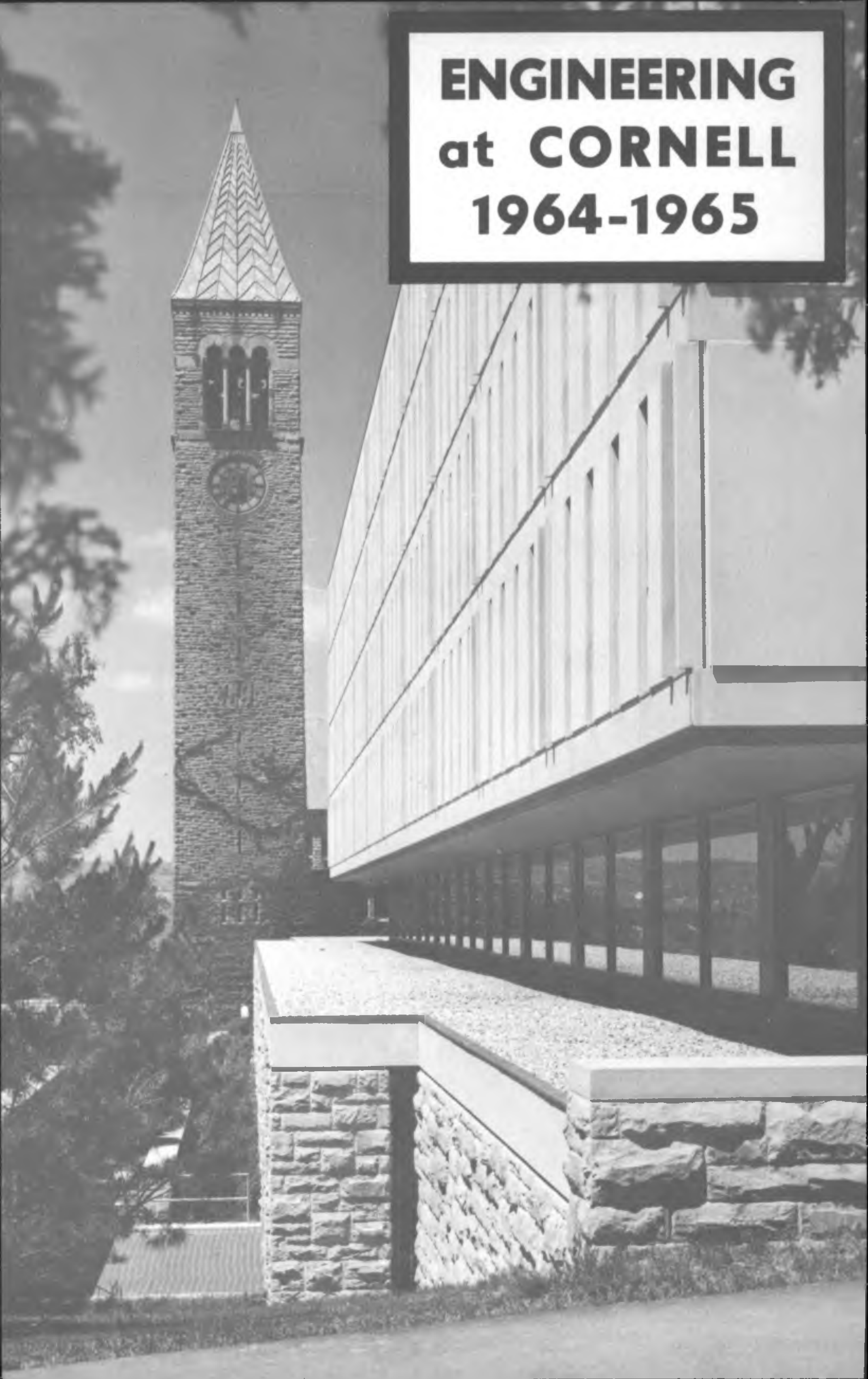
ENGINEERING at CORNELL 1964-1965



FURTHER INFORMATION

All prospective students should obtain the *Announcement of General Informatio* (See below.)

