. Pow. I	3-1-3	AS 32—Gr. & Dev. Aero. Pow. II	3-1-3

FOURTH YEAR (1969-70)

EE 94—Electrical Engrg.	3-0-3	IE 40—Management Sci. II	2-2-3
IE 39—Management Science I	2-2-3	IE 44—Systems Design II	2-2-3
IE 43—Systems Design I	2-2-3	IR 42—Contemporary Issues	3-0-3
IR 41—Management Practices	3-0-3	Elective (Human.)	3-0-3
Elective (Human.)	3-0-3	Elective (Tech.)	3-0-3
Elective (Tech.)	3-0-3	Elective (Tech.)	3-0-3

Aerospace Studies Option (In lieu of IR 41 and IR 42.)

AS 41—Professional Off. I	3-1-3	AS 42—Professional Off. II	3-1-3

Class of 1971

FIRST YEAR (1967-68). See page 57.

SECOND YEAR (1968-69)

1st Semester		2nd Semester	
IE 21—Intro. to Mgt. Sci.	3-0-3	IE 24—Prod. Proc. Design	2-2-3
Math 21—Calculus III	4-0-4	Hist 11—Dev. of Mod. World I*	3-0-3
Math 90—Computer Programg.*	2-2-3	Math 22—Differential Equa.	4-0-4
Phys 31—Physics III	4-2-5	Mech 10—Statics & Dynamics	4-0-4
SS 20—Economics**	3-0-3	Elective (Soc. Sci.)**	3-0-3
Aerospace Studies Option			
AS 21—World Mil. Systems III	1-1-1	AS 22—World Mil. Systems IV	1-1-1

THIRD YEAR (1969-70)

Eng 31—M. of World Lit. I	3-0-3	Eng 32—M. of World Lit. II	3-0-3
IE 33—Engrg. Cost Anal.	4-2-5	IE 31—Applied Statistics	3-0-3
IE 37—Work Design I	2-2-3	IE 38—Work Analysis II	2-2-3
Math 33—Probability & Statis.	3-0-3	Math 34—Math. for Mgt. Sci.	3-0-3
Mech 12—Mechanics of Mater.	3-1-3	ME 65—Mechanical Engrg.	5-0-5
Aerospace Studies Option			
AS 31—Gr. & Dev. Aero. Pow. I	3-1-3	AS 32—Gr. & Dev. Aero. Pow. II	3-1-3

FOURTH YEAR (1970-71)

EE 94—Electrical Engrg.	3-0-3	IE 40—Management Sci. II	2-2-3
IE 39—Management Science I	2-2-3	IE 44—Systems Design II	2-2-3
IE 43—Systems Design I	2-2-3	IR 42—Contemporary Issues	3-0-3
IR 41—Management Practices	3-0-3	Elective (Human.)	3-0-3
Elective (Human.)	3-0-3	Elective (Tech.)	3-0-3
Elective (Tech.)	3-0-3	Elective (Tech.)	3-0-3
Aerospace Studies Option (In lieu of IR 41 and IR 42.)			
AS 41—Professional Off. I	3-1-3	AS 42—Professional Off. II	3-1-3

Class of 1972

FIRST YEAR (1968-69). See page 57.

SECOND YEAR (1969-70)

IE 21—Intro. to Mgt. Sci.	3-0-3	Hist 22—Dev. of Mod. World II*	3-0-3
Math 21—Calculus III	4-0-4	IE 24—Prod. Proc. Design	2-2-3
Math 90—Computer Programg.*	2-2-3	Math 22—Differential Equa.	4-0-4
Phys 31—Physics III	4-2-5	Mech 10—Statics & Dynamics	4-0-4
SS 20—Economics**	3-0-3	Elective (Soc. Sci.)**	3-0-3
Aerospace Studies Option			
AS 21—World Mil. Systems III	1-1-1	AS 22—World Mil. Systems IV	1-1-1

THIRD YEAR (1970-71)

Eng 31—M. of World Lit. I	3-0-3	Eng 32—M. of World Lit. II	3-0-3
IE 33—Engrg. Cost Anal.	4-2-5	IE 31—Applied Statistics	3-0-3
IE 37—Work Design I	2-2-3	IE 38—Work Analysis II	2-2-3
Math 33—Probability & Statis.	3-0-3	Math 34—Math for Mgt. Sci.	3-0-3
Mech 12—Mechanics of Mater.	3-1-3	ME 65—Mechanical Engrg.	5-0-5
Aerospace Studies Option			
AS 31—Gr. & Dev. Aero. Pow. I	3-1-3	AS 32—Gr. & Dev. Aero. Pow. II	3-1-3

*, ** Paired courses. Half of the students will take these in reverse order.

FOURTH YEAR (1971-72)

1st Semester		2nd Semester	
EE 94—Electrical Engrg.	3-0-3	IE 40—Management Sci. II	2-2-3
IE 39—Management Science I	2-2-3	IE 44—Systems Design II	2-2-3
IE 43—Systems Design I	3-0-3	IR 42—Contemporary Issues	3-0-3
IR 41—Management Practices	3-0-3	Elective (Human.)	3-0-3
Elective (Human.)	3-0-3	Elective (Tech.)	3-0-3
Elective (Tech.)	3-0-3	Elective (Tech.)	3-0-3

Aerospace Studies Option (In lieu of IR 41 and IR 42.)

AS 41—Professional Off. I	3-1-3	AS 42—Professional Off. II	3-1-3

TECHNICAL ELECTIVES

IE 46—Law	3-0-3	IE 59—Production Control	3-0-3
IE 58—Tool Engineering	3-0-3	IE 63—Organ. Plan. & Contr.	3-0-3
IE 60—Inventory Models	3-0-3	IE 64—Prod. & Proc. Rel.	3-0-3
IE 61—Statis. Qual. Control	3-0-3	IE 65—Patent Law	3-0-3
IE 62—Budg. Plan. & Control	3-0-3	IE 82H—Investigations in I.E.	3-0-3
IE 81H—Investigations in I.E.	3-0-3		

MECHANICAL ENGINEERING: B.S. (M.E.)

Class of 1969

FIRST YEAR (1965-66). See page 57.

SECOND YEAR (1966-67)

Hist 21, 22; IE 23; IR 34; Math 21, 22, 90; Mech 7, 8; ME 10, 41; Phys 3, 4.

THIRD YEAR (1967-68)

Chem 25; EE 98; Eng 31, 32; IR 25 or AS 32, IR 27 or AS 31; ME 18, 31, 33, 42, 43, 44, 45; 1 Tech. Elect.

FOURTH YEAR (1968-69)

1st Semester		2nd Semester	
EE 99T—Elec. Engrg. for M.E. II	2-1-3	IE 94—Enterprise Mgt.	3-0-3
IR 41—Management Practices	3-0-3	IR 42—Contemporary Issues	3-0-3
ME 34—Mech. Engrg. Design I	3-2-4	ME 36—Mech. Engrg. Design II	3-2-4
ME 46—Mechanical Lab. II	1-2-2	ME 48—Mechanical Lab. III	1-2-2
Elective (Human.)	3-0-3	Elective (Human.)	3-0-3
Elective (Tech.)	3-0-3	Elective (Tech.)	3-0-3

Aerospace Studies Option (In lieu of IR 41 and IR 42.)

AS 41—Professional Off. I	3-1-3	AS 42—Professional Off. II	3-1-3

Class of 1970

FIRST YEAR (1966-67). See page 57.

SECOND YEAR (1967-68)

Hist 21, 22; IE 23; Math 21, 22, 90; Mech 7, 8; ME 10, 41; Phys 3, 4.

THIRD YEAR (1968-69)

EE 91—Electronics & Instr.	3-0-3	EE 95—Elect. Engrg. Prin.	3-2-4
Eng 31—M. of Western Lit. I	3-0-3	Eng 32—M. of Western Lit. II	3-0-3
ME 18—Metallurgy	3-2-4	ME 31—Theory of Machines	3-0-3
ME 33—Vibration Analysis	3-0-3	ME 42—Thermodynamics II	3-0-3
ME 44—Fluid Mechanics	3-0-3	ME 43—Mechanical Lab. I	2-2-3

Aerospace Studies Option

AS 31—Gr. & Dev. Aero. Pow. I	3-1-3	AS 32—Gr. & Dev. Aero. Pow. II	3-1-3

FOURTH YEAR (1969-70)

IR 41—Management Practices	3-0-3	IE 94—Enterprise Mgt.	3-0-3
ME 34—Mech. Engrg. Design I	3-2-4	IR 42—Contemporary Issues	3-0-3
ME 45—Heat Transfer	3-0-3	ME 36—Mach. Engrg. Design II	3-2-4
ME 46—Mechanical Lab. II	1-2-2	ME 48—Mechanical Lab. III	1-2-2
Elective (Human.)	3-0-3	Elective (Human.)	3-0-3
Elective (Tech.)	3-0-3	Elective (Tech.)	3-0-3

Aerospace Studies Option (In lieu of IR 41 and IR 42.)

AS 41—Professional Off. I	3-1-3	AS 42—Professional Off. II	3-1-3

Class of 1971

FIRST YEAR (1967-68). See page 57.

SECOND YEAR (1968-69)

1st Semester		2nd Semester	
Math 21—Calculus III	4-0-4	Hist 11—Dev. of Mod. World I*	3-0-3
Math 90—Computer Programg.*	2-2-3	Math 22—Differential Equa.	4-0-4
Mech 10—Statics & Dynamics	4-0-4	Mech 12—Mechanics of Mater.	3-1-3
ME 10—Manufacturing Proc.	1-2-2	Phys 31—Physics III	4-2-5
SS 20—Economics**	3-0-3	Elective (Soc. Sci.)**	3-0-3
Aerospace Studies Option			
AS 21—World Mil. Systems III	1-1-1	AS 22—World Mil. Systems IV	1-1-1

THIRD YEAR (1969-70)

EE 91—Electronics & Instr.	3-0-3	Eng 32—M. of Western Lit. II	3-0-3
Eng 31—M. of Western Lit. I	3-0-3	EE 95—Elect. Engrg. Prin.	3-2-4
ME 18—Metallurgy***	3-2-4	ME 31—Theory of Machines	3-0-3
ME 33—Vibration Analysis	3-0-3	ME 42—Thermodynamics II	3-0-3
ME 41—Thermodynamics I	3-0-3	ME 43—Mechanical Lab. I***	2-2-3
ME 44—Fluid Mechanics	3-0-3		
Aerospace Studies Option			
AS 31—Gr. & Dev. Aero. Pow. I	3-1-3	AS 32—Gr. & Dev. Aero. Pow. II	3-1-3

FOURTH YEAR (1970-71)

IR 41—Management Practices	3-0-3	IE 94—Enterprise Mgt.	3-0-3
ME 34—Mech. Engrg. Design I	3-2-4	IR 42—Contemporary Issues	3-0-3
ME 45—Heat Transfer	3-0-3	ME 36—Mech. Engrg. Design II	3-2-4
ME 46—Mechanical Lab. II	1-2-2	ME 48—Mechanical Lab. III	1-2-2
Elective (Human.)	3-0-3	Elective (Human.)	3-0-3
Elective (Tech.)	3-0-3	Elective (Tech.)	3-0-3
Aerospace Studies Option (In lieu of IR 41 and IR 42.)			
AS 41—Professional Off. I	3-1-3	AS 42—Professional Off. II	3-1-3

Class of 1972

FIRST YEAR (1968-69). See page 57.

SECOND YEAR (1969-70)

EE 91—Electronics & Instr.	3-0-3	Hist 22—Dev. of Mod. World II*	3-0-3
Math 21—Calculus III	4-0-4	Math 22—Differential Equa.	4-0-4
Math 90—Computer Programg.*	2-2-3	Mech 12—Mechanics of Mater.	3-1-3
Mech 10—Statics & Dynamics	4-0-4	Phys 31—Physics III	4-2-5
SS 20—Economics**	3-0-3	Elective (Soc. Sci.)**	3-0-3
Aerospace Studies Option			
AS 21—World Mil. Systems III	1-1-1	AS 22—World Mil. Systems IV	1-1-1

*, **, *** Paired courses. Half of the students will take these in reverse order.

THIRD YEAR (1970-71)

1ST SEMESTER		2ND SEMESTER	
Eng 31—M. of Western Lit. I	3-0-3	EE 95—Elect. Engrg. Prin.	3-2-4
ME 10—Manufacturing Proc.†	1-2-2	Eng 32—M. of Western Lit. II	3-0-3
ME 18—Metallurgy***	3-2-4	ME 31—Theory of Machines	3-0-3
ME 33—Vibration Analysis	3-0-3	ME 42—Thermodynamics II	3-0-3
ME 41—Thermodynamics I	3-0-3	ME 43—Mechanical Lab. I***	2-2-3
ME 44—Fluid Mechanics	3-0-3		
AEROSPACE STUDIES OPTION			
AS 31—Gr. & Dev. Aero. Pow. I	3-1-3	AS 32—Gr. & Dev. Aero. Pow. II	3-1-3

† To be taken either semester.
*, **, *** Paired courses. Half of the students will take these in reverse order.

FOURTH YEAR (1971-72)

IR 41—Management Practices	3-0-3	IE 94—Enterprise Mgt.	3-0-3
ME 34—Mech. Engrg. Design I	3-2-4	IR 42—Contemporary Issues	3-0-3
ME 45—Heat Transfer	3-0-3	ME 36—Mech. Engrg. Design II	3-2-4
ME 46—Mechanical Lab. II	1-2-2	ME 48—Mechanical Lab. III	1-2-2
Elective (Human.)	3-0-3	Elective (Human.)	3-0-3
Elective (Tech.)	3-0-3	Elective (Tech.)	3-0-3
AEROSPACE STUDIES OPTION (In lieu of IR 41 and IR 42.)			
AS 41—Professional Off. I	3-1-3	AS 42—Professional Off. II	3-1-3

TECHNICAL ELECTIVES

Courses indicated by an asterisk (*) are available with adviser's approval.

Math 31—Int. to Part. Diff. Eq.	3-0-3	Math 31—Int. to Part. Diff. Eq.	3-0-3
Math 32—Funct. of a Compl. Var.	3-0-3	Math 32—Funct. of a Compl. Var.	3-0-3
Math 33—Probability & Statis.	3-0-3	Math 33—Probability & Statis.	3-0-3
Math 35—Vector Analysis	3-0-3	Math 35—Vector Analysis	3-0-3
Math 100—Vector & Tensor Anal.*	3-0-3	Math 100—Vector & Tensor Anal.*	3-0-3
Math 111—Intro. to Num. Anal.	3-0-3	Math 146—Advanced Calculus II*	3-0-3
Math 145—Advanced Calculus I*	3-0-3	ME 37—Structural Analysis	3-0-3
ME 37—Structural Analysis	3-0-3	ME 53—Energy Conversion	3-0-3
ME 53—Energy Conversion	3-0-3	ME 54—Compressible Flow	3-0-3
ME 54—Compressible Flow	3-0-3	ME 55—Automatic Controls	3-0-3
ME 55—Automatic Controls	3-0-3	ME 56—Fluid Machinery	3-0-3
ME 56—Fluid Machinery	3-0-3	ME 57—Electro-Mech. Devices	3-0-3
ME 57—Electro-Mech. Devices	3-0-3	Phys 9—Nuclear Engrg. Lab.	0-3-3
ME 113—Dyn. of Comp. Fluids*	3-0-3	Phys 42—Intro. to Quan. Mech.	3-0-3
Phys 7—Nuclear Engineering	3-0-3		
Phys 41—Modern Physics	3-0-3		
Phys 43—Optics	3-0-3		

EVENING DIVISION

OBJECTIVES

The objectives stated on page 28 apply to the Evening Division as well. For students in the Evening Division, however, time is an important consideration.

Evening curriculums are closely coordinated with the Day programs to insure identical educational experiences. Because of the limited evening hours, Evening undergraduates proceed through their curriculum at approximately half the rate of their day counterparts, thereby completing requirements for the bachelor's degree in approximately eight years. The over-all time necessary to complete the work required for the degree may be somewhat reduced by summer study. A list of courses available for summer study is published each spring.

FACILITIES

The facilities and services of the College are available to students of both the Day and Evening Divisions. The College recognizes, however, that limitations of time and circumstances sometimes prevent evening students from taking full advantage of all areas of activity. The College has therefore provided evening hour coverage for those areas that are most important to the academic advancement of evening students. A complete description of College facilities appears on pages 25-27.

STUDENT ACTIVITIES

Activities concerned with student life, while usually scheduled during the daytime period, are also available to Evening Division students. Students interested in these extracurricular activities, which are described in the section "Student Life," are advised to consult the Dean of Students for additional information.

Inquiries regarding information about scholarships and loan funds available to evening students should be directed to the Dean of Students.

The Air Force ROTC program is not available to students registered in the Evening Division.

EXPENSES

TUITION AND FEES

JUNIOR DIVISION (EVENING)

During 1968-69, the tuition and regular fees per semester for students taking regular programs of study in the Junior Division (Evening) and Newark Technical School will be as follows:

	Charges per Semester	
	New Jersey Residents	*Non-Residents*
Tuition*	$108.00	$165.00
Regular Fees		
Registration	5.00	5.00
General Fee	7.00	7.00
Total Tuition and Regular Fees per Semester	$120.00	$177.00

* Tuition includes charges for services other than instruction, such as library, publications, counseling, placement, etc., but does not cover the breakage or loss of College property. The General Fee provides funds for the operation of health services and other non-academic facilities and services.

Tuition charges are somewhat higher for special programs of study differing from those shown in this catalog.

TUITION AND FEES

SENIOR DIVISION (EVENING)

It is necessary for the College to adjust its tuition charges in the Senior Division (Evening) in accordance with the individual Block programs contained therein. These charges vary somewhat in accordance with the number of hours offered under each Block. There are certain fixed fees due and payable at each registration period in addition to these tuition fees. As in the case of the Junior Division (Evening) and the Day Division, every effort has been made to establish these fees at a level which will maintain the proper relation between the State, the City, and the direct beneficiary, the student.

Students taking complete Block programs exactly as published in this catalog are charged tuition at the rate of $12.00 *per contact hour per semester* if residents of the State of New Jersey, and $18.00 *per contact hour per semester* if non-residents. Students taking programs which differ from the Block schedule are charged at the rate of $14.00 *per contact hour per semester* if residents of the State of New Jersey, and $21.00 *per contact hour per semester* if non-residents.

Tuition includes charges for services other than instruction, such as library, publications, counseling, placement, etc., but does not cover the breakage or loss of College property.

APPLICATION, MATRICULATION AND SPECIAL FEES

JUNIOR DIVISION (EVENING)

LATE REGISTRATION FEE

Registration is required for each semester. A LATE REGISTRATION FEE *of $10.00 is required for those who register late.*

BOOKS AND SUPPLIES

For the first semester of the first year, books cost approximately $65.00 with an additional $50.00 covering the cost of a slide rule and general supplies for that semester. Books and supplies for the second semester of the first year cost approximately $55.00.

SENIOR DIVISION (EVENING)

REGISTRATION FEES

A REGISTRATION FEE *of $5.00 per semester is charged for each semester. A* LATE REGISTRATION FEE *of $10.00 is required of those who register late.*

GENERAL FEE

Each evening student is charged a GENERAL FEE of $7.00 per semester.

LABORATORY FEE

Students registering for the professional work of any semester in the Chemical Engineering Department, are charged a special LABORATORY FEE of $10.00 a semester, if residents of New Jersey, or $20.00 a semester if non-residents.

GRADUATION FEE

A GRADUATION FEE of $25.00 is required of all candidates for the Bachelor's Degree. The graduation fee includes the cost of rental of academic dress.

JUNIOR AND SENIOR DIVISIONS (EVENING)

APPLICATION FEE

Each candidate for admission to the College must pay an APPLICATION FEE of $10.00 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 College. This fee covers service which is necessary to evaluate applications for admission.

READMISSION APPLICATION FEE

Any applicant for readmission to Newark College of Engineering must pay a READMISSION APPLICATION FEE of $10.00 at the time the Application for Readmission form is submitted.

(See section "Readmission," page 40.) This is not returnable, regardless of whether or not the student is readmitted to the College. This fee covers service which is necessary to evaluate applications for readmission.

MATRICULATION FEE

All students entering the College for the first time as candidates for a degree are charged a MATRICULATION FEE of $5.00.