Engineering curricula and course descriptions:

Cornell University Announcements
Edmund Ezra Day Hall
Ithaca, New York

Scholarships:

Office of Scholarships and Financial Aid
Edmund Ezra Day Hall
Ithaca, New York

Admission requirements, procedures, and applications:

Office of Admissions
Edmund Ezra Day Hall
Ithaca, New York

General Information and Other Announcements, listed below:

Cornell University Announcemen
Edmund Ezra Day Hall
Ithaca, New York

Announcements are available for other academic divisions of Cornell University follows: State College of Agriculture (four-year or two-year course), College Architecture, College of Arts and Sciences, School of Education, Department Asian Studies, State College of Home Economics, School of Hotel Administratio State School of Industrial and Labor Relations, Military Training, Summer Schoo Graduate study is described in other Announcements as listed on the cover of th *Announcement of General Information.*

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Engineering at Cornell

1964 - 196

CORNELL was a pioneer in bringing technical education into conjunction with liberal studies. Cornell also pioneered in the identification of electrical engineering, industrial engineering, and engineering physics. Currently, many new problems and situations—which stem from the terrific rate of development of science and technology—present new challenges. Such challenges are far different from the problems of engineering education which faced the men who introduced engineering study at Cornell, but the spirit of innovation remains a part of the Cornell tradition.

Today's engineers are called upon to work in fields which were not thought of a few years ago. They must also make decisions which have far reaching effects on society. They cannot avoid these challenges. Knowledge of current techniques and processes is not enough. Required is a mastery of fundamentals, the ability to apply the principles of mathematics and science to new situations, as they evolve, with originality and imagination and with understanding of social implications. The ability to master as they evolve, new techniques appropriate to the task is important if a person is to grow with the engineering profession.

The College of Engineering has reacted to meet these new conditions in several ways. One objective is to make it possible for the student to use most effectively Cornell's great sources and facilities to prepare himself to meet the new challenges. The Division of Basic Studies in which all engineers matriculate for their first two years provides an opportunity not merely to complete work in basic science and mathematics and to become familiar with such universally useful devic as the electronic digital computer but als ample time to study and appraise the mar possible fields of endeavor and specialties i engineering. From the Basic Studies Divisio he may enroll in any of the undergraduat fields, which provide a number of new up perclass programs with a wide range c choices. Depending on his interests and ap titudes the student may prepare more full for professional practice by deepening h competence in a special field, or he may be gin work in one of a number of pregraduat programs. Honors programs, available in number of fields, provide for early registra tion in the Graduate School for the qualifie engineering student.

The variety of students, men and womer from the United States and most other cour tries of the world, is in itself educational. S too is the variety of educational activities- humanities to labor relations, linguistics t history of art, astronomy to zoology. As a re sult, the engineer at Cornell is constantl faced with opportunities to expand his ir terests.

The College of Engineering is aware tha rapid change will continue, both in tech nology and society. It maintains an attitud of experimentation, convinced of the nee for a breadth which crosses and combine traditional disciplines. Its new campus pro vides an opportunity for such flexibility an growth. Its expanding research and graduat programs constantly feed new concepts ideas, and techniques into the undergraduat program. Such change and progress will con tinue and increase.

Our national strength and leadership de mand in the engineering profession the high est standard of excellence. Such excellence i essential to solve the already pressing prob lems of the future. Cornell's engineering education is directed to this end. I would like to invite you to consider it as a chal lenge. If I can help in your decision, pleas write.