PHYSICAL EXAMINATION FEE

A fee of $10.00 is charged if, at the discretion of the College, it seems advisable for the student to be given a physical examination.

SCHEDULE CHANGE FEE

A SCHEDULE CHANGE FEE of $3.00 is charged when a student requests a schedule change for reasons other than those beyond his control.

CHANGE OF GRADE FEE

A fee of $1.00 is charged for the removal of a grade of "INC."

SPECIAL EXAMINATION FEE

For SPECIAL EXAMINATIONS, taken at times other than those regularly scheduled, a fee of $5.00 is charged.

EXPENDITURES FOR BOOKS

Students are advised to defer expenditures for books until the official list of text books has been posted at the College Bookstore.

PROPERTY LOSS

The College is not responsible for loss of property by fire or theft in its buildings and grounds.

CURRICULUMS

EVENING DIVISION

The first three years are common to all curriculums. The fourth and subsequent years require a selection of one of the six curriculums.

All curriculums are undergoing extensive revision. Therefore, the courses listed apply only to the 1968-69 academic year. Students should consult with their advisers to determine requirements for graduation of their class. The next several years will bring a transition to new curriculums which will be essentially those listed for the Class of 1972 in the Day Division.

The numbers following the course title represent, in order, lecture-recitation hours per week, laboratory hours per week, and credits for the semester. The method of calculating credits has been changed to reflect greater emphasis on work performed outside the classroom.

FIRST YEAR

1st Semester		2nd Semester	
EG 1—Engrg. Graphics	1-2-2	EG 2—Int. to Engrg. Design	1-2-2
Eng 11—Literature & Comp.*	3-0-3	Hist 11—Dev. of Mod. World I*	3-0-3
Math 10A—Intro. Mathematics	2-1-2	Math 10B—Calculus I E	2-1-2
Orientation	1-0-0		

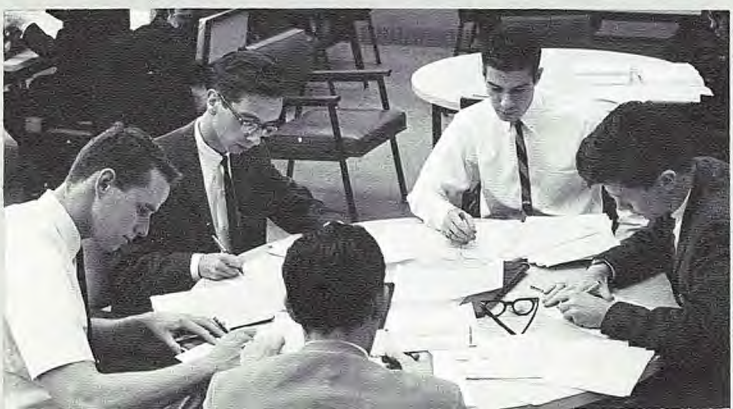
SECOND YEAR

Chem 15—General Chemistry	4-2-5	Chem 16—Chemistry of Mater.	3-2-4
Hist 11—Dev. of Mod. World I*	3-0-3	Math 90—Computer Programg.*	2-2-3
Math 20A—Calculus II E	3-0-3	Math 20B—Calculus III E	3-0-3

THIRD YEAR

Math 30A—Calculus IV E	3-0-3	Math 30B—Differential Equa.	3-0-3
Phys 1—Physics I	3-2-4	Phys 21—Physics II	3-2-4
SS 20—Economics*	3-0-3	Math 90—Computer Programg.*	2-2-3

*Paired courses. Half of the students will take these in reverse order.



CHEMICAL ENGINEERING: B.S. (Ch.E.)

FIRST, SECOND, AND THIRD YEARS. See page 78.

FOURTH YEAR

1st Semester		2nd Semester	
Chem 31—Physical Chemistry I	3-0-3	Chem 32—Physical Chem. II	3-0-3
Mech 10—Statics & Dynamics	4-0-4	Math 90—Computer Programg.	2-2-3
SS 20—Economics	3-0-3	Phys 31—Physics III	4-2-5

FIFTH YEAR (Block 41 ChE—Class of 1972)

Chem 31—Physical Chemistry I	3-0-3	Chem 32—Physical Chem. II	3-0-3
Math 31—Int. to Part. Diff. Eq.	3-0-3	Chem 43—Phys. Chem. Lab.	0-6-3
or		ChE 27—Chemical Engrg. Prob.	3-0-3
Math 33—Probability & Statis.	3-0-3		
SS 20—Economics	3-0-3		

SIXTH YEAR (Block 42 ChE—Class of 1971)

Chem 33—Organic Chemistry I	3-3-4	Chem 34—Organic Chemistry II	3-3-4
Chem 42—Physical Chem. Lab. II	0-3-2	ChE 46—Ch.E. Thermodynamics II	3-0-3
ChE 45—Ch.E. Thermodynamics II	3-0-3	ChE 63—Transport Oper. I	3-0-3

SEVENTH YEAR (Block 43 ChE—Class of 1970)

ChE 64—Transport Oper. II	3-0-3	ChE 65—Transport Oper. III	3-0-3
IR 41—Management Practices	3-0-3	IR 42—Contemporary Issues	3-0-3
Elective (Human.)*	3-0-3	Elective (Human.)*	3-0-3

EIGHTH YEAR (Block 44 ChE—Class of 1969)

ChE 49—Reaction Kinetics	3-0-3	ChE 70—Proc. & Plant Design	3-0-3
ChE 69—Chemical Engrg. Lab.	0-6-3	ChE 74—Proc. Dyn. & Control	2-2-3
Elective (Tech.)**	3-0-3	Elective (Tech.)**	3-0-3

* Humanities electives are listed on pages 109-115.
** Technical electives are listed on page 60.

CIVIL ENGINEERING: B.S. (C.E.)

FIRST, SECOND, AND THIRD YEARS. See page 78.

FOURTH YEAR (1968-69—Class of 1973)

1ST SEMESTER		2ND SEMESTER	
CE 3—Surveying†	3-3-4	Math 90—Computer Programg.	2-2-3
Phys 31—Physics III	4-2-5	Mech 10—Statics & Dynamics	4-0-4
		SS 20—Economics	3-0-3

FIFTH YEAR (1968-69—Block 41 CE A—Class of 1971)

CE 3—Surveying†	3-3-4	EE 94—Elec. Engrg. Prin.	3-0-3
Elective (Human.)*	3-0-3	ME 61—Thermodynamics	3-0-3
		Elective (Human.)*	3-0-3

FIFTH YEAR (1968-69—Block 41 CE B—Class of 1972)

CE 3—Surveying†	3-3-4	EE 94—Elec. Engrg. Prin.	3-0-3
SS 20—Economics	3-0-3	IE 97—Enterprise Mgt.	3-0-3
Elective (Tech.)**	3-0-3	ME 61—Thermodynamics	3-0-3

* Humanities electives are listed on pages 109-115.

† Eight six-hour Saturday field or laboratory periods are to be arranged. No field work will be scheduled on the first Saturday of the semester.

SIXTH YEAR (1967-70—Block 42 CE—Classes of 1972 and 1973). Not offered 1968-69.

CE 24—Strength of Mater.	4-3-5	CE 26—Structures I	3-3-4
Elective (Tech.)**	3-0-3	Elective (Tech.)**	3-0-3

SEVENTH YEAR (1968-69—Block 43 CE—Classes of 1969 and 1970)

ME 61—Thermodynamics	3-0-3	Electives (Tech.)**	9-0-9
Electives (Tech.)**	6-0-6		

EIGHTH YEAR (1969-70—Block 44 CE—Class of 1970). Not offered in 1968-69.

CE 18—Soil Mechan. & Found.	3-3-4	CE 28—Structures II	3-3-4
CE 27—Structures I	3-0-3	IR 42—Contemporary Issues	3-0-3
IR 41—Management Practices	3-0-3	Elective (Tech.)**	3-0-3

** Technical electives are listed on page 63. In the Evening Division an elective may be given in either the first or second semester, depending on student interest and availability of staff. Only a limited number of technical electives will be offered each year. A total of six technical electives is required for graduation.

ELECTRICAL ENGINEERING: B.S. (E.E.)

EIGHT-YEAR PROGRAM

FIRST, SECOND, AND THIRD YEARS. See page 78.

FOURTH YEAR

1st Semester		2nd Semester	
EE 11—Electrical Engrg. I	3-2-4	EE 12—Electrical Engrg. II	3-0-3
Phys 31—Physics III	4-2-5	Math 90—Computer Programg.	2-2-3
		Mech 10—Statics & Dynamics	4-0-4

FIFTH YEAR (Block 41E—Class of 1972)

EE 10—Elec. Circuits & Meas.	3-2-3	Chem 25—Principles of Engrg.	3-0-3
Math 32—Funct. of a Compl. Var.	3-0-3	EE 20—Passive Circuits	4-0-3
SS 20—Economics	3-0-3	EE 40—Electronic Devices	3-0-2
		ME 61—Thermodynamics	3-0-3

SIXTH YEAR (Block 42 E—Class of 1971)

EE 30—Magnetic Circuits	3-3-4	EE 25—Electromag. Fields	4-0-3
EE 40—Electronics Devices	3-0-2	EE 42—Active Circuits I	4-3-5
Math 32—Funct. of a Compl. Var.	3-0-3	IR 41—Management Practices	3-0-5

SEVENTH YEAR (Block 43E—Class of 1970)

EE 22—Transmission Circ.	4-0-3	EE 80—Adv. Measurements	2-3-3
EE 25T—Electromag. Fields	3-0-3	Elective (Human.)*	3-0-3
ME 61—Thermodynamics	3-0-3	Elective (Tech.)**	3-0-3

EIGHTH YEAR (Block 44E—Class of 1969)

EE 80—Adv. Measurements	2-3-3	EE 86—Electrical Engrg. Proj.	0-3-2
Elective (E.E.)**	3-0-3	Elective (E.E.)**	3-1-3
Elective (Tech.)**	3-0-3	Elective (Tech.)**	3-0-3

NINE-YEAR PROGRAM

A regular Nine-Year Program will not be offered to students who entered the Fifth Year of the Evening Program in 1967 or thereafter.

SEVENTH YEAR (Block 53E—Class of 1971)

EE 42—Active Circuits I	4-3-5	EE 44—Active Circuits II	3-3-4
EE 62—Electrokinetics I	3-0-3	Elective (Tech.)**	3-0-3

EIGHTH YEAR (Block 54E—Class of 1970)

EE 25—Electromag. Fields	4-0-3	EE 22—Transmission Circ.	4-0-3
Elective (Human.)*	3-0-3	Elective (Human.)*	3-0-3

NINTH YEAR (Block 55E—Class of 1969)

EE 80—Adv. Measurements	2-3-3	EE 86—Elec. Engrg. Project	0-3-3
Elective (E.E.)**	3-0-3	Elective (E.E.)**	3-1-3

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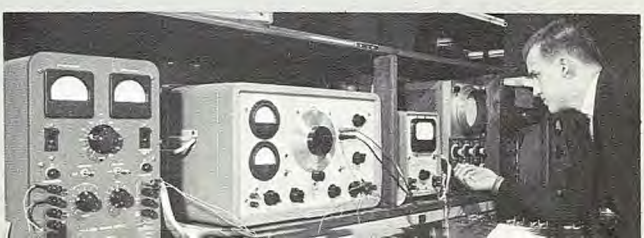
* Humanities electives are listed on pages 109-115.

** Electives are listed on page 66. Evening students may also offer Math 32 or Math 90 as a technical elective.



ENGINEERING SCIENCE: B.S. (E.S.)

FIRST, SECOND, AND THIRD YEARS

The courses required in the first three years are listed on page 78.

FOURTH YEAR

Students should elect any Fourth Year program offered by one of the Engineering departments.

FIFTH, SIXTH, SEVENTH, AND EIGHTH YEARS

Requirements for the last four years are identical with those listed for the Day Division Third and Fourth Years. Over-all degree requirements are also identical with those of the Day Division. (See page 67.)

INDUSTRIAL ENGINEERING: B.S. (I.E.)

FIRST, SECOND, AND THIRD YEARS. See page 78.

FOURTH YEAR

1st Semester		2nd Semester	
IE 21—Intro. to Mgt. Science	3-0-3	IE 24—Prod. Proc. Design	3-0-3
Phys 31—Physics III	4-2-5	Math 90—Computer Programg.	2-2-3
SS 20—Economics	3-0-3	Mech 10—Statics & Dynamics	4-0-4

FIFTH YEAR (Block 41 IE—Class of 1972)

Eng 31—M. of World Lit. I	3-0-3	Eng 32—M. of World Lit. II	3-0-3
Math 33—Probability & Statis.	3-0-3	IE 31—Applied Statistics	3-0-3
Mech 12—Mechanics of Mater.	3-1-3	Math 34—Math for Mgt. Science	3-0-3

SIXTH YEAR (Block 42 IE—Class of 1971)

IE 33—Engrg. Cost Anal.	4-2-5	IE 38—Work Analysis II	2-2-3
IE 37—Work Analysis I	2-2-3	ME 65—Mechanical Engrg.	5-0-5

SEVENTH YEAR (Block 43 IE—Class of 1970)

EE 94—Electrical Engrg.	3-0-3	IE 40—Management Sci. II	2-2-3
IE 39—Management Science I	2-2-3	IR 42—Contemporary Issues	3-0-3
IR 41—Management Practices	3-0-3	Elective (Tech.)**	3-0-3

EIGHTH YEAR (Block 44 IE—Class of 1969)

IE 43—Systems Design I	2-2-3	IE 44—Systems Design II	2-2-3
Elective (Human.)*	3-0-3	Elective (Human.)*	3-0-3
Elective (Tech.)**	3-0-3	Elective (Tech.)**	3-0-3

* Humanities electives are listed on pages 109-115.
**Technical electives are listed on page 70.

MECHANICAL ENGINEERING: B.S. (M.E.)

FIRST, SECOND, AND THIRD YEARS. See page 78.

FOURTH YEAR

1st Semester		2nd Semester	
Mech 10—Statics & Dynamics	4-0-4	Mech 12—Mechanics of Mater.	3-1-3
Phys 31—Physics III	4-2-5	Math 90—Computer Programg.	2-2-3
		SS 20—Economics	3-0-3

FIFTH YEAR (Block 41M—Class of 1972)

EE 91—Electronics & Instr.	3-0-3	Mech 12—Mechanics of Mater.	3-1-3
ME 18—Metallurgy	3-2-4	ME 10—Manufacturing Proc.	1-2-2
SS 20—Economics	3-0-3	ME 31—Theory of Machines	3-0-3

SIXTH YEAR (Block 42M—Class of 1971)

EE 91—Electronics & Instr.	3-0-3	Mech 12—Mechanics of Mater.	3-1-3
ME 18—Metallurgy	3-2-4	EE 95—Electrical Engrg. Prin.	3-2-4
ME 33—Vibration Analysis	3-0-3	ME 44—Fluid Mechanics	3-0-3

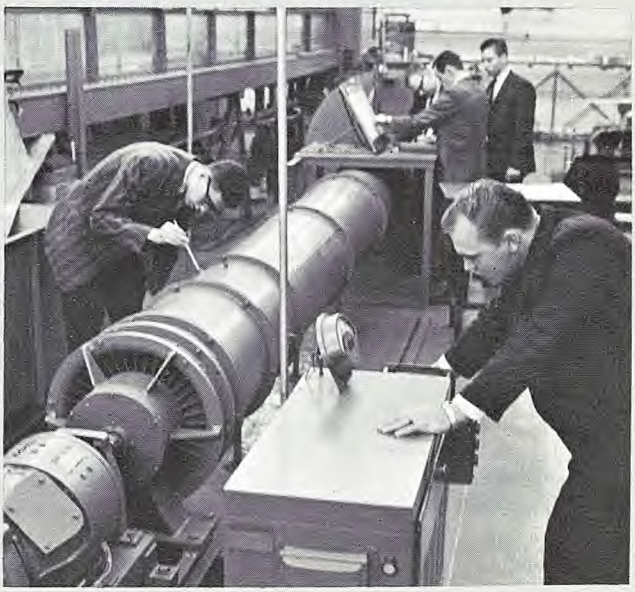
SEVENTH YEAR (Block 43M—Class of 1970)

ME 31—Theory of Machines	3-0-3	EE 95—Electrical Engrg. Prin.	3-2-4
ME 45—Heat Transfer	3-0-3	IE 94—Enterprise Mgt.	3-0-3
Elective (Tech.)**	3-0-3	ME 43—Mechanical Lab. I	2-2-3

EIGHTH YEAR (Block 44M—Class of 1969)

ME 34—Mech. Engrg. Design I	3-2-4	ME 36—Mech. Engrg. Design II	3-2-4
ME 46—Mechanical Lab. II	1-2-2	ME 48—Mechanical Lab. III	1-2-2
Elective (Tech.)**	3-0-3		

** Technical Electives are listed on page 73.



DEPARTMENTS AND COURSES OF INSTRUCTION

DEPARTMENTS OF ENGINEERING

Departments granting degrees at Newark College of Engineering include Chemical Engineering and Chemistry, Civil Engineering, Electrical Engineering, Mechanical Engineering, and Industrial and Management Engineering.

The Department of Aerospace Studies offers Day Undergraduate students the opportunity to take the Air Force ROTC program leading to a commission as a Second Lieutenant in the U. S. Air Force Reserve.

BASIC SCIENCE DEPARTMENTS

Providing NCE students with a common background in mathematics and science, especially in the early years of their training, are the departments of Engineering Graphics, Mathematics, Physics; and the Chemistry Division of the Department of Chemical Engineering and Chemistry. Basic instruction in the area of mechanics is provided by the Department of Civil Engineering. These departments also conduct advanced courses on both the undergraduate and graduate levels.

HUMANISTIC-SOCIAL DEPARTMENTS

Since engineering education also requires that students receive a thorough grounding in the humanities, two additional departments have a prominent place in the curriculum: the Department of Humanities and the Department of Industrial Relations. Beside basic courses in English, history, economics, and management, these two departments offer a series of elective courses designed to provide students with opportunities for specialized studies in the humanities and the social sciences typical of the liberal arts tradition.

DIVISION OF HEALTH, PHYSICAL EDUCATION AND ATHLETICS

Common to the education of all Day Undergraduate students at NCE is a strong emphasis on health and physical activity. For this reason, Health, Physical Education and Athletics has been established as a separate, functional division of the College, gearing its programs to the needs and abilities of all students, and supervising a wide range of activities from formal gymnasium instruction to intramural and informal sports to health services.

DEPARTMENT OF AEROSPACE STUDIES

Chairman: LT. COLONEL JAMES A. MACKENZIE.
Associate Chairman: LT. COLONEL MELVYN FENTON.

Professor: MACKENZIE; *Assistant Professors:* FARRELL, FENTON, MEYER; *Instructors:* GREENFELDER, LEVANS, O'CONNOR.

The Department of Aerospace Studies offers qualified students an educational experience leading to a commission as an officer in the U.S. Air Force and is conducted by an instructing staff consisting of professional Air Force officers.

The Air Force Education Program (ROTC) qualifies for commission as a Second Lieutenant those college men who desire to serve in the United States Air Force. Emphasis is placed upon student participation and self-expression through seminars, briefings, and discussions.

Enrollment is voluntary. It is open to all regularly enrolled day session students who are citizens of the United States, possess good moral character, are physically qualified, are not less than fourteen years of age, and are approved by the President of the College and the Professor of Aerospace Studies. Entrance into the Professional Officer course is on a competitive basis. Selection is based upon composite scores derived from Air Force Officer Qualifying Tests, Air Force ROTC grades, academic grades, and instructors' and Professional Officer Course Selection Committee Members' estimate of the cadet's potential officer qualities and leadership ability. In addition, an applicant for enrollment in the Professional Officer course will not be eligible unless he will be less than 28 years of age at the time of graduation, if enrolling in Category II, or less than 26½ years of age at time of graduation, if enrolling in Categories IP or IN. Choice of category is made at time of application for enrollment in the Professional Officer course. The categories to choose from are as follows:

CATEGORY IP. Included are those cadets who desire to enter pilot training after graduation and who meet the mental and physical standards for this type of training.

CATEGORY IN. Included are those cadets who desire to enter navigation training after graduation and who meet the mental and physical standards for this type of training.

CATEGORY II. Included are those cadets who are pursuing Electrical, Mechanical, Industrial, Chemical, or Civil Engineering or other scientific and technical fields, and who meet the mental and physical standards for an Air Force commission.

CATEGORY II (Meteorology). Included are those cadets who meet certain academic prerequisites in physics and mathematics and who desire to serve as weather officers.

The inclusion of Aerospace Studies courses in the student's program does not materially increase his workload, as these courses receive comparable credits and may be substituted for certain courses in the standard curriculum.

Uniforms and textbooks are furnished without cost by the United States Air Force. Students in the junior and senior years receive a subsistence allowance of $50 per month. Each student enrolled in the freshman and sophomore year will be required to pay a $15 uniform deposit.

All cadets entering the sophomore year may be selected to receive an Air Force ROTC grant. This grant will cover the cost of tuition, books, fees and equipment, and a monthly retainer pay of $50.

Between the Junior and Senior years, advanced students will normally attend a 28-day field training encampment at an Air Force base. While attending summer training, students receive pay, transportation to and from training, medical attention, subsistence, quarters, and uniforms.

COURSES OF INSTRUCTION

AS 11. WORLD MILITARY SYSTEMS I. 1 *credit.*

This introductory course explores the present world conflict, and the role and relationship of military power to that conflict. The formation and role of nations in the international community is examined. This is followed by a discussion of the means that nations develop to pursue their objectives and how they confront each other in the use of these means. The course then presents the role and functions of the U.S. Department of Defense and the U.S. Air Force. One class hour per week, and one hour of corps training.

AS 12. WORLD MILITARY SYSTEMS II. 1 *credit.*

This course emphasizes the military aspect of international conflict by examining the role of strategic offensive and strategic defensive forces. One class hour per week, and one hour of corps training.

AS 21. WORLD MILITARY SYSTEMS III. 1 *credit.*

This course continues the discussion of the military aspect of international conflict by examining the role of general purpose military forces and aerospace support forces. One class hour per week, and one hour of corps training.

AS 22. World Military Systems IV. 1 *credit.*

This course compares differing political philosophies and includes an analysis of democracy versus communism. An examination of the resulting world alliances, the system of collective security and the continuing search for peace follows. One hour of class per week, and one hour of corps training.

AS 31. Growth and Development of Aerospace Power I. 3 *credits.*

A seminar course which examines each student's communicative skill and encourages him to develop these talents. The history of airpower, aerospace power today, and the future of manned aircraft are discussed. Three hours of class per week, and one hour of corps training.

AS 32. Growth and Development of Aerospace Power II. 3 *credits.*

This seminar course reviews the United States space programs, and the vehicles, systems, and problems encountered in space exploration. Three hours of class per week, and one hour of corps training.

AS 41. The Professional Officer I. 3 *credits.*

This seminar course explores the theory, function, and practice of leadership as applied to specific situations. The role of discipline and military justice is examined in leadership situations. Three hours of class per week, and one hour of corps training.

AS 42. The Professional Officer II. 3 *credits.*

This seminar course examines management philosophy and how management principles, tools, practices, and controls are used. Both the decision making process and the actual execution of decisions are discussed. Three hours of class per week, and one hour of corps training.

DEPARTMENT OF CHEMICAL ENGINEERING AND CHEMISTRY

Chairman: JOSEPH JOFFE.
Associate Chairmen: GEORGE C. KEEFFE, AVNER SHILMAN.
Assistant Chairmen: JOSEPH M. FITZGERALD, JEROME J. SALAMONE.

Chemical Engineering Staff: Distinguished Professor: JOFFE; *Professors:* ANDERSEN, KEEFFE, KREPS, SALAMONE; *Associate Professors:* HANESIAN, MCCORMICK, ROCHE; *Assistant Professors:* CHEN, GREENSTEIN, HUANG, PERNA, TASSIOS; *Adjunct Instructing Staff:* WOLKSTEIN.

Chemistry Staff: Professor Emeritus: BAUDER; *Professors:* BISHOP, CARLSON, FITZGERALD, RAM; *Associate Professors:* POETZ, SHILMAN, SNYDER, SUCHOW, WENISCH; *Assistant Professors:* CAGNATI, GETZIN, KATORSKI, KIMMEL, LAMBERT, PARKER, PERLMUTTER, SCHLESSINGER, TRATTNER; *Instructors:* KEBBEKUS, KNAPP, KRISTOL, MULTHAUP, POIGNANT; *Special Instructing Staff:* ALBERT, FREAR, SCHNEIDER, SUTTON; *Adjunct Instructing Staff:* FEUER, GEYER.

The Chemical Engineering curriculum is designed to give the student a thorough background in the fundamental sciences and engineering subjects. It prepares the student for a professional career in chemical engineering in the process industries involving the development of practices in chemical manufacture and related operations, the design and operation of plants, as well as chemical and engineering application in non-chemical organizations.

The chemical engineering student acquires a strong foundation in chemistry, physics, and mathematics, with the emphasis gradually shifting toward chemical engineering courses in the junior and senior years. The senior course in process and plant design coordinates and brings into focus the technical aspects of the chemical engineering curriculum.

The chemistry courses offered by the Department of Chemical Engineering and Chemistry serve the broad purpose of providing an adequate scientific foundation for the engineering education of all engineering students at the College. The more advanced chemistry courses are integrated into the chemical engineering curriculum or provide students with certain options in the areas of engineering science and in biomedical and sanitary engineering.

The laboratories in chemical engineering, organic chemistry, physical chemistry and instrumentation as well as many of the research laboratories are located in Tiernan Hall. Laboratories in general chemistry, analytical chemistry, sanitary chemistry, and related areas, as well as a number of chemical research laboratories, are located in Colton Hall.

The department encourages active participation of its students in the Student Chapters of the American Institute of Chemical Engineers and of the American Chemical Society. These student groups arrange for guest speakers from industry

and for plant trips, both of which are important in orienting professional interest and attitude.

In addition to the one day trips arranged by the student chapters, the chemical engineering students, with the cooperation of the department, visit industries outside the Newark area.

COURSES OF INSTRUCTION IN CHEMICAL ENGINEERING

ChE 27. CHEMICAL ENGINEERING PROBLEMS. 3 *credits.*
Prerequisite: Math 12, Phys 2, Chem 16. A course in the application of principles of physics and chemistry and the quantitative solution of industrial chemical process problems. Emphasis is placed on material and heat balance of complex chemical reactions.

ChE 45. CHEMICAL ENGINEERING THERMODYNAMICS I. 3 *credits.*
Prerequisites: ChE 27, Math 22. The thermal properties of matter are studied and interpreted in terms of the fundamental concepts and laws of thermodynamics. Generalized methods for handling p-V-T relations and thermodynamic properties of fluids are considered. Applications are made to batch and flow processes.

ChE 46. CHEMICAL ENGINEERING THERMODYNAMICS II. 3 *credits.*
Prerequisite: ChE 45. The concepts and methods developed in ChE 45 are applied to the treatment of compressors, heat engines, refrigeration, phase equilibria, and chemical reactors. The student is introduced to the thermodynamic analysis of practical processes as a method for the evaluation of energy utilization.

ChE 49. REACTION KINETICS. 3 *credits.*
Prerequisites: Chem 22, ChE 46. A study of the kinetics of homogenous chemical reactions in batch and flow reactors and of the applications of kinetics to chemical reactor design. Problems also stress economic choice among alternate designs.

ChE 63. TRANSPORT OPERATIONS I. 3 *credits.*
Prerequisites: ChE 27, Math 22, Phys 4. The principles of the molecular and turbulent transport of momentum, heat, and mass, with applications to the design of chemical process equipment are considered. This first semester of a 3-course sequence emphasizes momentum transport, with applications.

ChE 63H. TRANSPORT OPERATIONS I. 3 *credits.*
Prerequisites: ChE 27, Math 22, Phys 4. Corequisite: Math 31. An honors course, with an emphasis on the mathematical description of the physical phenomena considered in ChE 63.

ChE 64. TRANSPORT OPERATIONS II. 3 *credits.*
Prerequisite: ChE 63. A continuation of ChE 63, emphasizing heat transport, with applications.

ChE 64H. TRANSPORT OPERATIONS II. 3 *credits.*
Prerequisite: ChE 63H. A continuation of ChE 63H at the honors level.

ChE 65. TRANSPORT OPERATIONS III. 3 *credits.*
Prerequisite: ChE 64. A continuation of ChE 64 emphasizing mass transport, with applications. Heat and mass transport are also considered.

ChE 65H. TRANSPORT OPERATIONS III. 3 *credits.*

Prerequisite: ChE 64H. A continuation of ChE 64H at the honors level.

ChE 69. CHEMICAL ENGINEERING LABORATORY. 3 *credits.*

Prerequisite: ChE 64. Corequisite: ChE 65. Steady and unsteady state processes involving fluid mechanics, heat transfer, simultaneous mass, energy and momentum transfer and reaction kinetics are investigated. Process instrumentation and analog computer techniques are emphasized. An experimental project dealing with a phase of chemical engineering of special interest to the student will be developed and conducted by the student.

ChE 70. PROCESS AND PLANT DESIGN. 3 *credits.*

Prerequisites: ChE 46, 49, 65. Development of the computer aided design project with an economic approach. Process and mechanical design of equipment; process and equipment flow sheets; material, heat, and utility balances; plant location factors; process raw materials and utility supplies; optimization of energy utilization; and process instrumentation are covered.

ChE 73. MATHEMATICAL METHODS IN CHEMICAL ENGINEERING. 3 *credits.*

Prerequisite: Math 31 or 33. A course in applied mathematics in fields of interest to the chemical engineer. A short treatment of Fortran type programming for computer use and a study of the method of computer operation is included to provide a sound basis for understanding the limitations of computers. Matrix methods are studied as they are used with computers. Problem setup and solution of differential equations for both steady state and unsteady state processes are studied. Particular reference is made to the use of Bessel functions, error functions, the Laplace transforms and the principles of coupling and superposition.

ChE 74. PROCESS DYNAMICS AND CONTROL. 3 *credits.*

Prerequisites: ChE 49, 65, Math 31 or 33. An introduction to the principles of process dynamics and control with application to the automatic control of chemical processes. Mathematical description and analysis of chemical process systems is included.

ChE 74H. PROCESS DYNAMICS AND CONTROL. 3 *credits.*

Prerequisites: ChE 49, 65, 73. An introduction to the principles of process dynamics and control with application to the automatic control of chemical processes. Mathematical description and analysis of chemical process systems. This course is similar in content to ChE 74, but covers the subject matter in greater depth.

ChE 75. STATISTICAL THERMODYNAMICS. 3 *credits.*

Prerequisite: ChE 46. Application of statistical methods to the evaluation of thermodynamic properties. Among the topics considered are the ideal gas, monotomic crystals, chemical equilibrium, the transition-state theory of reaction, intermolecular forces, and virial coefficients.

ChE 78. CHEMICAL REACTOR DESIGN. 3 *credits.*

Prerequisite: ChE 49. A project and problem course emphasizing the application of thermodynamics, kinetics, and economics to the design of chemical processes. Procedures for process optimization and scaling up of designs are considered.

ChE 79. CHEMICAL PROCESS ANALYSIS. 3 *credits.*

Prerequisites: ChE 27, 45, Math 90. This course deals with complex simultaneous heat and material balances in steady state and unsteady state processes. Other topics covered include estimation of physical properties, economic optimization, and analysis of plant problems.

ChE 80. MATHEMATICAL MODELING IN CHEMICAL ENGINEERING. 3 *credits.*

Prerequisite: ChE 73. The application of mathematical techniques and computers to the simultation of chemical processes. Use is made of transport phenomena relations, residence time distribution models, and empirical models based on regression analysis of plant data. Models are applied to both overall systems and subsystems.

ChE 91H. RESEARCH AND INDEPENDENT STUDY. 3 *credits.*

An honors course open to a limited number of qualified students. This course provides the student with an opportunity to work in research or on projects of special interest under the individual guidance of a member of the department staff.

ChE 92H. RESEARCH AND INDEPENDENT STUDY. 3 *credits.*

A continuation of ChE 91H at the honors level.

COURSES OF INSTRUCTION IN CHEMISTRY

Chem 15. GENERAL CHEMISTRY. 5 *credits.*

Fundamental chemistry, including general inorganic, analytical, and some organic and nuclear chemistry, with particular emphasis on those concepts which are basic to an engineering education. Both the pace and content of the course presuppose a full year of high school chemistry prior to entering college.

Chem 15H. HONORS CHEMISTRY. 5 *credits.*

This is an honors course in chemistry which follows in general the course content of Chem 15 but differs from it in that the fundamental theory is covered more comprehensively and in somewhat greater depth. Admission to the course is restricted.

Chem 16. CHEMISTRY OF MATERIALS. 4 *credits.*

Prerequisite: Chem 15. A continuation of Chem 15, with particular emphasis on application of fundamentals to understanding the chemistry of materials. Among the topics covered are properties of metallic and non-metallic compounds, aggregate states of matter, energy bonds in solids, metals and metallurgy, polymers, and nuclear chemistry. The laboratory work consists of volumetric analysis.

Chem 16H. HONORS CHEMISTRY OF MATERIALS. 4 *credits.*

Prerequisite: Chem 15. This is a continuation of Chem 15H, which parallels the course content of Chem 16 but emphasizes fundamental theories.

Chem 31. PHYSICAL CHEMISTRY I. 3 *credits.*

Prerequisites: Math 22, Phys 4, Chem 28, ChE 27. The topics covered include the properties of ideal and non-ideal gases, liquids, solids, solutions, thermochemistry, and elementary thermodynamics. The relationship between physical properties and molecular structure is shown.

Chem 32. PHYSICAL CHEMISTRY II. 3 *credits.*

Prerequisite: Chem 31. The topics covered are homogeneous and heterogeneous equilibria, phase rule, electrolytic transference and conductance, ionic equilibria, electromotive force, and kinetics.

Chem 33. ORGANIC CHEMISTRY I. 4 *credits.*

Prerequisite: Chem 28. Lectures, problems, and laboratory exercises in the principles and practice of organic chemistry presenting an integrated study of aliphatic, aromatic, and heterocyclic compounds. Modern concepts of structure and mechanism are considered.

Chem 34. ORGANIC CHEMISTRY II. 4 *credits.*

Prerequisite: Chem 33. A continuation of the integrated study of organic chemistry. Laboratory work will emphasize more advanced analytic and synthetic procedures.

Chem 42. PHYSICAL CHEMISTRY LABORATORY II. 2 *credits.*

Prerequisite: Chem 32 and 41. This course extends the laboratory experimentation of Chem 41. Included are experiments on the determination of rate constants, distribution constants, ionization constants, conductance and electrode potentials. The student is introduced to the use of instruments, such as spectrophotometers, gas chromatographs, and electrometric apparatus.

Chem 43. PHYSICAL CHEMISTRY LABORATORY. 3 *credits.*

Prerequisites: Chem 28, 32. This course consists of laboratory experimentation in which the student applies and extends the basic knowledge of physical chemistry acquired in Chem 31 and 32. Some of the experiments performed are on physical properties such as surface tension, vapor pressure and viscosity, and on heats of reaction, equilibria, and electrochemistry. The student is introduced to the use of instruments such as spectrophotometers, gas chromatographs, and electrometric apparatus. Laboratory reports must include an analysis of experimental errors and a quantitative treatment of the reliability of calculated results.

Chem 102. ADVANCED ORGANIC CHEMISTRY I. 3 *credits.*

Prerequisites: Undergraduate organic chemistry and physical chemistry. Organic reactions are treated from a mechanistic point of view. Some of the topics covered include chemical bonding, nucleophilic aliphatic substitution, additions to multiple bonds, elimination reactions, and electrophilic and nucleophilic aromatic substitution.

Chem 120. ADVANCED INORGANIC CHEMISTRY. 3 *credits.*

A course in the theory and applications of inorganic chemistry. Chemical theory is applied to the prediction and elucidation of the properties and behavior of inorganic compounds.

Chem 140. INTRODUCTION TO POLYMERS. 3 *credits.*

Prerequisite: Undergraduate physical chemistry or thermodynamics. Synthesis of typical polymers of commercial importance is presented from a descriptive viewpoint. Determination of the size and shape of polymer molecules and the morphology of crystalline polymers is considered. Mechanical properties of polymers in the crystalline, glassy and elastomeric states are related to structure. Properties of available polymers are examined in relation to specific applications.

Chem 151. BIOCHEMISTRY. 3 *credits.*

Prerequisites: Undergraduate organic and physical chemistry, or permission of the instructor. An introductory course in biochemistry which includes fundamentals from the viewpoint of physical and organic chemistry and the industrial applications of the field. It is directed particularly to those students who have an interest in biophysics and bioengineering.

DEPARTMENT OF CIVIL ENGINEERING

Chairman: JAMES M. ROBBINS.
Associate Chairman: EIVIND G. F. RAMBERG.

Distinguished Professor: LEHMAN; *Professors:* MANGASARIAN, METZGER, MONACK, NIELSEN, RAAMOT, RAMBERG, ROBBINS; *Associate Professors:* GRANIK, LAW, WILLIAMS; *Assistant Professors:* CHAN, CHENG, CIESLA, DRESNACK, KHERA, KOO, MONAHAN, OLSEN, STACK, WITTES; *Instructors:* KOREN, TAYLOR; *Assistant Instructors:* DUL, FRENCH; *Teaching Fellows:* CAMPORINI, HODGETTS; *Adjunct Instructing Staff:* ADDONIZIO, BERSON, BUTLER, DEMEHAK, KIVEN, MARKO, PAE, TIMBERLAKE.

Modern civil engineering includes within its scope the economic planning, design, construction, operation, and maintenance of the fixed structures and works required by our present industrial civilization. Its coordinated subdivisions comprise: structural engineering, which provides bridges, dams, industrial plants, foundations, buildings, tunnels, and other important stationary structures; transportation engineering, which provides highways, railroads, airways, inland waterways and the terminal facilities requisite thereto; hydraulic engineering, covering the development of water supplies, irrigation, drainage, hydro-electric power, flood control and shore protection; sanitary engineering, which provides potable water supplies, treatment and disposal facilities for sewage and industrial wastes, and measures incident to the engineering control of communicable disease; surveying, which furnishes the engineering surveys required by all construction operations, the proper delineation of property, and the base maps of the nation; and construction management, which provides the planning and direction required to get things built.

A field so varied requires that the academic training of those who enter it have breadth as well as depth. Rigorous education in the basic sciences is fundamental. A knowledge of numerical methods is necessary to enable the practicing engineer to program his long and complex problems for solutions by electronic computers. Economics and finance are of the essence in this field. Knowledge of the properties of engineering materials is essential not only in design but in research. A rational approach to personnel problems is vital. Chemistry, biology and bacteriology are required by the sanitarian. The operation of highly mechanized construction plants requires basic training in mechanical and electrical engineering. The ability to write clearly and to speak convincingly must be inculcated. Liberal training must be provided in the humanities if the student is to develop to take his proper part, as engineer and citizen, in the community. Integrated with, and built upon, this broad foundation we have the applications of the engineering method to the professional work of the field.

To provide for breadth of training in a four-year under-

graduate program, the hours devoted to courses which are primarily vocational in character have been reduced to a minimum. Depth of training is obtained by permitting the student to select approximately one full semester of technical electives best suited to his graduate professional or academic interests. Highly specialized instruction of an advanced character has been definitely placed in the graduate program.

The Department provides instruction in statics, dynamics, and strength of materials to students in the other engineering disciplines as well as to those students taking the civil engineering program.

COURSES OF INSTRUCTION IN CIVIL ENGINEERING

CE 3. SURVEYING. 4 *credits.*

Prerequisite: Math 11. Theory, fieldwork, drafting and computations dealing with plane, cadastral, topographic, and route surveys.

CE 5. ADVANCED SURVEYING. 3 *credits.*

Prerequisite: CE 3. The theory of engineering astronomy, of satellite and space vehicle tracking, and of geodetic and hydrographic surveying will be considered in class. An occasional day or evening field period will be held in lieu of classes to permit the student to make field observations on the sun, stars or other heavenly bodies for the determination of latitude, longitude, time and azimuth.

CE 6. AERIAL PHOTOGRAPHIC INTERPRETATION. 3 *credits.*

Analysis and study of land forms, surficial soils and rock formations by the use of aerial photos and stereograms with special emphasis on the engineering significance of the results. The applications of aerial photography to materiels surveys, land surveying, traffic engineering, highway construction and general construction are discussed in detail.