ANDREW S. SCHULTZ, JR
Acting Dean

Contents


EZRA · CORNELL
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A Sketch of Cornell

VHEN Cornell was founded in 1865, it was considered a revolutionary inovation in American education. Instead of pursuing conventional :ademic ideas, it purposed to offer *any* intellectually qualified person istruction in *any* subject. Ignoring distinctions based on religion, sex, nd color, the "Cornell Idea" was then viewed as a questionable ex-eriment. Actually the University was in the vanguard of a great shift ı American education. It answered the three most pressing demands f the time: liberalization of the arts curriculum, promotion of re-earch, and advanced training in engineering and agriculture.

Ezra Cornell, the founder of the University, was practical and ener-etic but had a Quaker conscience which impelled him to say, "My reatest care is how to spend this large income to do the greatest ood. . . ." He was not born to wealth, and his formal education was ıeager. However, he concluded that support of education was the best ay to use his personal fortune for the good of posterity.

Some universities are sustained by public money; others depend on rivate funds supplied by alumni, friends, and philanthropic sources. Cornell draws its support from both because part of the University is ate-supported and part is financed privately through tuition, endow-ıent, and gifts.

Cornell is situated on a hill between two magnificent rocky gorges hose streams flow into Cayuga Lake, one of the major Finger Lakes f the central New York region. No matter what the season, the visitor lways remembers Cornell for its incomparable campus setting.

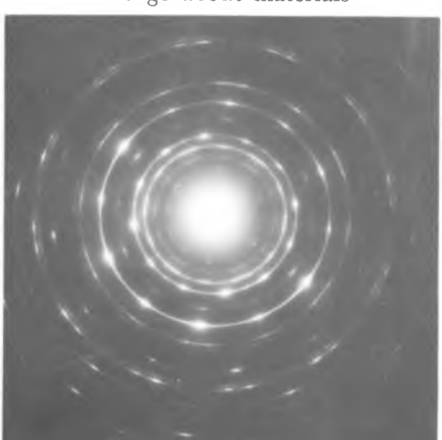
Today, Cornell has become a national—in fact, an international—ıstitution. Every state in the Union and almost ninety foreign countries re represented in its student body. More than 8800 men and women udy in the eight undergraduate divisions and colleges, each with its wn curricular characteristics and identity. In addition, approximately 000 students are enrolled in advanced degree programs in the Uni-ersity's Graduate School. Two thousand engineering students not only njoy the advantages of an entirely new engineering quadrangle, but ll the opportunities—both curricular and extracurricular—of the Cornell community.

Fundamentals underlie many things . . .