CE 7. GEOMETRIC DESIGN FOR HIGHWAYS. 3 *credits.*

Prerequisite: CE 3. A course in highway design based on a study of traffic distribution, volume, speed, and projection. The elements of at-grade intersections and interchanges are analyzed. Studies are made of the geometrics of highway design and intersection layout with advanced curve work including compound and transition curves.

CE 17. ENGINEERING GEOLOGY. 3 *credits.*

A study of physical geology and physiography with particular emphasis placed on the applications of the material considered in Civil Engineering work.

CE 18. SOIL MECHANICS AND FOUNDATIONS. 4 *credits.*

Prerequisite: CE 24 or equivalent. A study of all soil types and properties; the significance of soil tests; the methods of compaction, consolidation, and settlement; bearing capacity and pile tests and formulas; lateral pressures; frost heaving; soil stabilization; and problems relating to the proper design of soil supported foundations for engineering structures. The theoretical studies carried out in the classroom are supplemented by experimental work in the soil mechanics laboratory.

CE 23. STRENGTH OF MATERIALS. 3 *credits.*

Prerequisite: Mech 8. A continuation of the study of strength of materials beyond the scope of the material covered in Mech 7 and Mech 8. Laboratory work associated with non-destructive testing is carried out.

CE 24. STRENGTH OF MATERIALS. 5 *credits.*

Prerequisites: Mech 10, Math 21, or equivalents. A consideration of the relations between external forces acting on engineering structures and the resulting internal forces and stresses, and the relations between external forces and strains. Many practical problems are worked out illustrating the use of the derived principles. In the laboratory, tests are conducted in both destructive and non-destructive testing to investigate some of the physical characteristics of materials and to verify the assumptions made in theoretical analysis. The results of each test are summarized in an engineering report.

CE 26. STRUCTURES I. 4 *credits.*

Prerequisites: Mech 10, CE 24, or equivalents. A course in statically determinate and indeterminate structural theory and steel design.

CE 27. STRUCTURES I. 3 *credits.*

Prerequisites: Mech 7, 8, CE 23 or Mech 1, CE 22. A course in statically determinate and indeterminate structural theory. The practical design considerations will be carried out by those interested in the civil engineering projects courses.

CE 28. STRUCTURES II. 4 *credits.*

Prerequisite: CE 27. This course covers the fundamentals of structural design and the elements of reinforced concrete theory and design involving indeterminate structural applications. Further practical design considerations will be carried out by those interested in the civil engineering projects courses.

CE 29. STRUCTURES II. 4 *credits.*

Prerequisite: CE 26. This course covers the elements of reinforced concrete theory and design involving indeterminate structural applications. Further design projects will be selected and completed by each individual student.

CE 31. CONSTRUCTION MANAGEMENT I. 3 *credits.*

Prerequisite: IE 97. A study of engineered construction with emphasis on planning and management. Organization of projects with special attention to critical path analysis for control. Detailed discussion of contract documents, construction methods, materials handling and expedition of projects.

CE 32. CONSTRUCTION MANAGEMENT II. 3 *credits.*

Prerequisite: CE 31. A study of the economic feasibility and financing of various construction projects. Detailed analysis of bid procedures and methods used in estimating cost including the use of critical path scheduling with programming for computer solutions.

CE 41. FLUID MECHANICS I. 4 *credits.*

Prerequisites: Math 21, CE 20, or equivalents. A problem course treating the static and dynamic behavior of fluids with a majority of applications dealing with the flow of water and other incompressible fluids. Emphasis is placed on the understanding of fundamental laws and the equations derived from them. Problems of compressible fluids and of similitude are also studied as well as the means for measuring fluid flow by theoretical and semi-empirical methods.

CE 45. FLUID MECHANICS II. 3 *credits.*

Prerequisite: CE 41. A problem course treating with fluid flow in pipe networks, flow in open channels, backwater curves, hydraulic jump, and some dynamic problems.

CE 47. HYDRAULIC AND SANITARY ENGINEERING I. 3 *credits.*

A study of the occurrence, distribution and utilization of water and of the analyses required for the design of regulatory works for water supplies, hydro-electric developments, irrigation, flood control, erosion control and inland navigation. Design problems deal with the development of the water resources of a river basin, the determination of the safe yield of a reservoir, flood routing and the design of hydrologic structures.

CE 48. HYDRAULIC AND SANITARY ENGINEERING II. 3 *credits.*

A course covering the principles of the design, construction and operation of water supplies, distribution systems and treatment works, of storm drains and sanitary sewers, and of waste water treatment and disposal structures. Design problems deal with water distribution lines, storm drains and sanitary sewers.

CE 51. URBAN PLANNING. 3 *credits.*

Topics will include the interrelated concept of planning, politics, and the public interest; land use and its interaction with traffic and transportation; and the problems of the older city including urban renewal and rehabilitation. Practical applications will be presented in the form of case studies. Assignments will consist of readings from the available literature and a number of short problems.

CE 52. TRANSPORTATION ENGINEERING. 3 *credits.*

A study of the principal modes of transportation, with emphasis on the planning, design, and construction of facilities for modern transportation systems. The practical design considerations will be carried out by those interested in the civil engineering projects courses.

CE 63. NUMERICAL METHODS IN ENGINEERING ANALYSIS I. 3 *credits.*

Prerequisite: Satisfactory senior standing. Modern powerful methods of analysis will be introduced through a number of simplified engineering problems of current interest. Students will use the College Computing Center for some of the solutions. Topics will include matrix methods, iteration and relaxation, methods of finite calculus, and polynomial approximations.

CE 64. NUMERICAL METHODS IN ENGINEERING ANALYSIS II. 3 *credits.*

Prerequisite: Satisfactory senior standing. The method of approach is the same as in CE 63. Topics will include simulation and mathematical models, principles of linear programming, and the application of probability and random processes to quality control, treatment of data, and the waiting line problem.

CE 71. CIVIL ENGINEERING PROJECTS I. 3 *credits.*

Prerequisite: Limited to seniors who ranked in the upper half of their Junior class. The student works on one or more individually selected projects, guided by the Civil Engineering Department staff. The projects may include planning, research (library or laboratory), engineering reports, statistical or analytical investigations, and designs. Any of these may follow class inspired direction or the student may branch out on his own. The project or projects of each student must be completed and professionally presented by assigned due dates for appropriate review and recording of accomplishment. Critiques will be held and the student will present his work to other students having similar interests.

CE 72. CIVIL ENGINEERING PROJECTS II. 3 *credits.*

Prerequisite: Satisfactory senior standing. One or more individually selected projects conforming to the specifications given in the description for CE 71.

CE 102. ENVIRONMENTAL CHEMISTRY. 3 *credits, 1st sem.*

Prerequisite: Undergraduate chemistry. Basic physical and chemical principles applicable to environmental and sanitary engineering are presented and amplified by work in the laboratory.

CE 109. ADVANCED STRENGTH OF MATERIALS. 3 *credits, 1st sem.*

Prerequisite: CE 24 or Mech 12. Topics beyond the scope of elementary strength of materials are studied, with particular emphasis on the assumptions and limitations of the derivations and on applications to actual problems.

COURSES OF INSTRUCTION IN MECHANICS

Mech 10. STATICS AND DYNAMICS. 4 *credits.*

Prerequisites: Phys 1, Math 12. In the field of statics the topics considered include elementary vector algebra, scalar and vector products applied to two and three dimensional force systems, equilibrium, friction (sliding, belt, and bearing), second moments of areas and of masses, flexible cables, virtual work, and various engineering applications of statics. In the area of dynamics (kinematics and kinetics), the subjects covered include curvilinear motion with respect to fixed and rotating axes of particles and rigid bodies, Newton's laws of motion for particles and rigid bodies, the principles of work and energy and of impulse and momentum. The emphasis is on engineering mechanics in which a maximum use is made of the free body diagram approach, together with vector analysis methods.

Mech 10H. STATICS AND DYNAMICS. 4 *credits.*

Prerequisites: Phys 1, Math 12. While paralleling Mech 10 in both orientation and presentation, Mech 10H considers both statics and dynamics in greater depth. More subject matter is studied and greater use is made of the vector analysis method by more extensive application to three-dimensional problems.

Mech 12. MECHANICS OF MATERIALS. 3 *credits.*

Prerequisites: Mech 10, Math 21, or equivalents. The physical basis of stress and strain analysis is studied in theory and demonstrated by laboratory experiments. The principles and methods are applied to practical problems involving the elements of which structures and machines are composed, such as axial, flexural, and torsional members as well as combinations of these.

Mech 12H. MECHANICS OF MATERIALS. 3 *credits.*

Prerequisites: Mech 10, Math 21 or equivalents. In addition to covering the material in Mech 12, this honors course considers topics beyond the scope of the material covered in Mech 12. However, orientation and presentation are the same in both courses.

DEPARTMENT OF ELECTRICAL ENGINEERING

Chairman: FREDERICK A. RUSSELL.
Associate Chairman: ROBERT E. ANDERSON.
Assistant Chairmen: CHUNG-WEI CHOW, ROBERT R. MEOLA, ROBERT H. ROSE.

Distinguished Professor: RUSSELL; *Professors:* ANDERSON, DICKEY, JORDAN, MISRA, PADALINO, ZAMBUTO; *Associate Professors:* CARLUCCIO, CHING, KLAPPER, EISENBERG, KUO, LAWRENCE, MEOLA, MEYER, REDMON, RIPS, ROSE, WEISBECKER, WINSTON. *Assistant Professors:* AYOUB, CHOW, ITTLESON, MCMILLAN, RICCI, ROSENSTEIN, SOHN, STRANO, TROOP. *Instructors:* E. COHEN, MISHRA. *Teaching Fellows:* BARRETT, CREUTZ, FISCHER, HONICKMAN. *Adjunct Instructing Staff:* H. COHEN, CROW, FALCONE, FRIEDMAN, HOLLINGSWORTH, KURLAND, MAGID, RANSON, SHAW, TIKIJIAN, TORCICOLLO, WOERNER. *Special Lecturer:* KOOPERSTEIN.

The Electrical Engineering curriculum provides a broad, basic engineering education. A student will have completed his preparatory education in mathematics, the physical sciences, English, and the humanities during the first half of his college curriculum. During the final years his education is broadened into associated fields of engineering and includes increased specialization in his chosen field, electrical engineering.

The electrical engineering courses emphasize basic principles, concepts, and their interrelations upon which the design and operation of electrical devices of our present electrical age depend.

The aim is to educate an electrical engineer who can think analytically and creatively, work efficiently, and convey the results of his work effectively to others. He is prepared for responsibilities as a professional engineer and citizen in a democracy by his experiences within the group of fellow students and laboratory co-workers.

His electrical engineering education is as broad as possible so that employment opportunities upon graduation will not be restricted. His education is adequate for further advanced study in his chosen field if his interest lies in research or development. However, the curriculum can serve as a terminal engineering program leading to industrial work or activity as an engineer dealing with production, operation, or service.

Branches of the Institute of Electrical and Electronic Engineers and Eta Kappa Nu are active and stimulate interest in the practical and professional aspects of electrical engineering.

COURSES OF INSTRUCTION

EE 10. ELECTRIC CIRCUITS AND MEASUREMENTS. 3 *credits.*

Prerequisites: Phys 3, Math 30A, 30B. A class and laboratory introductory course in Electrical Engineering. Definitions of electric circuit parameters, Kirchhoff's rules for instantaneous values in differential equation form, and special solutions to these using complex quantities. Mesh and nodal analysis, resonance, and balanced polyphase circuits. The laboratory work covers electrical measurements over a wide range of frequencies. The class work features problem solving, and the laboratory work emphasizes basic measurement techniques.

EE 11. ELECTRICAL ENGINEERING I. 4 *credits.*

Prerequisites: Phys 2, Math 12. A class and laboratory course for electrical engineering students constituting an introduction to the basic concepts of electric circuits and electronic devices. Included are a coverage of alternating-current circuits, and electrical characteristics of transistors and other electronic devices. The laboratory work stresses instruments and techniques for the measurement of circuit characteristics over a broad range of frequencies.

EE 12. ELECTRICAL ENGINEERING II. 3 *credits.*

Prerequisite: EE 11. A continuation of EE 11 which introduces the electrical engineering student to the use of electronic devices in rectifiers and amplifiers. The analysis of transients in electric circuits using the Laplace transformation is applied to passive circuits and to active circuits such as transistor amplifiers.

EE 20. PASSIVE CIRCUITS. 3 *credits.*

Prerequisites: EE 10, Math 22 or 25. Loop and nodal analysis of network, pole-zero diagrams and complex-frequency variable response analysis, matrix algebra, max. power transfer analysis, Thevenin and Norton theorems, Laplace transform, initial and final value theorems, convolution integral, impedance function manipulation, superposition and reciprocity theorem, Fourier series and frequency spectrum, and Fourier integral and Fourier transform.

EE 20H. PASSIVE CIRCUITS FOR HONORS STUDENTS. 3 *credits.*

Prerequisitees: EE 10, Math 22 or 25 and approval by EE Department. Students cover the subject material of EE 20 at an accelerated rate. In addition, there will be a presentation of advanced analysis in the frequency domain, matrix manipulation, numerical analysis and computer applications.

EE 22. TRANSMISSION CIRCUITS. 3 *credits.*

Prerequisite: EE 20. This course includes the study of four-terminal networks with linear passive circuit elements. Hyberbolic functions, image and characteristic impedance, transmission equations and propagation are dealt with. Distributed parameter transmission lines at the variety of frequencies at which they are used are covered. Other topics include: lossless lines, Smith Chart applications, transient response of lines, insertion loss, and electric wave filters.

EE 22H. TRANSMISSION CIRCUITS FOR HONORS STUDENTS. 3 *credits.*

Prerequisites: EE 20 and approval by EE department. This course provides the honors student with the opportunity to cover the regular material of transmission circuits through a planned summer program of self-study. A final examination is given just prior to the start of Fall classes.

EE 25. ELECTROMAGNETIC FIELDS. 3 *credits.*

Prerequisites: Math 22, 35. This is a foundation course to develop an understanding of the static and dynamic characteristics of electric and magnetic fields. Static fields are studied so that subsequently the motion of charges in fields can be comprehended, and the magnitudes of important voltage gradients determined. Dynamic electromagnetic fields are presented to indicate their wave characteristics which are important in transmission and radiation applications.

EE 26. ELECTROMAGNETIC FIELDS I. 4 *credits.*

Prerequisites: EE 10, Math 21. This is an introductory course in electromagnetic theory. The topics covered include vector analysis, electrostatics, magnetostatics, Faraday's Law, and time-dependent fields.

EE 27. ELECTROMAGNETIC FIELDS II. 3 *credits.*

Prerequisite: EE 26. This course includes some applications of Maxwell's equations. The topics covered include plane wave propagation, waveguides, radiation from single antennas, and the motion of charged particles in a field.

EE 30. ELECTROMAGNETICS AND ENERGY CONVERSION. 4 *credits.*

Prerequisite: EE 20. This course deals with magnetic materials and circuits, reluctance, permeability, parameter effects and properties of electromagnetic and permanent magnet materials. Flux leakage is considered for various configurations. Magnetically-induced voltages are studied, including self inductance, magnetically-coupled circuits, transformers, impedance matching, saturating core devices and magnetic amplifiers. Basic electromechanical energy conversion principles are covered, including magnetic circuits with mechanical motion, reluctance forces and torque, multiple winding magnetic devices, and elementary energy converters. The laboratory includes experiments on transformers, saturable reactors, relays, loudspeakers, and other magnetic circuit and energy conversion devices as well as experiments on magnetic material properties.

EE 31. MAGNETIC TRANSDUCERS. 3 *credits.*

Prerequisites: EE 20, 60. A discussion of some of the basic energy conversion processes and application of the principles studied to various types of electromagnetic transducers which are important in the electronic and control system fields. Typical applications of theory will be made to Hall-effect devices, digital to analog converters, loudspeakers, hysteresis and eddy-current torque devices, a-c and d-c servomotors, and rate generators. Many of the devices studied are applied to control systems. Classroom demonstrations of the principles studied form an important part of the course.

EE 40. ELECTRONIC DEVICES. 2 *credits.*

Prerequisites: Phys 3, 4, EE 10. This course is a study of the conduction of current in vacuum, gas, and semiconductors, as applied to diodes, triodes and multiterminal electronic devices. Also included is a study of the applications of these devices in elementary circuits.

EE 42. ACTIVE CIRCUITS I. 5 *credits.*

Prerequisites: EE 20, 40. This class and laboratory course covers four areas of communication theory, including two-terminal nonlinear circuit elements, vacuum tube circuits, gas tube circuits, and semiconductor circuits. Basic equivalent circuits for the transistor, vacuum triode, and the pentode are covered. Small signal amplifiers are studied using both vacuum tubes and transistors. Other subjects covered are single-ended power amplifiers and push-pull amplifiers operating in the audio range.

EE 44. ACTIVE CIRCUITS II. 4 *credits.*

Prerequisite: EE 42. This course extends the work of the preceding course into the area of active nonlinear circuits, including class B and C amplifiers and oscillators; coding, transmission, and decoding of information, including amplitude, frequency, and pulse modulation and demodulation. The course includes class and laboratory work in the above areas.

EE 64. ELECTROKINETICS II. 4 *credits.*

Prerequisite: EE 60. A class and laboratory course with laboratory work covering electromechanical energy conversion. Electromechanical energy conversion in terms of the interactions of the magnetic fields, polyphase synchronous machines, polyphase induction machines, fractional-horsepower a-c motors; dynamic coupled-circuit theory, d-q variables, matrix or tensor methods of solving dynamic equations for machine performance.

EE 69. POWER SYSTEM ANALYSIS. 3 *credits.*

Prerequisite: EE 60, Math 90. The function of electric power systems, the equivalent circuit of a power transmission line, the use of circle diagrams, representation of power systems, per-unit computations, load flow studies on A-C board and digital computer, economic operation of power systems and automatic load dispatching, symmetrical components and unsymmetrical faults calculations, power system steady-state and transient stability studies.

EE 70. TRANSISTOR CIRCUITS. 3 *credits.*

Corequisite: EE 44. Topics to be covered include low frequency parameters and equivalent circuits, circuit characteristics of various configurations, biasing and bias stability; design of R-C coupled amplifiers and power amplifiers; high frequency parameters and equivalent circuits; design of wide-band amplifiers, feedback amplifiers and oscillators; and other selected topics.

EE 71. CONTROL SYSTEMS. 3 *credits.*

Prerequisites: EE 44, Math 32 or 256. This is an introductory course in the theory of automatic control. General analysis, design and stability studies of linear control systems are made. Applications of this theory to physical systems familiar to the students, such as electromechanical control systems, are investigated.

EE 72. FEEDBACK AMPLIFIERS. 3 *credits.*

Prerequisites: EE 44, Math 32 or 25H. A course oriented toward the application of electronic closed-loop systems of principles developed in preceding electronics and networks courses. Additional analytical methods are introduced, including signal-flow graphs and block diagrams. Design techniques are developed which include the use of Bode diagrams, Nyquist plots, and root-locus plots.

EE 73. ELECTRONIC DEVICES. 3 *credits.*

Corequisite: Phys 8. Prerequisite: Math 32 or 25H. An introduction to the principles and technology of molecular electronics. Included are fundamentals of quantum theory, properties of gases and solids, interaction of energy and matter, and selected topics on maser and laser devices, plasma and solid state power conversion techniques, parametric amplifiers, and other high frequency generators and amplifiers.

EE 74. ANALOG COMPUTATION IN ANALYSIS AND DESIGN. 3 *credits.*

Prerequisite: EE 44. This course will introduce the analog computer as a tool in engineering analysis and design. Emphasis will be placed on programming procedures for the study of linear and nonlinear systems. Electrical engineering applications will be stressed. The use of the computer in the laboratory will be required to complete several extensive analysis and design problems.

EE 75. DIGITAL COMPUTER CIRCUITS. 3 *credits.*

Prerequisite: EE 44. This course develops the mathematics and minimization techniques necessary for the design of combinational and sequential digital solid state logic circuits. Adders, multipliers, comparators, translators, counters, and other sample circuits are designed. After design, some of the circuits are connected using laboratory logic modules.

EE 76. MICROWAVES. 3 *credits.*

Prerequisite: EE 25. This course is concerned with a study of guided electromagnetic waves and radiation from antennas. The topics to be covered include plane waves, waves between parallel plates, waves in rectangular and circular guides, radiation from dipole antennas, and characteristics of antenna arrays.

EE 77. INTRODUCTION TO RELIABILITY PROBLEMS IN E.E. 3 *credits.*

Prerequisite: Math 22. Corequisite: Math 33. Status of reliability and its impact on engineering will be introduced. Reliability and stability factors in electron tubes, transistors, capacitors, and dielectrics will be studied in some detail, particularly from the design point of view. Generalized factors on mechanisms of failure will be derived. A brief introduction to the noise theory and its implications on reliability for series and parallel cases will be developed. Reliability factors of systems will be considered and methods for calculation of M.T.B.F. covered. Where required, statistical concepts will be introduced.

EE 78. INFORMATION TRANSMISSION. 3 *credits.*

Prerequisite: Math 30. Corequisites: Math 177, EE 44. A study of the encoding of information for transmission, its survival in transmission through networks and noisy environments, and its ultimate recovery for use. The techniques permit comparative analysis of information transmission systems.

EE 79. PULSE TECHNIQUES. 3 *credits.*

Corequisite: EE 44. This course deals with the analysis and design of circuitry for the generation and shaping of waves. Fundamental applications are covered, including linear and diode waveshaping, diode logic, voltage and current sweeps, multivibrators, blocking oscillators, basic switching and counting circuits; introduction to memory devices; and selected topics from television, computer, radar, and control applications.

EE 80. ADVANCED MEASUREMENTS. 3 credits.

Prerequisites: EE 22, 25, 44. Advanced techniques in circuit measurements over a wide range of frequencies are studied in this class and laboratory course. Included are a-c bridge measurements, filters, harmonic analysis, resonance measurements and square-wave testing, transients in circuits, very-high and ultra-high frequency measurements, noise and field analogs.

EE 81. NETWORK SYNTHESIS. 3 *credits.*

Prerequisites: EE 20, Math 32. Topics from network synthesis include Foster and Cauer LC, RL, and RC networks, the synthesis of inverse networks, positive real functions, Sturm's theorem, Brune synthesis, the relationships between parts of network functions, symmetric symmetrical lattices and lattice decomposition, Darlington synthesis, RC transfer function synthesis, Butterworth, Tschebycheff, and elliptic function filters, and the approximation problem.

EE 86. ELECTRICAL ENGINEERING PROJECT. 2 *credits.*

Prerequisite: EE 44. A synthesis and focusing of the student's previous experience, in college and out, upon one or more electrical engineering projects selected by the student. Library research, design, cost analysis, construction, and testing are usually involved. Class members are in touch with all projects through seminar discussions. Projects are available in optional fields of power and communications.

EE 86H. ELECTRICAL ENGINEERING PROJECT FOR HONORS STUDENTS. 2 *credits.*

Prerequisites: EE 44, 22H, and approval by EE department. This course, similar to EE 86, allows honors students to select projects of a research nature and work in close liaison with a research staff member of the department. Informal seminar meetings are held during the semester preceding registration for this course, and the students are expected to have their research well under way before being permitted to register for the course.

EE 91. ELECTRONICS AND INSTRUMENTATION. 3 *credits.*

Prerequisites: Phys 2, Math 21. A course in electronic applications of semiconductor devices and special purpose tubes. The topics covered include emitter followers, amplifier frequency response, feedback amplifiers, power amplifiers, and waveshaping circuits. Transducers and instrumentation systems are discussed in the latter part of the course.

EE 94. ELECTRICAL ENGINEERING PRINCIPLES. 3 *credits.*

Prerequisites: Phys 2, Math 21. A course emphasizing linear systems analysis and the development of engineering models. Applications of circuit analysis techniques are used to study the response of physical systems and to indicate how these principles may be applied to various engineering problems. The latter part of the course is devoted to the development of linear models of electronic and electromagnetic devices.

EE 95. ELECTRICAL ENGINEERING PRINCIPLES. 4 *credits.*

Prerequisites: Phys 2, Math 21. A course emphasizing linear systems analysis and the development of engineering models. Application of circuit analysis techniques are used to study the response of physical systems and to indicate how these principles may be applied to various engineering problems. The latter part of the course is devoted to the development of linear models of electronic and electromagnetic devices. The laboratory will include experiments in steady-state and transient response of circuits, electronic circuits, and transducers.

EE 96. ELECTRICAL ENGINEERING FOR INDUSTRIAL ENGINEERS I. 3 *credits.*

Prerequisites: Phys 3, Math 25. This is a comprehensive laboratory and class course surveying broadly the fields of electrical engineering. Basic a-c circuits, three-phase circuits, power and reactive power, resonance, steady-state frequency-response, and elementary transients. Included are basic principles of thermionic vacuum tubes, transistors, gas-filled thermionic tubes; and applications to rectifier and amplifier circuits, cathode-ray, photoelectronic and other special electronic devices and their applications are considered.

EE 97. ELECTRICAL ENGINEERING FOR INDUSTRIAL ENGINEERS II. 3 *credits.*

Prerequisite: EE 96. A continuation of EE 96, this course considers the theory and applications of transformers and goes then into the area of rotating machines, stressing applications of the various types. Introduction to the physical aspects of rotating machines, including the generation of voltage and torque follows. Performance and characteristics of d-c and a-c machines. The course concludes with an elementary study of electronic control of motors and processes, both open and closed-cycle systems, including servomechanisms.

EE 98. ELECTRICAL ENGINEERING FOR MECHANICAL ENGINEERS I. 3 *credits.*

Prerequisites: Phys 3, Math 22. A course in linear circuit analysis with emphasis on electrical networks. Topics covered include definitions of circuit parameters, methods for solutions to the circuit equations, the impedance concept, steady state frequency response, and special network theorems applicable to the analysis of electrical analogs of mechanical systems.

EE 99. ELECTRICAL ENGINEERING FOR MECHANICAL ENGINEERS II. 4 *credits.*

Prerequisite: EE 98. A class and laboratory course covering the significant terminal characteristics of electrical devices and instruments, including a survey of the significant operating characteristics of various electromechanical transducers and associated equipment. The laboratory work includes the application of the principles discussed in EE 98 in the measurement of the important parameters of the devices considered.

EE 99T. ELECTRICAL ENGINEERING FOR MECHANICAL ENGINEERS II. 3 *credits.*
Prerequisite: EE 98. A class and laboratory course similar to EE 99, above. The laboratory part of the course meets for a two-hour session every second week. Offered Fall, 1968 to students who completed EE 98 in the preceding Spring semester.

GRADUATE COURSES

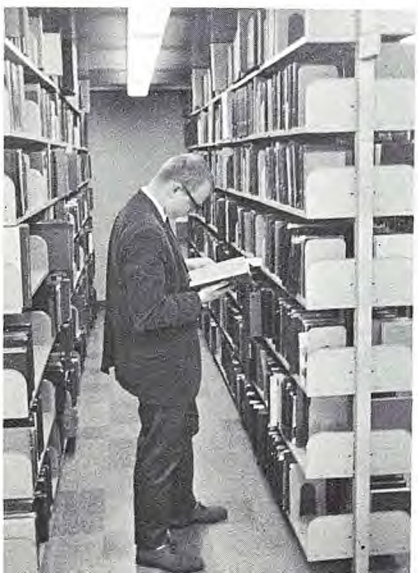
The following graduate courses are open to undergraduate students with adviser's approval.

EE 120. ELECTROMAGNETIC FIELD ANALYSIS. 3 *credits.*
Prerequisites: Math 35, EE 25. The course covers electrostatic fields, magnetostatic fields, Maxwell's equations, the Poynting vector, relationship between circuit theory and Maxwell's equations, some low-frequency and high-frequency applications of the equations; retarded potential type of solutions; wave equations; and plane waves.

EE 140. ELECTRONIC CIRCUITS. 3 *credits.*
Prerequisite: EE 42. Topics included are untuned vacuum tube and transistor amplifiers, with linear and nonlinear circuits; feedback amplifiers and oscillators; amplitude modulation; and rectifiers and filters.

EE 150. CIRCUIT ANALYSIS. 3 *credits.*
Prerequisite: EE 20. The course includes 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 as applied to systems with non-zero initial conditions.

EE 160. A-C MACHINERY. 3 *credits.*
Prerequisites: EE 20, 60. This course includes a review of induction and synchronous machine fundamentals; the balanced and unbalanced polyphase induction machine; the single-phase machine; the synchrounous machine in steady-state; and a review of winding and skew factors.



DEPARTMENT OF ENGINEERING GRAPHICS

Chairman: FRANCIS J. BURNS.
Associate Chairman: ROBERT G. SALAMON.

Professors: BURNS, SALAMON; *Associate Professors:* DIMATTEO, DUJETS, HANUS; *Assistant Professors:* GOLDEN, KETZNER, RIGHTS; *Instructor:* O'HARA; *Special Instructing Staff: Davidson.*

The Graphics courses, through the application of a carefully considered system of problems, aim at preparing beginning students for those engineering experiences which they will encounter in their future professional courses. Chief among these lessons is the development of the ability to interpret data, to represent it in graphical form, and to visualize it in three-dimensional space, and to evaluate problems using modern design techniques.

COURSES OF INSTRUCTION

EG 1. ENGINEERING GRAPHICS. 2 *credits.*

This course deals mainly with descriptive geometry and its application to engineering problems. It develops the orthographic system which represents three dimensional space data, so as to solve problems by projective principles. The fundamental principles are used to examine related points, lines, and planes as abstract elements. These ideas are then applied to selected practical engineering problems. Freehand sketching is presented as a means for rapidly conveying information and more industrially oriented presentations are considered.

EG 2. INTRODUCTION TO ENGINEERING DESIGN. 2 *credits.*

Prerequisite: EG 1. This course considers the solution of design problems in various engineering fields and conveys this information in graphical form wherever possible. An attempt is made to expose the student to the climate and attitudes required for the generation of sound basic engineering designs. Problems in the many fields of engineering are included and presented within the framework of modern design philosophy.

PROGRAM IN ENGINEERING SCIENCE

Committee on the Undergraduate Engineering Science Program:

Chairman: L. BRYCE ANDERSEN.

Professors: ANDERSEN, FOSTER, RAMBERG; *Associate Professors:* ROCHE, ROSE, SHILMAN, STAMPER, STONE; *Assistant Professor:* JERMAKIAN.

The Engineering Science curriculum is intended for students who wish to pursue an individual course of study in an interdisciplinary area of engineering and science. An appropriate selection of courses may serve as a preparation for graduate study and professional work in one of the newer interdisciplinary engineering fields, such as nuclear engineering, biomedical engineering, materials engineering, systems engineering, computer science and engineering, urban engineering, or ocean engineering.

The curriculum is also intended for students whose interests fall between science and engineering. The complexity of modern engineering problems often requires a team effort involving both scientists and engineers. As a result, the boundary between science and engineering has become indistinct. Many scientists do engineering work, and many engineers are deeply involved in scientific endeavors. The Engineering Science program provides an education for work at the boundary between science and engineering, in an area sometimes designated "Applied Science." The program is designed to give all Engineering Science students a strong background in both science and engineering. Qualified students may specialize, for example, in chemistry, mathematics, physics, or mechanics, while at the same time gaining an understanding of the engineering disciplines in which these sciences are applied.

An individual program of study must be developed by the student in consultation with the Committee on the Undergraduate Engineering Science Program. General requirements for the degree are summarized on page 67. Students should apply for admission to the program toward the end of the First or Second Year.

DEPARTMENT OF HUMANITIES

Chairman: SAMUEL K. WORKMAN.

Associate Chairmen: JAMES J. NAPIER (English); STANLEY B. WINTERS (History).

Professors: CRATER, ESTRIN, NAPIER, WORKMAN; *Associate Professors:* CAMP, FERNSLER, KEABLES, LYNGSTAD, STEINBERG, WINTERS, WISE; *Assistant Professors:* EPSTEIN, GOLDBERG, JOHNSON, PATTINSON, STARK, WACKER; *Instructors:* BADENHAUSEN, BOCHNER, D'AMBRUOSO, FLEISCHER, HECHT, HOMMON, JACKSON, LEE, LEVINSON, LYNCH, PLOTKIN, MCQUADE, SPIRA, TOBIAS, WARING, WEINBERG; *Special Instructing Staff:* BURNS, FEINSTEIN, HOTT, HOWE.

Newark College of Engineering has always recognized the importance of the humanities in the education of the engineer. The Department of Humanities has developed a seven-semester program which places a continuing emphasis on responsiveness in reading and skill in writing, increases understanding of literature and history, and then offers opportunities in the arts and in philosophy.

In the first year, the stress is on an understanding of historical processes as they can be viewed in perspective and of literature in its typical forms. Each field requires careful reading and offers topics for writing that can be practiced for a variety of purposes.

Over the next two years, the understanding of history is applied to developments and issues that are more recent and therefore seem more complex, and the study of literature is extended to masterpieces chosen from many periods and areas of Western civilization. The need continues for careful reading and pointed writing.

In the fourth year, with considerable experience in the humanistic kind of perception and thought, the student may go on to more specialized courses in literature or in history, or he may turn with substantial confidence to philosophy or to one of the arts. For any of these, he will write analytical and critical papers of increasing challenge.

The Department also provides honors courses in English and in history. These include a semester in literature and composition for freshmen (Eng 11H), a separate semester in history each for freshmen and for sophomores (Hist 11H, 22H), two separate semesters in literature for juniors (Eng 31H, 32H), and college seminars in literature and in history for seniors. These honors courses run parallel with the regular required courses but are adapted to the abilities and needs of superior students. Entrance is voluntary, subject to Department approval, and may be applied for in any semester; continuation also is voluntary, after any one semester.

Qualified students may also earn the designation of "Distinction in Humanistic Studies" by meeting the following requirements:

1. Completion of three semester-courses at the honors level. Of these, two must be (a) in the field of English *or* in that of History and (b) beyond the Freshman courses.
2. Inclusion from the Humanities Electives of two courses in the field chosen, English or History.
3. Maintenance of a high level of scholarship in college work generally as well as in English and other humanistic studies. This shall ordinarily be construed as maintenance of a minimum grade-point average of "3," exception to be made at the discretion of the Department of Humanities.

COURSES OF INSTRUCTION

Eng 11. LITERATURE AND COMPOSITION. 3 *credits.*

This course is centered around imaginative literature in its principal forms—fiction, poetry, and drama—with stress on the reader's ability to perceive what can be expressed by imaginative uses of language and by the whole story, novel, poem, or play. The student writes frequently on topics arising from the reading. Guidance for this writing stresses the selecting and the inter-relating of materials, language, and expository techniques according to an understood purpose.

Eng 11H. LITERATURE AND COMPOSITION. 3 *credits.*

An honors course. While paralleling Eng 11 in nature and purpose, this course offers opportunity for training in other forms of writing besides expository. Special areas of study will be in the relation of language and structure to the particular purpose of a piece of exposition; in the relation between the literary forms and the purposes of literature; and in the criticism and evaluation of writing.

Eng 31. MASTERPIECES OF WESTERN LITERATURE I. 3 *credits.*

Prerequisite: Eng 11 or 11H, Hist 22 or 22H. A study of major works of Western literature, from the Classical period to the Renaissance, which acquaints the student with the principal varieties of literary perception that are significant to our time.

Eng 31H. MASTERPIECES OF WESTERN LITERATURE I. 3 *credits.*

Prerequisite: Eng 11 or 11H, Hist 22 or 22H, and departmental approval. An honors course. While the basic material is the same as in Eng 31, discussion is both deeper and broader, and the student is specially encouraged to pursue for himself, both in reading and in writing, the lines of these discussions that interest him most.

Eng 32. MASTERPIECES OF WESTERN LITERATURE II. 3 *credits.*

Prerequisite: Eng 31 or 31H. A continuation of Eng 31, presenting major literary works in poetry, drama, and the novel, from the period after the Renaissance to the present.

Eng 32H. MASTERPIECES OF WESTERN LITERATURE II. 3 *credits.*

Prerequisite: Eng 31 or 31H, and departmental approval. A continuation of Eng 31 or 31H, at the honors level.

Eng 41. ENGINEERING REPORT WRITING. 2 *credits.*

Prerequisite: Eng 11 or 11H. The principles of report writing are studied, with careful attention to models of sound technical writing. Instead of preparing unmotivated practice reports, the student is guided in fulfilling actual assignments of reports for his professional department. Finished work is judged by professional standards. Required for Civil Engineering students.

Eng 80. MODERN FOREIGN LANGUAGE. 3 *credits, two semesters.*

Prerequisite: A minimum of 2 units of high school credit in the subject—except for Russian. A year of advanced study of French, German, Italian, Spanish, or Russian, or an introduction to Russian, as may be elected by the student. Sections will be instituted in those subjects for which a sufficient number of students register.

Hist 11. DEVELOPMENT OF THE MODERN WORLD I. 3 *credits.*

Introduction to significant events, ideas, and institutions from the era 1350-1850. Selected topics emphasize the Eurasian continent and may include the Renaissance and the Reformation, early modern science, the beginnings of modern industry and agriculture, emergence of the centralized nation-state, and changing East-West relationships. The student approaches such topics through careful reading of relevant essays and books and through written reports and discussions.

Hist 11H. DEVELOPMENT OF THE MODERN WORLD I. 3 *credits.*

Prerequisite: Departmental approval. An honors course. While paralleling Hist 11, this course offers added opportunity to observe past modes of life and thought and criticize present theories about forces that have shaped history. The student's individual interests are furthered through discussion and outside research.

Hist 22. DEVELOPMENT OF THE MODERN WORLD II. 3 *credits.*

Prerequisites: Hist 11, Eng 11. The period from 1850 onward as a distinct historic phase marked by accelerating change. Subjects may include modern wars and their causes, imperialism, the collapse of democracy and collective security between the World Wars, the Cold War, the revolts of Asia and Africa, and aspects of contemporary culture. As in Hist 11, much of the approach is through relevant reading and writing.

Hist 22H. DEVELOPMENT OF THE MODERN WORLD II. 3 *credits.*

Prerequisite: Hist 11 or 11H, and departmental approval. A continuation of Hist 11 or Hist 11H at the honors level.

HUMANITIES ELECTIVES

At preregistration for these courses, students will have the opportunity to indicate their order of preference. Prerequisites for all courses in this program are: Eng 11 or 11 H, 31 or 31H, 32 or 32H, and Hist 11 or 11H, 22 or 22H.

ARTS

Arts 51. APPRECIATION OF MUSIC. 3 *credits.*

This course is not concerned with the history of music but with creative listening through the perception of and appreciation of the basic materials of melody, harmony, rhythm, dynamics, tonality, tone, color, form, style, texture, and design. While ability to perform music is not assumed or taught, students are adviseed not to enter the course unless (a) they already have some familiarity with the terms used in formal descriptions of music, and (b) they intend to add depth to their study of music by taking the sequel to the course, Arts 52.

Arts 52. PERIOD, STYLE, AND GENRE IN MUSIC. 3 *credits.*

Representative Music of the Main Eras of Western Music. The purpose of this course is to develop creative listening to carefully programmed representative forms, styles, and schools of all the main eras of the historical development of Western music down to and including the "New Music."

Arts 53. APPRECIATION OF VISUAL ARTS. 3 *credits.*

The Development of Modern Art. The course explores the significance of historic examples in the development of modern art. Particular emphasis is placed on modern examples as they relate to the fundamental nature of art. The aim of the course is to increase understanding of these fundamentals and to develop an ability to express this understanding.

Arts 54. APPRECIATION OF VISUAL ARTS. 3 *credits.*

Form and Space in Visual Arts. This course involves an analysis of form in three-dimensional art with primary emphasis on modern architecture. Some studio work involving design fundamentals of simple two- and three-dimensional space will be required but the emphasis is on the eventual ability to discuss these fundamentals with understanding. A useful terminology for the discussion of art is developed.

Arts 55. THE CINEMA. 3 *credits.*

History and Criticism of Films. A study of the genesis and development of cinema techniques with an introduction of criticism of the movie as an art form. Selected American and foreign films will be analyzed and criticized.

Arts 59A. CREATIVE WORK. 3 *credits.*

The Craft of the Theater: Elements. Using the resources of the theater in the Humanities Center, students will receive instruction in the elements of stage presentation: acting, design, lighting and other technologies, direction, etc. While there will be opportunity to develop special interests and talents, the usual purpose will not be to prepare for a career in dramatic arts but to increase appreciation of them from direct participation. Students should enter the course with the expectation of continuing in Arts 59B.