. . . engineering judgments

. . . computer solutions

. . . knowledge about materials



. . . experimental research

Cornell Engineering

THE ENGINEERING PROFESSION AND YOU

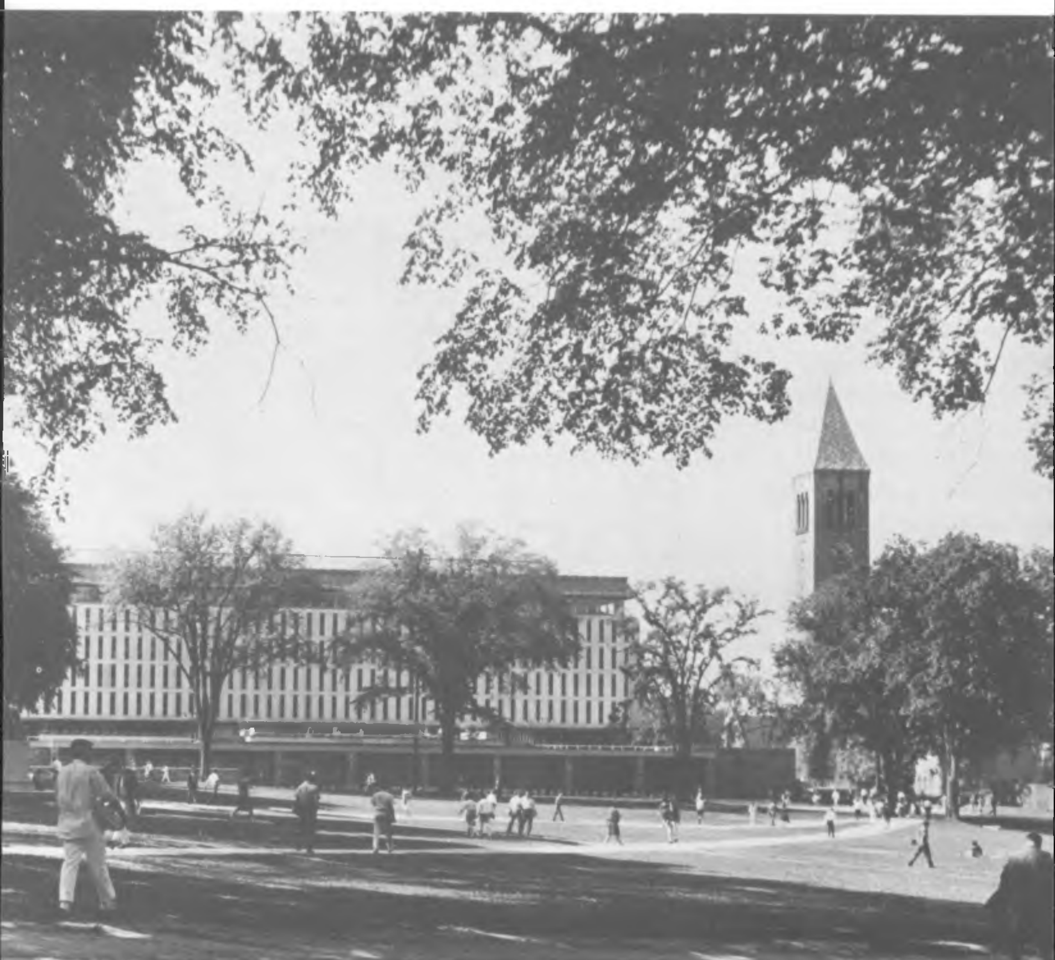
If you like mathematics *and* do well at it; if you have enjoyed what science courses you may have had; if you think you would like to apply the principles of these studies to create systems for useful purposes, then you probably have the ability and interest to consider a career in engineering. Engineers shape the discoveries of science to meet diverse human needs. Machines which transform energy into usable power, highway and building construction, manufacturing processes, the design of communication systems, and experimental work on new materials and chemical processes are but a small part of the spectrum of opportunities awaiting the young engineering graduate. What engineers do is sometimes routine, but more often than not it is exciting. The energies of engineers are having a profound effect in shaping the direction of our dynamic civilization.

Engineering requires the best that is in you and helps develop that best. It is a rigorous and demanding intellectual discipline and an excellent training of the mind. The bridge builder or missile maker cannot afford to be right only 70 per cent of the time, because the safety, comfort, convenience, and economy of millions of people are affected by his ability or lack of it. To be a success in engineering you must have the ability to concentrate, systematize, and organize your work; make an orderly approach to solving problems; persist in the face of repeated failures; and thrive on all this.

The decision to enroll in engineering is not quite the same as a decision to undertake a program in liberal arts. Those students who study the humanities, or the natural or social sciences, are learning about their cultural heritage or the world around them but are not necessarily preparing for a specific professional career. As a result, liberal arts students can do a good bit of experimenting before they have to decide on their major field. In a sense, the engineering student has chosen his program of studies before he arrives on campus for his freshman year. It is important to note that he has made this choice understanding that engineering is a highly developed profession like law or medicine. The liberal arts student, while he obtains a broader cultural background, must, if he seeks professional training in his undergraduate field or in law or medicine, enter graduate school. On the other hand, the engineer is ready to enter his profession directly upon receipt of his Bachelor's degree, even though he may subsequently go on to advanced study.

Cornell does not expect all students who are interested in engineering to be free of doubts about a decision as singularly important as this. Those who have made the choice and banished all doubts are invariably in the minority. But Cornell does think, and its experience has shown, that most students who are capable in and who like science and mathematics find they have chosen well. To help make this decision a sound one, you should find out as much as you can about engineering. If you come to Cornell feeling that your choice of engineering appears to be a reasonable one, it should increase your enthusiasm and motivation in carrying you through what may seem rather rigorous years. Lack of motivation growing out of a failure to understand what engineering school is all about may cause a number of engineering students to fall by the wayside. Rarely is a lack of ability the reason for failure during the early years of the engineering curriculum.

The McGraw Tower of the Uris undergraduate library at Cornell University is familiar to more than 100,000 alumni and 12,000 students. The new Olin Library for research and graduate study is in the foreground.



Main reading room in the Engineering Library in Carpenter Hall

CORNELL ENGINEERING IN PERSPECTIVE

Ever since its founding in 1865, Cornell has been a pioneer in engineering education. Cornell, for example, granted the first doctorate in engineering in the country and also established the nation's first specific program granting a degree in electrical engineering. In order to meet the modern engineer's need for more fundamentals, for professional breadth and depth, and for increased personal and social perspective, the College of Engineering adopted five-year programs in all its curricula in 1946. Today a common curriculum for all engineering students is offered during the first two years. During their early years students have ample opportunity to explore the various engineering fields, not only in their course work, but by talking with their advisers, with faculty, and with upperclass engineering students.

Later in the upperclass years, the student develops his competence in the sciences and technology of a particular engineering field and has manifold opportunities either to broaden his educational program through special upperclass sequences of courses or to intensify his training in a particular area of his chosen field.

Cornell engineering is moving to meet and even to anticipate challenges brought about by new demands. Courses of study in the traditional engineering fields are pointing in new directions, and new courses have been added. The new engineering campus incorporates the latest equipment for instruction in traditional and pioneering technologies, and for research by both faculty and students. Research creates an air of discovery and points the way to careers in developing technologies and sciences.

High school students who enter Cornell engineering apply themselves to fundamentals of basic sciences and engineering sciences. They study both processes and machines. They expand their abilities to confront and solve new engineering problems, their awareness of new engineering opportunities, and their insight into the world's new social, economic, and political responsibilities.

THE CORNELL IDEA

With the ever-diminishing time span in which an idea is created and ultimately translated into practical application, engineers in future years must be more capable of finding solutions to problems which cannot be solved with a knowledge of familiar machines, existing organizations, and known structures. Therefore, Cornell places a firm emphasis on mathematics, physics, and chemistry, and the application of their principles to basic engineering problems and situations. Such a mastery of fundamentals makes it possible to keep up with what is and what *will be* new.

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ind them.

Depth and Breadth

By explanation, by problem solving, and by working directly on all kinds of equipment in the laboratory, Cornell engineers become competent in a particular field of engineering, which they select to place their emphasis on in the upperclass years. It is during this time that they learn how to solve engineering problems within their own field, and how to approach problems in others.

All the traditional fields of engineering are expanding and are requiring a breadth of comprehension and application of diverse engineering techniques. Nuclear engineering, for instance, requires not only a solid grasp of basic sciences, but a versatile knowledge of principles and practices of chemical, civil, electrical, mechanical, and metallurgical engineering. The five-year curriculum of study fosters not only the necessary competence in a single professional field of engineering but an understanding and the competent knowledge of the breadth required in modern engineering practice. Engineers are needed in management, production, construction, design, development, and research. Within the framework of the engineering programs offered at Cornell, students can prepare for future graduate work or deepen their professional competence to enter business or industry directly.

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Cornell engineering seeks to graduate men who understand the meanings of their profession in the world of affairs; who can express themselves and their profession clearly, intelligently, and resolutely; who have had the opportunity to gain insight into man, the arts, and the structure of society.