Arts 59B. CREATIVE WORK. 3 *credits.*

The Craft of the Theater: Styles. A continuation of Arts 59A with attention to the distinctive styles in theater tradition and especially to recent "experimental" styles.

HISTORY

Hist 51. ASPECTS OF CLASSICAL AND MEDIEVAL CIVILIZATION. 3 *credits.*

The Legacy of Ancient Greece and the Roman Republic. A survey of the political, institutional, and cultural developments of Ancient Greece, the Hellenistic states, and the Roman Republic. The aim is to provide an articulated perspective of the heritage of Ancient Greece and Rome.

Hist 51A. ASPECTS OF CLASSICAL AND MEDIEVAL CIVILIZATION. 3 *credits.*

The Roman Empire to the Fall of Constantinople in 1453. A survey of the Roman Empire from its creation by Augustus to its fall in 1453 to the Ottoman Turks. The Roman and Byzantine world and its heritage through fifteen centuries of development and transition. Includes the rise of Christianity, the rise of Islam, and the emergence of the Russians, Serbs, Bulgars, Hungarians, and Turks.

Hist 52. ASPECTS OF BRITISH CIVILIZATION. 3 *credits.*

The Emergence of Modern British Society. The evolution of the British people during the social, economic, and political changes of the last one hundred and fifty years: the Industrial Revolution, Victorianism, Imperialism, the rise of democracy, the welfare state.

Hist 52A. ASPECTS OF BRITISH CIVILIZATION. 3 *credits.*

The Emergence of Representative Government. A study of the origin and nature of representative government with emphasis upon Great Britain: Magna Carta, the development of the common law, Parliament and its victory over absolutism, the growth of political parties, and the English influence on American institutions.

Hist 53. ASPECTS OF AMERICAN CIVILIZATION. 3 *credits.*

Recent American History. A study of the twentieth century internal history of the United States, with emphasis on political responses to social change: the Progressive Movement, the 1920's, the New Deal, the Fair Deal, and the Eisenhower and Kennedy years.

Hist 53B. ASPECTS OF AMERICAN CIVILIZATION. 3 *credits.*

The United States as a World Power. The essentials of United States foreign policy, with emphasis on the period after 1895, including turn-of-the-century imperialism, involvement in the two World Wars, the Cold War after 1946, and expanding commitments in the world today.

Hist 54A. SPECIAL AREAS. 3 *credits.*

The Development of Modern Germany. This course considers the economic and political foundations of Germany's world position, aspects of its literature, science, and philosophy, and such movements as liberalism, Pan-Germanism, Nazism, and democracy.

Hist 54B. SPECIAL AREAS. 3 *credits.*

Contemporary Europe. European society in the twentieth century. Nationalism, imperialism, totalitarianism, movements toward European unity, and prominent cultural developments are among topics discussed.

Hist 54C. SPECIAL AREAS. 3 *credits.*

France since the Revolution. France and its political, social, and intellectual transformation since the Revolution of 1789, and the French role, both political and cultural, in Europe and the world.

Hist 55. PROBLEMS IN MODERN HISTORY. 3 *credits.*

Political and Social Movements. Significant movements of political and social dissent in the past century and their justifications, among them liberalism, democracy, socialism, communism, fascism, and guerrilla and non-violent resistance.

Hist 55C. PROBLEMS IN MODERN HISTORY. 3 *credits.*

The Intellectual Revolution of the 18th Century. The creative genius of the Age of Enlightenment in its political and social background, the impact of Newtonian science, the growth of religious toleration and skepticism, and their influence on the American Revolution.

Hist 55D. PROBLEMS IN MODERN HISTORY. 3 *credits.*

Political Ideas—Plato to Locke. The major contributions to political thought from antiquity through the end of the seventeenth century. Concepts such as law (Divine and earthly), constitutionalism, absolutism, and representative government will be studied as they have been treated in some of the great political writings in history.

Hist 55E. PROBLEMS IN MODERN HISTORY. 3 *credits.*

The Development of the European State System. This course examines the changing interactions of modern national states in the perspective of general cultural development. It does not attempt complete coverage of diplomatic incidents, wars, or treaties but uses a wide range of historical events as illustrations. Topics include the varied concepts of state interest; attempts at constructing a durable peace; the problem of morality in foreign policy; the balance of power; and the conflict between European and non-European diplomatic principles.

LITERATURE

Lit 51. AN ERA OF LITERATURE. 3 *credits.*

The Renaissance. The cultural advancements of Europe during the fifteenth and sixteenth centuries in thought, religion, science, education, literature, art and music are examined. The "rebirth" of learning is seen through the works of such authors as Sir Thomas More, Niccolo Machiavelli, Francois Rabelais, Miguel de Cervantes, and Christopher Marlowe. Lectures, some illustrated by reproductions of the art of the period and by recordings, will develop the Renaissance concept of the well-educated man, the humanist whose province was the whole world of thought and whose aims predicated the reform of early modern times.

Lit 51A. AN ERA OF LITERATURE. 3 *credits.*

Twentieth Century British and American Literature. An examination of some of the more provocative Twentieth Century British and American works in fiction, drama, and poetry to about World War II. The student acquires critical criteria whereby he is able to distinguish between popular forms and literature.

Lit 51B. AN ERA OF LITERATURE. 3 *credits.*

Twentieth Century European Fiction. An examination of significant stories and novels drawn from the literatures of four continental European countries—France, Germany, Sweden, and Russia. The individual works, representative of such figures as Gide, Malraux, Sartre, Camus, Kafka, Mann, Lagerkvist, and Pasternak, will be approached principally as literary formulations of intellectual problems and beliefs, with consideration of social and biographical factors as demanded by the nature of the materials.

Lit 51C. AN ERA OF LITERATURE. 3 *credits.*

Modern Drama. An examination of some of the dramas from the late nineteenth and from the twentieth century with the purpose of gaining some understanding of how dramatists in both subject matter and technique reflect the spirit of the times. Representative playwrights include Ibsen, Shaw, Wilde, Strindberg, O'Neill, Chekhov, O'Casey, Pirandello, Williams, Miller, Brecht, and Ionesco.

Lit 51D. AN ERA OF LITERATURE. 3 *credits.*

Greek and Roman Classics in Translation. An examination of some of the masterpieces of classical literature: the epics by Homer and by Vergil; Greek comedy and tragedy; selections from the philosophical work of Plato and Lucretius; some Greek and Roman lyric poems; and examples of Roman satire. These works are studied primarily as literary masterpieces in their own right, but some account is given of their historical setting and of their influence upon subsequent literature.

Lit 51E. AN ERA OF LITERATURE. 3 *credits.*

Recent American Literature. A study of fiction, drama and poetry since World War II. Proportionately, drama and poetry will be secondary to fiction. Most of the reading will be in the novels and short stories of the younger writers whose subjects and methods identify them as spokesmen for the present era. Among these are Ellison, Bellow, Mailer, Malamud, and Flannery O'Connor.

Lit 52. A FORM OF LITERATURE. 3 *credits.*

The Growth of European Fiction. A study of some outstanding novels and short stories, mostly of the nineteenth century. Major figures, including Balzac, Flaubert, Dostoyevsky and Tolstoy, are seen as contributors to the expanding art of modern fiction.

Lit 52A. A FORM OF LITERATURE. 3 *credits.*

The English Novel. A study of selected English novels from the first masterpieces to the present day. The works will be approached primarily as distinctive achievements in the art of prose narrative, but some account will be taken of their place in a continuous and varied tradition and of their relation to the changing social and intellectual scene.

Lit 52E. A FORM OF LITERATURE. 3 *credits.*

The Russian Novel and Short Story. This course will examine a number of significant works of Russian fiction of the 19th and 20th centuries. In the presentation of the stories and novels selected a balance will be maintained between two ways of looking at the material: (1) as artistic expressions of individual visions of man's condition, and (2) as documents that find a definite place within Russian social and intellectual history.

Lit 52F. A FORM OF LITERATURE. 3 *credits.*

Forensic Literature. This course examines great speeches from ancient Greece and Rome to our own day. Analyses will be made of famous masterpieces of eloquence and historic addresses noted for their powerful thought and logical presentation. Careful consideration will be given to the style of each orator, and to the form and content of each oration. Experiences will be provided for the student in the delivery of and listening to several outstanding speeches. Through this study the student should acquire a knowledge and understanding of the art of public speaking.

Lit 53. A RECURRENT SUBJECT OF LITERATURE. 3 *credits.*

The Family. Various depictions of family life, or of the family as a social institution—or of both—are examined in each of several novels and plays of high literary rank. These will be selected for their depictions of relationships within the family, for their attitudes toward the institution itself, and for the historical differences that they reflect, especially differences developing in recent times.

Lit 53A. A RECURRENT SUBJECT OF LITERATURE. 3 *credits.*

The Good Life and the Search for Value. The course is to be a survey of various views of the Good Life as reflected in certain literary works of our culture. The course will begin with traditional values of Western Civilization derived from the ancient Greeks and the Judeo-Christian ethos. The second half of the course will deal with some of the more important challenges, and the conflicts of values in the modern world.

Lit 53C. A RECURRENT SUBJECT OF LITERATURE. 3 *credits.*

Literature and Politics. An intensive study of significant literary works dealing with the relationship of the individual and the state. Works examining such subjects as monarchism, democracy, anarchism, totalitarianism, communism, fascism, commitment, loyalty, political corruption, and nationalism (political and cultural) will be treated. Consideration will be given to works dealing with specific political events (Salem witch trials, French revolution, Spanish Civil War), as well as works presenting Utopian visions of future societies. The relation of the artist-citizen to the body politic will also be considered.

Lit 53D. A RECURRENT SUBJECT OF LITERATURE. 3 *credits.*

Modern Social Criticism. Analysis of the works of leading social critics as a way of gaining insights into American society. Particular emphasis is given to examining problems created by a highly mechanized, increasingly urbanized society. While the focus is primarily on the 20th Century, earlier critics are read to provide historical background for evaluating more recent writers. The writers dealt with are principally novelists but include sociologists and economists as well as more wide-ranging commentators on the American scene. Current social criticism in leading periodicals will be discussed as it appears.

Lit 53E. A RECURRENT SUBJECT OF LITERATURE. 3 *credits.*

Literature and History. This course studies the approaches various playwrights and novelists have taken in dealing with historical events. It will present concepts of history, different ways of looking at the past, different ways writers use the past to tell us as much about themselves and the age in which they write as about the age with which they deal. Included are such writers as Shakespeare, Schiller, Dickens, Crane, Arthur Miller, and Peter Weiss.

Lit 53F. A RECURRENT SUBJECT OF LITERATURE. 3 *credits.*

The Frontier. This course focuses on the role which the frontier has played in stimulating and establishing native American cultural and literary traditions. After an initial study of such writers as Cooper, Whitman, Twain, and Faulkner, the course considers the concept of the frontier as it has extended into the contemporary American scene, especially by certain writers who are engaged with the possibilities of new "psychic frontiers."

Lit 54. THE PRINCIPAL WORKS OF ONE WRITER. 3 *credits.*

William Shakespeare. The reading will include about ten plays from the histories, comedies, and tragedies, and some short poems, chosen to typify the various facets of this writer. There will be attention to Shakespeare's times and to the basis for his distinction among dramatists.

Lit 54A. THE PRINCIPAL WORKS OF ONE WRITER. 3 *credits.*

William Faulkner. A close reading of some of Faulkner's most reputed novels and short stories, with attention to the meaning of Faulkner's way of writing and to the twentieth century beliefs and forms of expression with which Faulkner was familiar.

PHILOSOPHY

Phil 51. PRINCIPLES OF PHILOSOPHY. 3 *credits.*

Philosophical Problems. An examination of problems of a social, ethical, aesthetic, religious, and scientific nature and a study of the related principles and methods of philosophy. Particular attention is given to the application of these principles in everyday living. It is recommended that either Phil 51A or Phil 52 be taken as a continuation of this course.

Phil 51A. PRINCIPLES OF PHILOSOPHY. 3 *credits.*

Representative Philosophers. A study of the ideals of important philosophers from the time of the Greeks to the present day. This course does not attempt a survey of philosophy but concentrates on the work of a few great thinkers so that the student may perceive at first hand how these men once accelerated intellectual progress and how their work may still contribute to the solution of modern problems. In granting admission to this course, preference will be given to those who have credit for Phil 51 or Phil 53.

Phil 52. HISTORICAL DEVELOPMENTS IN PHILOSOPHY. 3 *credits.*

The Development of Modern Thought. A survey, analysis, and evaluation of the basic concepts which have moulded man's view of nature, of the political and societal environment, and of the individual from ancient Egypt to the present, as they are a requisite for an understanding of the modern world. In brief: A history of the ideas which have affected modern thought in science, religion, political theory, and aesthetics. In granting admission to this course, preference will be given to those who have credit for Phil 51 or Phil 53.

Phil 53. PHILOSOPHICAL FOUNDATIONS. 3 *credits.*

Science and First Principles. This course is a brief introduction to the philosophy of science: the impact of scientific theories and hypotheses on the subject matter of philosophy. After the nature, function, and scope of philosophy are examined, the concepts of science are introduced as providing a formulation of, and avenues of approach to, the basic problems of philosophy itself. The implications of this relationship are then extended to the problem of values, involving man's place in the universe about him. It is recommended that either Phil 51A or Phil 52 be taken as a continuation of this course.

Phil 53B. PHILOSOPHICAL FOUNDATIONS. 3 *credits.*

The Philosophy of Language: Patterns. Beginning with the structure of language and the relationships between sounds and meanings, the course examines formation, tradition, and change in some typical patterns drawn from English, including American English. It presents the most noted speculations upon the ways of the human mind that these patterns reflect. This study will lead to some consideration of the relations between language and religion, science, and literature. Students are advised not to enter the course unless they expect to extend their interest in language into the sequel course, Phil 53C.

Phil 53C. PHILOSOPHICAL FOUNDATIONS. 3 *credits.*

The Philosophy of Language: Symbolism and Society. This course, a continuation of Phil 53B, examines various symbolic aspects of language and stresses the relationships between language and society.

SEMINAR

Hu 59H. COLLEGE SEMINARS IN THE HUMANITIES. 3 *credits.*

Prerequisites: Those for other electives, as cited above; recommendation by former instructors in English, history, and social studies, and a satisfactory record in the student's major field of engineering study. An honors course. Seminars will be offered both in literature and in history. The subjects for them will be announced at the time of preregistration for a senior course in humanities. Each seminar is limited to 12 students.

Hu 59AH. COLLEGE SEMINARS IN THE HUMANITIES. 3 *credits.*

Prerequisites: As for Hu 59H. An honors course. Seminars will be offered both in literature and in history. The subjects for them in each case are different from any taken up in Hu 59H, and will be announced at the time of preregistration for a senior course in humanities. Each seminar is limited to 12 students.

DEPARTMENT OF INDUSTRIAL AND MANAGEMENT ENGINEERING

Chairman: OLIVER J. SIZELOVE.
Associate Chairman: JAMES L. RIGASSIO.

Distinguished Professor: SIZELOVE; *Professors:* JAFFE, RICH, RIGASSIO; *Associate Professors:* BROSH, GOLDSTEIN, LAVERDA, MIHALASKY, STONE; *Assistant Professors:* KEREKES, MLADINEO, WOLF, ZIMMERMAN; *Assistant Instructor:* AIELLO; *Special Instructing Staff:* DEAN; *Adjunct Instructing Staff:* BLOU, O'CONNOR, RITTER, THOMAS, YANTZ.

The curriculums of the department meet the needs of industry for engineers who are not only competent in the areas of mathematics, the physical and engineering sciences, and engineering analysis and design, but who are equally well qualified to apply the fundamentals of these areas to the design, improvement, and installation of integrated systems of men, materials, and equipment. Individuals thus trained—Industrial Engineers—solve the problems that arise in the management of an enterprise and make these solutions available for administrative decision within the functional areas of research, design and development, manufacture, personnel, and distribution.

The Industrial Engineering curriculum combines three professional stems: production process design, work design, and management science. In the early years of the curriculum the student is primarily concerned with the mathematics, the physical sciences, and the engineering sciences, upon which depend the material presented in the later years. Courses stress fundamental principles and concepts, and culminate in a systems design which classifies either within or between the three professional stems of the curriculum. In addition, service courses in Enterprise Management are in operation for other engineering departments.

The new modern laboratories of the Department include a work methods and measurement laboratory and adjacent experimental shops, an accounting and statistics laboratory, and a plant design laboratory. In addition, the facilities of the NCE Computing Center allows use of electronic computers in applicable courses.

For early indoctrination in professional development, Day and Evening Division students in the department become affiliated with the NCE student chapter of The American Institute of Industrial Engineers. In addition to their local meetings at the College, the student members attend the meetings and conferences of the sponsoring North Jersey Chapter of The American Institute of Industrial Engineers.

The Day Division class of 1964 was the first to complete

the Bachelor of Science in Industrial Engineering curriculum. In the Evening Division, the class of 1968 will be the first to complete the Industrial Engineering curriculum.

COURSES OF INSTRUCTION

IE 21. INTRODUCTION TO MANAGEMENT SCIENCE. 3 *credits.*

This course gives a broad and fundamental view of the field of industrial engineering in both its traditional and contemporary aspects. It introduces the student to operations research as applied to industrial and managerial problems, stressing the logical methods used. It specifically treats problems in all phases of industry—research, financial, production, and distribution—and builds to an analysis of decision theory and model building.

IE 24. PRODUCTION PROCESS DESIGN. 3 *credits.*

Introduction to design and control of manufacturing processes. Study covers theory and practice of machine tool selection, production tooling, measurement and quality control, automated processes and tape controlled machines. Selection of the best and most economical process to meet design specifications is stressed. In addition to lecture and discussion the student observes equipment in operation in the laboratory and in plants which are visited. Where practical, films of special tooling research or materials processing and fabrication are shown. A student project is included in which the student determines manufacturing feasibility, prepares specifications and operation sheets, selects equipment and tooling, and prepares flow charts for the fabrication of a metal, plastic, ceramic. wood or rubber product.

IE 31. APPLIED STATISTICAL METHODS. 3 *credits.*

This course presents statistical methods together with their applications. Subjects treated include the selection, classification, treatment, and analysis of data, frequency distributions, central tendency, dispersion, skewness, curve fitting, probability distributions, student's "t," significant differences, analysis of variance, regression, and correlation. Special emphasis is placed on the application to industrial fields.

IE 33. ENGINEERING COST ANALYSIS. 5 *credits.*

Prerequisite: SS 20. The objective of this course is to provide the engineering student with an understanding of accounting and engineering economics fundamentals used in the planning, control, and evaluation of industrial operations. Topics covered include financial, cost, and management accounting; statement analysis; policy decisions regarding asset purchase and replacement; cost estimation; depreciation; and increment costs. The impact of accounting and engineering economics information on costs, pricing, and profits is stressed.

IE 37. WORK ANALYSIS I. 3 *credits.*

Prerequisite: IE 24. Integration of plant flow, layout design, material handling systems, and work place layout and design. Emphasis is placed on the interrelationship of organization, production planning and control, service activities, work simplification, human factors, methods, and tool design. Included are the use of motion economy, jig and fixture design, and micromotion analysis techniques.

IE 38. WORK ANALYSIS II. 3 *credits.*

Prerequisite: IE 37, Math 33. Quantitative analysis of manufacturing activities, man and machine systems, wage payment plans, line balancing problems, and plant location decisions. Involved is the use of standard data, method measurement systems, work sampling, time study, value analysis, predetermined time systems and simulation of production systems.

IE 39. STUDIES IN MANAGEMENT SCIENCE I. 3 *credits.*

Prerequisites: Math 34, IE 21, SS 20. Introduction to quantitative and analytical techniques useful in managerial decision making. Treated are such techniques as model formulation, linear and non-linear programming, queueing theory, game theory, statistical applications, Markov processes, Monte Carlo techniques, and multi-stage processes.

IE 40. STUDIES IN MANAGEMENT SCIENCE II. 3 *credits.*

Prerequisite: IE 39. Application of the quantitative and analytical techniques of IE 39 to selected topics such as organization, production and distribution management including plant location, layout, inventory control, transportation, scheduling and market research.

IE 43. SYSTEMS DESIGN AND CONTROL I. 3 *credits.*

Prerequisites: IE 21, 24, 37, 38, Math 33, 34. The concepts of industrial engineering systems and sub-systems design; principles, procedures, and techniques of systems design; the management control as an integral system component. Selection of a specific system design for the project of IE 44, establishment of plant contacts, determination of the system specifications, preliminary collection, classification, and analysis of the system data.