New Directions through Research

The best way to study engineering is to gain a firm hold on fundamentals; but the best way to learn what directions the use of those fundamentals is taking, is to be where new frontiers are being explored through research. The engineering faculty itself conducts such research, directs graduate students, and advises senior undergraduates on their own independent projects.

Fundamental research is conducted in all established engineering fields. But research is also being conducted in new fields not bound by traditional lines. The Center for Radiophysics and Space Research, for instance, brings together investigators in astronomy, engineering physics, electrical engineering, physics, and aerospace engineering. They are studying the atmosphere and properties of space near the planets, development of space vehicle instrumentation, and use of radio astronomy for investigating the solar system and our own and other galaxies. This Center's principal facility, the Arecibo Ionospheric Laboratory in Puerto Rico, is but one example not only of an engineering idea being translated to operational reality but of the commitment which is Cornell's—moving well out on the frontiers where new knowledge may be found. A 1000-foot radar-radio telescope (or "big ear") is the principal facility of that Laboratory.

Studies like those in Cornell's Nuclear Reactor Laboratory, interdisciplinary Materials Science Center, and Computing Center bring the excitement of discovery into the undergraduate classroom. They enable the traditional branches of engineering to participate in the newest developments, and help students to define future engineering problems and opportunities.

Research at Cornell is not a separate entity but is a planned part of the whole educational program.

Students us
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. . . small recitation sections

. . . informal seminars

. . . lectures

The Five-Year Curriculum

THE PURPOSES OF THE FIVE-YEAR PROGRAM

A PRINCIPAL feature of Cornell's five-year program is the extent to which a student not only gains command of all the important aspects of a field but can concentrate on a special interest as well. Mechanical engineers, for example, get extensive training in such branches as machine design, engineering mechanics, and thermal engineering. If they wish further concentration in one of these, they can select a sequence of advanced courses adapted to their special interest. Thus a student interested in thermal engineering can build a full thermal engineering program on top of a basic program in mechanical engineering.

A civil engineering student, after a core program including work in structural, transportation, sanitary, and hydraulics engineering, and construction engineering and administration, can pursue any one of these in intensity or extend his competence in several. In electrical engineering special advanced sequences can be selected in such areas as electrical network theory, industrial electronics, feedback control systems and computers, communication systems, radio science, and many others. Engineering physics and metallurgical engineering students can obtain unusually sound training in materials science, or engineering physicists can select a series of courses in space science and technology. In chemical engineering, after thorough coverage of the field, students can undertake studies in biochemical engineering, polymeric materials, reaction kinetics, or automatic process control. These are only some of the possibilities that are offered through the increased flexibility of a five-year curriculum.

Opportunities for independent work are provided in the senior project, required in some schools, optional in others. Independent work gives a student the chance to initiate, plan, and carry out "open-ended" investigations, which have no fixed time for completion and which allow a student to go as far as he can see worthwhile things to do. Such an experience stimulates his ability to think and to do original work. The senior projects can be conducted with pencil, paper, and slide rule or computer, or on equipment which the student designs, constructs, and tests.

ring graphics

Some projects have employed the Control Data 1604 and the Burroughs 220 at the Cornell Computing Center, or the synchrotron in Cornell's Laboratory of Nuclear Studies. The reactor facility expands opportunities still further. Students can take advantage of the considerable laboratory space available in all of the engineering buildings, and of the many group and individual project rooms. Some undergraduate projects have been highly original work of distinctly graduate caliber or have been adopted in industry. Often they work into some part of Cornell's extensive research program; students help professors who are conducting advanced investigations, or design equipment which later becomes a device used in undergraduate laboratory courses. Nor are opportunities to work on research projects limited to the senior year. Some students get first-hand research experience during the summer as assistants to faculty members or graduate students.

Cornell believes that its five-year curriculum offers prospective engineers the best chance to develop from a proper foundation not only full competence in an engineering field but adequate opportunity for general, managerial, and liberal studies.

In this integrated program, courses build upon each other, so that understanding increases in an orderly way. Students are better able to correlate their knowledge of subjects within engineering and between engineering and other studies. Since opportunities for elected courses are spaced over several years, students can plan their engineering electives, independent work, and liberal studies with greater purpose.

Usually, beginning even in the second year and increasing through the fifth, students can expand their personal horizons by electing courses in art, literature, history, philosophy, economics, or social sciences. Some familiarity with man's expressions through thinking, writing, or painting is an invaluable stimulus to further explorations throughout life. The best education should not only develop the mind but enlarge the perspective. It should induce understanding and respect for problems upon which men have reflected during times of doubt and of illumination. Each school of the College of Engineering requires study in the humanities and social sciences. In fact, well over the equivalent of one of the five years in the College is devoted to nontechnical course work. Moreover, each school provides for free technical electives that can be used to develop more fully an engineering technology or to prepare for graduate study.

The engineering profession is changing. Old fields are becoming transformed, new ones are evolving, and engineers are more and more often required to make judgments which have extensive social and political implications. Such conditions demand full integration and flexibility. Cornell's five-year program helps fulfill these needs.

SPECIAL OPPORTUNITIES WITHIN THE FIVE-YEAR CURRICULUM

One of the main reasons why Cornell engineering offers so many educational challenges, represented in part in the following programs, is that there have never been so many opportunities in so many fields. Cornell graduates are called upon to provide leadership—as professional engineers, as engineering scientists, and as executives. They must be prepared today to apply their knowledge and creativity to the conquest of space, to the development of the automatic factory, to renewal of our cities, or to world problems of natural resources, power, and communications. Such tasks require men who know how to approach such problems, who are challenged by novel situations and unexpected difficulties, who prefer exciting possibilities to routine.

Graduate Honors Program

Throughout the undergraduate years, students with special competence in individual subjects as well as excellent over-all scholastic performance are given opportunity to enroll in enriched and advanced sections of those subjects. By moving along at a faster academic pace than that required in the general programs of the College, a student can materially advance the date in which he may be permitted to enroll in graduate-level courses, and can subsequently earn a graduate degree in engineering in a shorter period of time.

Learning

Usually, a student may become eligible for admission into the Graduate Honors Program at the conclusion of his third year of residence at Cornell. The program in his field of engineering is appropriately modified in the fourth year so that it is possible to undertake graduate work in engineering during the fifth year of the undergraduate program. Usually, with the addition of one summer or term in residence beyond the required five-year curriculum, a student may earn both his Bachelor's degree and Master's degree in engineering.

At present, approximately 40 per cent of the graduating classes in engineering continue their formal education by enrolling in graduate degree programs either at Cornell or elsewhere. It is anticipated that half of this group, or roughly the top fifth of the class, are eligible for consideration for this accelerated program in the College of Engineering.

Industrial Cooperative Program

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oratory.

During the fourth term, above-average students who plan to enroll in electrical engineering, engineering physics, industrial engineering and administration, or mechanical engineering at the beginning of the fifth term are eligible to apply for admission to the Industrial Cooperative Program.

The cooperative program provides three term-length work periods (about sixteen weeks each) with one of several participating companies.*

The program incorporates the summer vacation periods after the fourth term into the student's work-study schedule. The cooperative student completes the regular academic study for his Bachelor's degree, pursues his work program totaling one year in industry, and still graduates on time with his regular class, which is unique among cooperative programs. He remains on campus with his regular classmates except for the fifth and eighth terms; that work is taken by the student in the summer co-op terms.

The work program of each student is arranged to advance his individual interests and aptitudes within the regular activity of the company with which he is affiliated. He has no industry assignment the first summer, and he does his industrial work in one company throughout the entire program. These two requirements enable him to pursue his engineering objectives in meaningful work areas seldom available through ordinary summer placement. The individual counseling and appraisal of progress that characterize the program enable the student to pursue his studies and to graduate with realistic industrial objectives.