IE 44. SYSTEMS DESIGN AND CONTROL II. 3 *credits.*

Prerequisite: IE 43. A continuation of IE 43 with the project culminating in a system design, including the related management controls. The design will draw upon the applicable mathematical, scientific, engineering, and humanistic principles included in the curriculum. Whether theoretically and/or practically oriented the design will classify within or between the broad curriculum areas of process design, work design, or management science.

IE 46. LAW. 3 *credits.*

Prerequisite: SS 20. This course familiarizes the student with basic principles of common and statutory law applicable to business and professional relationships, emphasizing contracts, negotiable instruments, sales of goods, agency and business organization.

IE 58. TOOL ENGINEERING. 3 *credits.*

Prerequisite: IE 24. The planning and fabrication of production tools will be treated from an economic viewpoint as well as from the engineering aspects. Included are classifications of tools, make or buy decisions, and the use of mathematical models for optimum design.

IE 59. COMPUTERIZED PRODUCTION CONTROL. 3 *credits.*

Prerequisite: Math 90. A study of the components and functioning of integrated production planning and control systems. Consideration is given to material, equipment, and manpower requirements for optimizing continuous and intermittent manufacturing operations. The use of a computer to simulate such models is introduced.

IE 60. INVENTORY MODELS. 3 *credits.*

Prerequisites: Math 33, 34, 90. A scientific approach to inventory problems under conditions of known and probabilistic demand. Order quantities, order times, shortage considerations, and price breaks are some of the topics investigated. Cost minimization for both discrete and continuous cases are discussed.

IE 61. STATISTICAL QUALITY CONTROL. 3 *credits.*

Prerequisites: IE 31, Math 33, 34. This course is designed to present the application of statistics and probability to the control of product and process quality. The subject matter to be studied includes process and machine capability studies, statistical control charting, and sampling plans. The management and engineering associated with a quality control program will also be considered.

IE 62. BUDGETARY PLANNING AND CONTROL. 3 *credits.*

Prerequisite: IE 33. Introduction of budgeting procedures as a tool for planning and control in the areas of production, sales, indirect expense, cash, inventory, and capital expenditures. Emphasis will be made on the application of industrial engineering principles in the preparation and execution of budgets for profit planning and management.

IE 63. ORGANIZATION PLANNING AND CONTROL. 3 *credits.*

A study of classical and behavioral approaches to organization planning, this course integrates both functional and adoptive points of view in an applied atorgenics approach to the delineation of the duties, responsibilities, authorities, and relationships of the positions of a business enterprise. Included in the course is a survey of current practice in organization design and control.

IE 64. PRODUCT AND PROCESS RELIABILITY. 3 *credits.*

Prerequisites: IE 31, Math 33, 34. Treated in this course will be the methods of planning, organizing, and control needed to assure the reliability of a product or process. Inherent in this treatment will be a study of the various statistical and non-statistical means of attaining and measuring this reliability.

IE 65. PATENT LAW. 3 *credits.*

A broad coverage of the principles and philosophy of patent law is treated in this course. The main goal is to point out more effective protection and exploitation of ideas and inventions. Also, trademark selection and protection will be considered.

IE 81H. INVESTIGATIONS IN INDUSTRIAL ENGINEERING I. 3 *credits.*

Prerequisites: Senior I.E. standing and a minimum G.P.A. of 3.0. Independent investigation through readings, visits with recognized authorities and institutions which deal with specialized and contemporary industrial engineering theory and problems, and reports in seminar. Each student will explore in depth and report on an area in which he has an interest.

IE 82H. INVESTIGATIONS IN INDUSTRIAL ENGINEERING II. 3 *credits.*

Prerequisites: Senior I.E. standing and a minimum G.P.A. of 3.0. A continuation of IE 81H.

IE 91. ENTERPRISE MANAGEMENT. 3 *credits.*

Prerequisite: SS 20. A survey course for electrical and mechanical engineering students which includes sources of investment funds; organizational structure; product development and distribution, production management; engineering economy analysis of alternatives; estimating collecting, analyzing and control of enterprise costs; and the legal aspects of contracts; agency, and patents. Emphasis is on the operational management problems with orientation to the overall planning, organization, and control of the enterprise.

IE 94. ENTERPRISE MANAGEMENT. 3 *credits.*

Prerequisite: SS 20. A survey course for mechanical engineering students which includes sources of investment funds; organizational structure; product development and distribution; production management; engineering economy analysis of alternatives; and estimating, collecting, analyzing, and control of enterprise costs. Emphasis is on the operational production management with orientation to cost analysis.

IE 97. Enterprise Management. 3 *credits.*

Prerequisite: SS 20. A survey course for civil engineering students concerned with the organization, design, administration, and operation of enterprises, and the economic evaluation of projects and alternatives with special emphasis on their application to civil engineering. Legal aspects such as contracts, agency, and workmen's compensation are examined.

IE 98. Basic Accounting and Finance for Construction Management. 3 *credits.*

A basic background course in the principles of accounting and cost accounting necessary for the understanding of financial data and statistics in connection with the supervision of engineering projects. Sources and methods for financing these projects, both public and private, are discussed.

IE 99. Management and Control of Construction. 3 *credits.*

Prerequisite: IE 98 or permission of the instructor. Introduction to financial and management techniques employed by construction management to maintain operating control. Topics include pre-job procedures, subcontracting policies, insurance problems, change order routines, and profit controls.

DEPARTMENT OF INDUSTRIAL RELATIONS

Chairman: ROBERT E. KIEHL.
Associate Chairman: JOHN H. METZLER.

Professors: CAMBRELENG, KIEHL, STOCHAJ, ZANER; *Associate Professors:* LORD, LUBIN, METZLER; *Assistant Professors:* KANG, MALKIN, RUCKER, SPITZ, TALMADGE; *Instructors:* HILTON, RHODES; *Special Instructing Staff:* ALLINSMITH, GAITER, HABER, ILIVICKY, NOYES, THOMPSON, WEBBER, WHELAN, YAROSZ; *Adjunct Instructing Staff:* BEVERLEY, CHEATHAM, FICKS, MASUR, MCGUIRE, O'CONNOR, ROSS.

The guiding philosophy of the Department of Industrial Relations, derived from the stated aims and objectives of the College, is based on a recognition that the student must understand himself as a maturing individual if he is to take his place in the community as a genuinely educated man.

To assist in the achievement of this important goal, the courses are planned to provide a broad foundation upon which to build an understanding, not only of the relationship of the individual to other individuals, which is the province of human relations, but also an appreciation of the complex industrial world. With this knowledge, the scientific and mathematical proficiency of the engineer will be complemented by insights important to leadership and success.

The Department of Industrial Relations is associated with the Placement Office and the Counseling Center in assisting students with career choices and placement.

COURSES OF INSTRUCTION

SS 20. ECONOMICS. 3 *credits.*

This course is designed to combine the classical and contemporary approaches to economics. It presents basic principles which form the groundwork for analysis and discussion of contemporary problems of economic life. Attention is also given to other economic systems, the stock market, and problems of economic development and foreign trade.

SS 21. INDUSTRIAL PSYCHOLOGY. 3 *credits.*

The many applications of psychology to the industrial scene are studied. The course deals with industrial environments, personnel psychology, men and machines, special groups in industry, and social interaction and adjustments.

SS 22. SOCIOLOGY. 3 *credits.*

An examination of modern society and culture, analyzing the forces for stability and change. Topics to be covered are: the individual and society—socialization, conformity, alienation, class structure; social institutions—religion, law, education, family, state; social processes—conflict and harmony, cohesion and dissolution, power, authority and revolution; urbanization, industrialization and technological change.

SS 23. LABOR RELATIONS. 3 *credits.*

Worker response to industrialization and its resulting bigness has been group action. The course examines the motives, direction and results of this phenomena. It also concerns itself with the internal governments of these groups, their policies and responses to the 20th century challenges, encompassing union bargaining issues, tactics and legislative activities.

SS 24. POLITICAL SCIENCE. 3 *credits.*

The course concerns itself with such items as the concept of the state, authority; institutions of control, monarchy, dictatorship, democracy; constitutionalism and liberty; and the relationship between the law, the state, and the individual.

IR 41. MANAGEMENT PRACTICES. 3 *credits.*

The concepts and programs of modern management with emphasis upon the role of the engineer at all levels of responsibility are studied. Coverage includes organization, motivation and morale; scientific management and human relations; the functions of planning, directing, and controlling; the influence of industrial engineering, labor unions, staff personnel departments, and research; innovation and decision-making; and the development of a management ethic. The case method and other participative techniques will be applied throughout the course.

IR 42. CONTEMPORARY ISSUES. 3 *credits.*

The student examines an integrated picture of human society and its current problems through the emphasized interrelationships of anthropology, sociology, economics, and political science. Special emphasis is placed on the cultural concepts developed through a senior convocation program, class conferences, and lectures. Whenever possible, students are assigned to sections in line with their own interests. These sections bear the designations IR 42A through IR 42E and deal with the areas listed below:

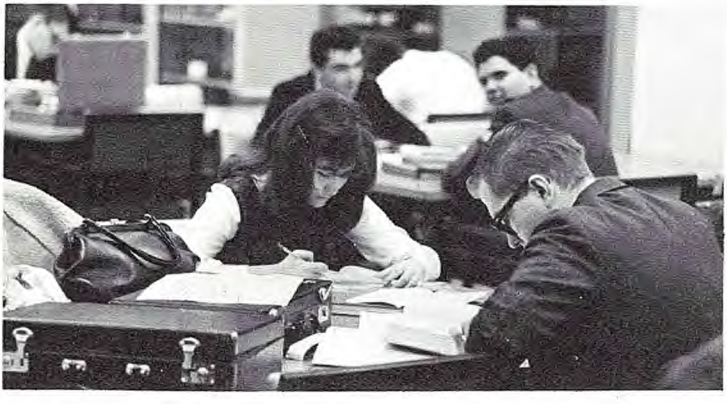
IR 42A. INTERNATIONAL ISSUES.

IR 42B. NATIONAL ISSUES.

IR 42C. LABOR ISSUES.

IR 42D. ECONOMIC ISSUES.

IR 42E. MANAGEMENT ISSUES.



DEPARTMENT OF MATHEMATICS

Chairman: HENRY ZATZKIS.
Associate Chairman: POMPEY MAINARDI.
Assistant Chairmen: ACHILLES E. FOSTER, CARL KONOVE.

Professors: BARKAN, FOSTER, KONOVE, KOREN, MAINARDI, PEYSER, ZATZKIS; *Associate Professor Emeritus:* WASSON; *Associate Professors:* BROWER, FLATOW, LIONE; *Assistant Professors:* CHEN, KATZEN, LIEB, RAUSEN, VORONKA; *Instructors:* ANDRUSHKIW, BERLINER, CHAN, FELDMAN, KADETS, LEVINE, MANOCHIO, MARX, ORSER, SPENCER, TARNAWSKY, TEKEL, YEE, ZAMES; *Assistant Instructors:* DY-REYES, MILLER, RAPPAPORT, RUGGIERO; *Special Instructing Staff:* MULLAN; *Adjunct Instructing Staff:* ALLSTAEDT, CARROLL, GODDERZ, MEGIBOW, REISS, SQUIRES, STEADY, TRACHTENBERG, VAN MEERBEKE.

The principal aim of the various courses offered by this department is to impart a knowledge of mathematics which will be useful to students during their study of science and which will also be of use to them later, in actual engineering practice. In keeping with the trend for greater emphasis on the humanities in engineering education, other aspects of mathematics relative to philosophical and cultural values are considered whenever opportunities arise.

COURSES OF INSTRUCTION

Math 10A. INTRODUCTORY MATHEMATICS I E. 2 *credits.*

This course contains review topics from college algebra, trigonometry, and analytic geometry with particular emphasis on the formulation and analysis of physical problems.

Math 10B. CALCULUS I E. 2 *credits.*

Prerequisite: Math 10A. This course includes most of the material covered in Math 11 described below.

Math 11. CALCULUS I. 4 *credits.*

This course considers the theory and techniques of differentiation and integration with applications of both processes to engineering and physics. Included are some topics from coordinate geometry.

Math 11H. INTRODUCTORY HONORS MATHEMATICS. 4 *credits.*

This is the first semester of an eight-semester program in Honors Mathematics. Topics covered include rates of change, continuity, theory of differentiation and integration, as well as applications to engineering problems. Admission to this course is restricted as described on page 30.

Math 12. CALCULUS II. 4 *credits.*

Prerequisite: Math 11. This course is a continuation of Math 11. Topics considered include the differentiation and integration of inverse trigonometric, exponential, and logarithmic functions and further methods of integration. Applications of the definite integral to physical problems are also included.

Math 12H. HONORS MATHEMATICS I. 4 *credits.*

Prerequisite: Math 11 or 11H. This is the second semester of an eight-semester program in Honors Mathematics. Topics covered include methods of integration, determinants and linear equations, advanced analytic geometry, hyperbolic functions, polar coordinates and curves by methods of analysis, introduction to vector analysis and parametric equations. Admission to this course is restricted as described on page 30.

Math 20A. CALCULUS II E. 3 *credits.*

Prerequisite: Math 10B. This course includes the subject matter of the latter part of Math 11 and the first half of Math 12.

Math 20B. CALCULUS III E. 3 *credits.*

Prerequisite: Math 20A. This course includes the subject matter of the second half of Math 12 and the first part of Math 21, described below.

Math 21. CALCULUS III. 4 *credits.*

Prerequisite: Math 12. This course is a continuation of Math 12. The main topics considered are partial differentiation, multiple integrals, infinite series, and the expansion of functions.

Math 21H. HONORS MATHEMATICS II. 4 *credits.*

Prerequisite: Math 12H. This is the third semester of an eight-semester program in Honors Mathematics and is a continuation of Math 12H. Topics covered include solid analytic geometry and vector analysis, partial differentiation, multiple integrals, infinite series, an introduction to the theory of complex variables and differential equations.

Math 22. DIFFERENTIAL EQUATIONS. 4 *credits.*

Prerequisite: Math 21. Methods for solving ordinary differential equations are studied, together with physical and geometrical applications. Laplace transforms and an introduction to Fourier Series are included.

Math 22H. HONORS MATHEMATICS III. 4 *credits.*

Prerequisite: Math 21H. This is the fourth semester of an eight-semester program in Honors Mathematics. Subjects considered are vector analysis and linear algebra.

Math 30A. CALCULUS IV E. 3 *credits.*

Prerequisite: Math 20B. This course includes most of the subject matter of Math 21 and a brief introduction to differential equations.

Math 30B. DIFFERENTIAL EQUATIONS E. 3 *credits.*

Prerequisite: Math 30A. This course includes most of the subject matter considered in Math 22.

Math 30H. HONORS MATHEMATICS IV. 3 *credits.*

Prerequisite: Math 22H. This is the fifth semester of an eight-semester program in Honors Mathematics. It is a rigorous first course in complex variables.

Math 31. INTRODUCTION TO PARTIAL DIFFERENTIAL EQUATIONS. 3 *credits.*

Prerequisite: Math 22 or 30 or 30B. This course is an introduction to some of the important partial differential equations encountered in engineering and physics. It deals mainly with problems arising in fluid flow, heat conduction, and diffusion.

Math 31H. HONORS MATHEMATICS VII. 3 *credits.*

Prerequisite: Math 32H or permission of instructor. This is the last semester of an eight-semester program in Honors Mathematics. Advanced special topics in probability are considered along with their applications. Topics included are: theory of runs, waiting line problems, random walks, Markov processes, and genetics.

Math 32. INTRODUCTION TO FUNCTIONS OF A COMPLEX VARIABLE. 3 *credits.*

Prerequisite: Math 22 or 30 or 30B. This is designed as a first course in complex variables. Emphasis is placed on techniques. Topics considered include the complex plane, Cauchy-Riemann equations, geometrical aspects, residues, and poles. Proofs requiring a knowledge of advanced calculus will not be included.

Math 32H. HONORS MATHEMATICS VI. 3 *credits.*

Prerequisite: Math 35H or permission of instructor. This is the seventh semester of an eight-semester program in Honors Mathematics. It is a course in linear algebra from an advanced point of view, equivalent to a one-semester graduate course.

Math 33. PROBABILITY AND STATISTICS. 3 *credits.*

Prerequisite: Math 21 or 25 or 25B or 30A. This is essentially a course in modern probability, statistics, and statistical inference. Specific topics include discrete and continuous distributions of random variables, probability models in science, and statistical inference.

Math 34. MATHEMATICS FOR MANAGEMENT SCIENCE. 3 *credits.*

Prerequisite: Math 33. This course considers mathematical methods found especially useful in contemporary fields such as operations research and reliability engineering. Topics are selected from set theory, finite mathematics, difference equations, matrices and determinants, functions of several independent variables, and special functions.

Math 35. VECTOR ANALYSIS. 3 *credits.*

Prerequisite: Math 21 or 25 or 25B or 30A. This course begins with a review of the algebra of vectors and develops the calculus of vectors. Applications to physical phenomena are considered throughout.

Math 35H. HONORS MATHEMATICS V. 3 *credits.*

Prerequisite: Math 31H. This is the sixth semester of an eight-semester program in Honors Mathematics. The course includes further complex variables theory and additional topics chosen at the discretion of the instructor.

Math 90. COMPUTER PROGRAMMING AND NUMERICAL METHODS. 3 *credits.*

Prerequisite: Math 12 or 20B. This course introduces the student to the computer field. Emphasis is placed on modern electronic computers as tools for solving engineering problems. Programming techniques and numerical methods suitable for use with a digital computer are discussed and applied.

GRADUATE COURSES

The following graduate courses are open to undergraduate students with adviser's approval:

Math 100. VECTOR AND TENSOR ANALYSIS. 3 *credits, 1st or 2nd sem.*

Prerequisites: Differential and integral calculus. Introduction to vector and tensor analysis, including a survey of cuvilinear coordinates, with applications to matrix algebra, problems in dynamics, electromagnetic theory, fluid dynamics, and potential theory.

Math 111. INTRODUCTION TO NUMERICAL ANALYSIS. 3 *credits, 1st sem.*

Prerequisites: Calculus and differential equations. This course is designed to familiarize students with theory and techniques of numerical methods applicable to problems in the field of engineering and the physical sciences. Attention is given to algorithms suitable for digital computer approximation in interpolation, differentiation and integration; discussion of iteration and convergence; least squares and other types of approximation; roots of algebraic and transcendental equations; and solution of ordinary differential equations.

Math 145. ADVANCED CALCULUS I. 3 *credits, 1st sem.*

Prerequisite: Undergraduate differential and integral calculus. This course deals with the topics of advanced calculus such as the number system, functions, continuity, differentiability, the Riemann Integral, sequences, series, and uniform convergence.

Math 146. ADVANCED CALCULUS II. 3 *credits, 2nd sem.*

Prerequisite: Math 145 or equivalent. This course is a continuation of Math 145 and considers such topics as partial differentiation, transformations, implicit function theorem, multiple integrals, and line and surface integrals.

Math 151. APPLIED MATHEMATICS I. 3 *credits, 1st sem.*

Prerequisites: Elementary differential equations, vector analysis, and introductory physics. Advanced mathematical methods useful in the analysis of engineering problems are considered. The course covers selected topics from the following: infinite series, improper integrals, elliptic integrals, Gamma functions, Beta functions, Fourier series, Fourier integrals, Laplace transforms and related integral transforms, partial differentiation, Green's and Gauss' integral theorems, and matrices.

Math 173. DIFFERENTIAL EQUATIONS I. 3 *credits.*

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

Math 174. DIFFERENTIAL EQUATIONS II. 3 *credits.*

Prerequisite: Math 173 or equivalent. A companion course to Math 273, dealing with partial differential equations, with emphasis on those of physics and their solution by means of Fourier Series, Bessel Functions, and Legendre Polynomials.

Math 177. STOCHASTIC PROCESSES. 3 *credits, 1st sem.*

Prerequisite: Undergraduate differential equations. The course begins with the development of basic probability concepts of discrete and continuous random variables. Gaussian processes, correlation functions and power spectra are introduced. Applications include the response of linear communication systems to random input signals.

Math 190. INTRODUCTION TO COMPUTING SCIENCE. 3 *credits.*

Prerequisites: Differential and integral calculus. This course is designed for engineers and scientists who have had little or no experience with digital computers. The course considers man-machine communication and emphasizes the reduction of engineering calculations to systematic numerical procedures suitable for computer programming. Machine-language programming is briefly considered and a problem-oriented language is extensively employed.

DEPARTMENT OF MECHANICAL ENGINEERING

Chairman: GEORGE B. THOM.
Associate Chairman: WALTER J. MICHELS.
Assistant Chairmen: RICHARD GAAL, EUGENE STAMPER.

Professors: HSIEH, LEVY, MILLER, POLANER, SMITHBERG, THOM; *Associate Professors:* ALLENTUCH, BANNON, BUTEAU, DEUTSCHMAN, HERMAN, HRYCAK, JACOBS, MARTIN, MICHELS, PROGELHOF, SCHMERZLER, SCHNEIDER, STAMPER; *Assistant Professors:* CHEN, COCHIN, DROUGHTON, FLORIO, GAAL, JAFFE, PAPPAS, PAWEL, PEARCE, RACO, SCHRAM, SUN, WEATHERLY, WILSON; *Instructors:* GERECKE, KIRCHNER; *Special Instructing Staff:* BRESCKA; *Adjunct Instructing Staff:* FRIEZE, PASQUINE, PREUSS, STEGMAN, YOST.

Mechanical Engineering is concerned with the design, development, manufacture and operation of a wide variety of machines and apparatus devoted to the creation, conversion or use of power.

Practicing mechanical engineers may perform one or more of the above functions in such technological areas as aircraft engines and structures, including gas and gasoline engines, rockets and missiles; large scale power plants such as steam, hydraulic, gas and nuclear plants; materials of engineering construction; automatic control systems; production methods; and in the creation, design and use of equipment to accomplish these ends.

The curriculum for the first two years centers about the basic sciences of mathematics, physics, chemistry, and mechanics along with departmental courses in manufacturing processes and basic thermodynamics. Supplementing this core of science courses are service courses in the humanities area including English and history, engineering graphics, computer programming and problem solving, and a program of orientation toward the engineering profession and related human relations problems.

During the third and fourth years, major emphasis is directed toward the establishment of a thorough grounding in the sciences of thermodynamics, fluid mechanics, and heat transfer; in metallurgy and the properties of engineering materials; and in stress and vibration analysis. These are implemented through application courses in the areas of machine design and applied thermodynamics. The courses are supplemented by laboratory work, where appropriate, to develop an understanding of and a respect for testing procedures and also by special projects which enable the student to creatively apply engineering principles. Courses in the humanities and in the business side of the profession are continued, and various terminal courses are provided to give the student an insight into the methods available for applying theory to practice.

The undergraduate curriculum is designed to prepare the student for professional work in his field of major interest. It does more than this, however, for by virtue of the abundance of

training in the basic and engineering sciences it provides the student with the background needed for continued study at the graduate level.

The Department feels strongly that a professional attitude should be developed early in an engineering career and that professional and honorary engineering societies provide substantial encouragement in its development. The Department has a student section of the American Society of Mechanical Engineers and a chapter of Pi Tau Sigma, the honorary mechanical engineering society. Students are encouraged to meet the requirements for membership in both organizations.

COURSES OF INSTRUCTION

ME 10. MANUFACTURING PROCESS. 2 *credits.*
A combined lecture and laboratory course dealing with basic machining and fabrication processes. The lectures emphasize the advantages, disadvantages, accuracies, and economics of various machines and methods. Laboratory experiments are performed to study the generation of motion, power requirements, machineability, surface finishes, and joining methods.

ME 14. METALLURGY. 3 *credits.*
Prerequisite: Chem 25. A course designed to acquaint the student with the nature of a metal and the characteristics of the various types of alloys. Plastic deformation, phase-change interruption, and precipitation-hardening are emphasized. These are illustrated by frequent reference to such common commercial metals as brass, steel and aluminum alloys.

ME 18. METALLURGY. 4 *credits.*
Prerequisite: Chem 16. A course which acquaints the student with the nature of metals and the effects of various thermal and mechanical treatments upon the stability and properties of the various phases in alloy systems. The laboratory sessions implement and emphasize the effects of these treatments. Sample preparation and photomicrographic techniques are included.

ME 31. THEORY OF MACHINES. 3 *credits.*
Prerequisite: Mech 2 or 8, Math 22. A study of the kinematic and dynamic principles used in analyzing and synthesizing basic mechanisms of machines. Vector methods employing both graphical and analytical techniques are used to determine the velocity, acceleration, and inertial characteristics of linkages, gears, gear trains and cams. Where appropriate, computerized techniques are employed.

ME 33. VIBRATION ANALYSIS. 3 *credits.*
Prerequisites: Mech 6 or 8, Math 22. An introduction to the fundamental theory of mechanical vibrations. After the study of undamped and damped systems with single and multiple degrees of freedom, consideration is given to such topics as transient vibrations, vibrations of continuous media, and analog and numerical methods.

ME 34. MECHANICAL ENGINEERING DESIGN I. 4 *credits.*
Prerequisite: ME 31, 33, 42, Mech 6 or 8. A lecture and project course emphasizing the design and analysis of basic machine components as they are related to machines and mechanical systems. Topics covered in the classroom, in addition to the student's background in other engineering disciplines, become the foundation for executing the design projects. Emphasis is placed on creative design and the efficient use of engineering materials.

ME 36. MECHANICAL ENGINEERING DESIGN II. 4 *credits.*

Prerequisite: ME 34. A continuation of ME 34 from a more integrated viewpoint. The projects, although comprehensive in nature and still emphasizing creative design, require design decisions of a more sophisticated nature.

ME 37. STRUCTURAL ANALYSIS. 3 *credits.*

Prerequisite: Mech 6 or 8. A course designed to acquaint mechanical engineering students with the fundamentals of structural analysis. Consideration is given to such topics as moving loads, deflections, beams and columns, members and connections for both steel and reinforced concrete structures. Methods for graphical and analytical solution are developed.

ME 41. THERMODYNAMICS I. 3 *credits.*

Prerequisites: Math 21 or 25B or 30A, Phys 2. A course in thermodynamic fundamentals. Among those principles introduced are the first and second laws of thermodynamics, physical properties of pure substances including real and ideal gases, entropy and availability.

ME 42. THERMODYNAMICS. 3 *credits.*

Prerequisite: ME 41. A continuation of ME 41 including studies of gas-vapor mixtures, combustion, compressible flow with heat transfer and friction effects, and one-dimensional shock wave relations. The principles are applied to the analysis of power producing, refrigeration, and air conditioning systems.

ME 43. MECHANICAL LABORATORY I. 3 *credits.*

Prerequisites: ME 41, 44. A laboratory and lecture course in instrumentation and measurement for mechanical engineering students. Applications for the sensing of such variables as pressure, temperature, mass flow, and displacement are covered. Particular attention is directed toward applicability and sensitivity of instruments studied.

ME 44. FLUID MECHANICS. 3 *credits.*

Prerequisites: Mech 1, Phys 2, and Math 21 or equivalent. The theory and application of fluid systems are studied. Topics include fluid properties; statics, kinematics, and dynamics of fluids; control volume; relationship of mass, energy, and momentum; the flows associated with ideal, incompressible, viscous, and compressible fluids; dimensional analysis and dynamic similitude; and fluid machinery and fluid control applications.

ME 45. HEAT TRANSFER. 3 *credits.*

Prerequisite: Math 22 or 30. Corequisites: ME 42, 44. A course for senior mechanical engineering students which includes steady state and transient heat conduction in one and two dimensions, free and forced connection, boundary layer theory, experimental analog correlations, and radiation. The theory is applied to the analysis and design of heat exchanges and to other practical heat transfer applications.

ME 46. MECHANICAL LABORATORY II. 2 *credits.*

Prerequisites: ME 42, 43. A laboratory course for mechanical engineering students applying the principles of thermodynamics, fluid flow and heat transfer to energy conversion and vibratory systems.

ME 48. MECHANICAL LABORATORY III. 2 *credits.*

Prerequisites: ME 45, 46. An advanced laboratory course for mechanical engineering students in the testing and evaluating performances of complete energy conversion systems associated with steam power plants, internal combustion engines, air conditioning and refrigeration, and power absorption units. Selected student projects may be introduced, presenting an opportunity for student participation in design, test, and evaluation.

ME 53. ENERGY CONVERSION. 3 *credits.*

Prerequisites: ME 45, Phys. 4. An elective course for senior mechanical engineering students dealing with the theory, analysis, and design of modern static and dynamic energy conversion devices. The applications include thermoelectrics, magnetohydrodynamics, electrohydrodynamics, and fuel cells.

ME 54. COMPRESSIBLE FLOW. 3 *credits.*

Prerequisites: ME 42 and 44 or ChE 45 and 64, and Math 22 or 30. Equations of one dimensional compressible flow. Included are flows with variable area, friction, mass addition, heat addition, normal shocks, and combination of these effects. Special topics in two dimensional flows including oblique shocks.

ME 55. AUTOMATIC CONTROLS. 3 *credits.*

Prerequisites: Math 22 or 30, Mech 2 or 8, Phys 3. An introductory course covering the principles of automatic controls. Emphasis is placed on mechanical systems considering hydraulic, pneumatic, thermal, and displacement aspects. First and second order linear systems are studied. Various system analysis techniques such as Nyquist and Bode diagrams are introduced.

ME 56. FLUID MACHINERY. 3 *credits.*

Prerequisites: ME 42, 44, Math 22 or 30. An introduction to the underlying principles of rotating fluid machinery. The fundamentals of gas dynamics are introduced. Analytical, graphical, and dimensional analysis methods are used in analyzing axial and centrifugal machines. Airfoil, cascade and channel flow theories are introduced.

ME 57. ELECTRO-MECHANICAL DEVICES. 3 credits.

Prerequisites: Phys 3, Math 22 or 30, Mech 2 or 8. A unified treatment of electro-mechanical elements from both an analytical and a descriptive viewpoint. The mathematical techniques of vibration analysis and circuit theory are applied to precision electro-mechanical devices such as accelerometers, integrators, shaft readout devices, autocollimators, gyroscopes, and electro-mechanical bearings.

ME 61. THERMODYNAMICS. 3 *credits.*

Prerequisites: Phys 4 and Math 21 or equivalent. This course for non-mechanical engineering students includes the basic laws of thermodynamics; fluid, solid, magnetic, and electrical property functions; energy analysis for open and closed systems; gas and vapor power cycles; refrigeration; and an introduction to modern dynamic and static energy conversion devices.

ME 62. ENERGY ANALYSIS. 3 *credits.*

Prerequisite: ME 61 or 65. A technical elective for senior non-mechanical engineering students covering the fundamentals of fluid flow and heat transfer as well as system analysis of modern energy conversion devices, including static and dynamic devices, fossil fuel, and nuclear and solar power applications.

ME 65. FUNDAMENTALS OF MECHANICAL DESIGN. 5 *credits.*

Prerequisites: EG 2, Mech 6 or 8, IE 24. A course in mechanical design for industrial engineering students. Among topics treated are mechanisms, elements of machines, materials and their use in design, heat treatment, and dimensioning for production. In addition, various thermal, fluid and mechanical systems are analyzed, making use of the mechanical engineering laboratories.

GRADUATE COURSE

The following graduate course is open to undergraduate students with adviser's approval:

ME 113. DYNAMICS OF COMPRESSIBLE FLUIDS. 3 *credits, 1st sem.*

Prerequisites: Undergraduate differential equations, fluid mechanics, and thermodynamics. This course covers one dimensional reversible and irreversible compressible fluid flow including effects of variable area, friction, mass addition, heat addition, and normal shock; two dimensional reversible subsonic and supersonic flows with an introduction to the method of characteristics; and two dimensional oblique shock.

DEPARTMENT OF PHYSICS

Chairman: PAUL O. HOFFMANN.
Assistant Chairman: LEONARD M. SALZARULO.

Professors: BERTSCH, CAPECELATRO, HOFFMANN, MAINARDI, REFF, SAGURTON, SALZARULO, SMITH; *Associate Professors:* DUURSEMA, FARBER, KUHARETZ, NEIDHARDT, TOWFIK, WELLER; *Assistant Professors:* AARON, DISTEFANO, FABRICIUS, FINK, GAUTREAU, JERMAKIAN, KINGERY, LANDSMAN, MCGURN, NATAPOFF, OLECK, REISMAN, REIZISS, RUSSO, SAVIN, SHUKUR, STEVENSON; *Instructors:* AUSTEN, GIORDANO; *Special Instructing Staff:* ELLIS; *Adjunct Instructing Staff:* JACKSON, KESSELMAN, RAUPPIUS.

The Department of Physics has arranged the content of its courses to give the engineering student a sound background in physics. It is the aim of the department to have the student realize that physics serves as the foundation upon which his engineering knowledge must be based. Emphasis is placed upon the fact that the fundamental principles of physics must be applied in later professional studies.

The schedule of instruction includes a rather small amount of formal lecturing with a large number of informal recitations, problem work and demonstration periods, together with laboratory work in general physics. The Department of Physics is supplied with four general physics laboratories completely equipped to enable the student to perform experiments in mechanics, electricity, heat, sound, light and modern physics. A nuclear laboratory provides facilities for nuclear engineering experiments.

COURSES OF INSTRUCTION

Phys 1. PHYSICS I. 4 *credits.*

This course deals with the study of elementary mechanics. Emphasis is placed on the fundamental concepts and laws of mechanics, especially the conservation laws. Topics discussed are: scalar and vector quantities of mechanics; rectilinear, and circular motion; equilibrium and Newton's laws of motion; work, energy, momentum; the conservation laws; and elements of heat. Correlated experiments and computations run concurrently with lectures and recitations.

Phys 1H. PHYSICS I H. 4 *credits.*

This is the first semester of a three-semester program in Honors Physics. This course covers the material taken up in Phys 1, but topics are treated more comprehensively and in greater depth. More extensive use of mathematics is made than in Phys 1.

Phys 6. ENGINEERING PHYSICS. 3 *credits.*

Prerequisites: Phys 31, Math 30. Lagrange's and Hamilton's equations are studied. Field concepts are applied to elasticity, fluid flow, elastic waves and heat flow. Boundary value problems are solved, based on the wave equation, Laplace's equation and the equation of heat flow.

Phys 7. NUCLEAR ENGINEERING. 3 *credits.*

Prerequisites: Phys 31, Math 30. Neutron physics is applied to elementary nuclear reactor design. Topics included are nuclear reactions, nuclear fission, neutron diffusion, criticality, reactor start-up and reactor transients, radiation detection and shielding.

Phys 8. SEMICONDUCTOR PHYSICS. 3 *credits.*

Prerequisite: EE 40. The physics of semiconductors is examined and applied to problems of interest to the electrical engineer. The course includes the following topics: the band theory of solids, conduction in solids, hole and electron statistics, and P-N junction theory with emphasis placed upon low-level and high-level injection. Metal semiconductor contacts and P-N-P transistor theory are also discussed.

Phys 9. NUCLEAR ENGINEERING LABORATORY. 3 *credits.*

Prerequisite: Phys 7. The course includes basic experiments in nuclear instrumentation and experiments with a sub-critical reactor. The experiments performed are of such a nature as to assist the nuclear engineer in the general area of reactor design.

Phys 21. PHYSICS II. 4 *credits.*

Prerequisite: Phys 1. This course deals with an introduction to electricity and magnetism. Topics discussed include simple DC circuits, the electric field, the magnetic field, relationships between electric and magnetic fields, magnetic properties of matter, and simple AC circuits. Correlated experiments and computations are assigned concurrently with lectures and recitations.

Phys 21H. PHYSICS II H. 4 *credits.*

Prerequisite: Phys 1 or 1 H. This is the second semester of a three-semester program in Honors Physics. The course covers the material taken in Phys 21. Greater use is made of vector analysis. In addition, an introduction to Maxwell's equations for the electromagnetic field and applications to physical problems are discussed.

Phys 31. PHYSICS III. 5 *credits.*

Prerequisite: Phys 21. Simple harmonic motion, wave motion, geometric and physical optics are considered. The wave and particle duality of nature is emphasized and made plausible by an examination of the important experiments and theories which lead to the modern concepts of matter and radiation. The conservation laws are now broadened to include the law of equivalence of mass and energy. Experiments complement lectures and recitations.

Phys 31H. PHYSICS III H. 5 *credits.*

Prerequisite: Phys 21 or 21H. This is the third semester of a three-semester program in Honors Physics. This course covers the material taken up in Phys 31. Physical optics is treated in greater detail. Modern physics includes a greater number of topics, with special emphasis on the wave-particle duality in nature.

Phys 41. MODERN PHYSICS. 3 *credits.*

Prerequisite: Phys 4 or 31. After a brief review of classical physics and kinetic theory, the course considers nuclear and atomic structure. Key experiments illustrating the wave particle duality are discussed and elements of wave mechanics are introduced, followed by applications of two-state quantum systems. The motion of an electron in a periodic lattice is then discussed, leading to a consideration of the band theory of solids. The electrical, thermal, and magnetic properties of solids follow. The course terminates with a semi-quantitative description of plasmas and superfluid systems.

Phys 42. INTRODUCTION TO QUANTUM MECHANICS. 3 *credits.*

Prerequisite: Phys 4 or 31. After a brief review of the experiments leading to the development of quantum mechanics, the course deals with matter waves, Schrodinger's wave equation, Heisenberg's uncertainty principle, operators, and commutators. This leads to the concept of standing waves applied to particles bound in potential wells, the harmonic oscillator, the hydrogen atom, potential barriers, and angular momentum. This is followed with the concepts of degeneracy, composite states, and the general properties of eigenfunctions. The course concludes with time-independent and time-dependent perturbation problems.

Phys 43. OPTICS. 3 *credits.*

Prerequisite: Phys 4 or 31. The course deals with geometrical and physical optics. Geometric optics includes thick lenses and lens design. Physical optics is based on the electromagnetic theory of light and includes dispersion, absorption, optical activity, Fresnel and Fraunhofer diffraction, resolution of optical instruments, and phase contrast microscopy. Time permitting, elements of fiber optics and non-linear optics will be introduced.

GRADUATE COURSES

The following graduate courses are open to undergraduate students with adviser's approval:

Phys 102. HISTORY OF THE PHYSICAL SCIENCES. 3 *credits, 2nd sem.*

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

Phys 120. MODERN PHYSICS. 3 *credits, 1st sem.*

Prerequisite: Differential equations. The course deals with 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; and electrical, thermal, and magnetic properties of solids.

Phys 123. RADIOISOTOPES LABORATORY. 3 *credits, 2nd sem.*

Prerequisite: Modern physics. A series of experiments designed to acquaint the student with the theory and application of radioisotopes. These experiments will afford a study of the instrumentation and nuclear processes involved in this field. Some neutron experiments are included. Area surveying and decontamination methods will be carried out stressing the requirements of radiological safety. Experiments chosen will emphasize the application of physics to this field.

Laboratory fee: $25.00.
Offered 1969-70 and alternate years.

DIVISION OF HEALTH, PHYSICAL EDUCATION AND ATHLETICS

Director: ROBERT F. SWANSON.
Associate Director: PAUL C. HAUSSER.

Professor: SWANSON; *Associate Professors:* HAUSSER, SIMON; *Instructor:* KESIN; *Consulting Physician:* WARD.

The acquisition and maintenance of an optimal condition of health for the purpose of pursuing an engineering education is the primary purpose of the Division. To accomplish this purpose the Division coordinates the health-related needs of the college community through a health services area, and conducts a formal instruction program in physical education for freshmen students. The Division also coordinates and advises students in the operation of numerous intramural and intercollegiate athletic activities. In athletics there is a strong emphasis on programs of an intramural nature, while intercollegiate athletics are supported to the extent that they contribute to the primary purpose of the Division.

The health services program is of a consultative nature, bringing reliable, authentic advice to students where investigation and experience indicates a need. A consulting physician, nurses, and health educators comprise the staff. The facilities of a modern college infirmary are available day and evening in the event of sudden illness or injury. Students are urged to use the ample facilities of the health services area to solve health-related problems effecting their educational goals.

PHYSICAL EDUCATION. *No credit, two semesters.*

Physical Education is required of all freshman students. Those freshmen who submit evidence of a disability, or who have been examined by the College physician and declared physically unable to participate in strenuous physical activity, take part in an individualized program under the guidance of a physical education instructor.

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