The objective of the program is educational rather than remunerative, although the student receives a substantial salary from industry during his three work periods. Applicants are subject to approval both

* American Electric Power Service Corporation, Anaconda Wire and Cable Company, Cornell Aeronautical Laboratory, Emerson Electric Manufacturing Company, General Electric Company, General Radio Company, The Gleason Works, International Business Machines Corporation, Philco Corporation, Procter and Gamble Manufacturing Company, Raytheon Manufacturing Company, Stromberg-Carlson Company.

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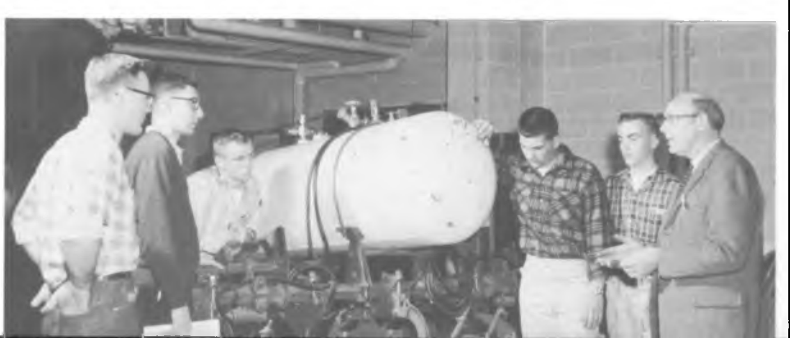
ural engineering



by the College and by one of the cooperating industries. Admission to the plan involves no obligation on the part of either the student or the industry with regard to future employment.

Nuclear Engineering

The elective program offered in nuclear engineering is one example of how Cornell's advanced research work has become subsequently translated into opportunities for students at the undergraduate level. During the fourth and fifth years, students in *any* engineering field with an aptitude for applied physics and mathematics can elect a sequence of courses in nuclear engineering which provides an exceptionally strong foundation for graduate study or for later professional work. With this sequence, a student may elect to carry out his senior project in nuclear engineering.

The facilities include a Zero Power Reactor, a Triga Swimming-Pool Reactor with a moderate power core offering an intense pulse of neutrons for investigation of various radiation effects, and a Gamma Irradiation Cell—all of which are available for student work.

The College of Engineering believes that the best preparation for work in nuclear engineering is a coordinated study of the principles of nuclear science and of any of the major fields of engineering.

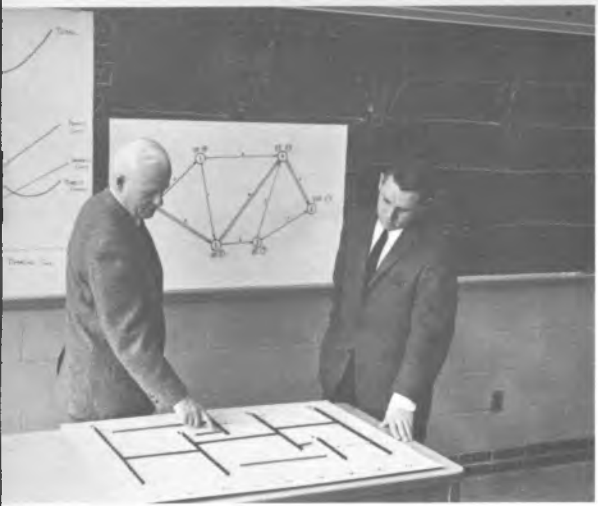
Pressure v
test set-up

Engineering Mechanics

Most future advances in technology will depend upon a firm understanding of mechanics and of its appropriate engineering applications. Students enrolled in *any* of the fields of engineering can elect advanced courses in applied mechanics and applied mathematics during their upperclass years. These courses are especially suited to students who have demonstrated superior analytical or experimental ability, and who wish to develop it.

For students desiring to continue graduate work in this discipline, some of the areas of specialization include space mechanics (including research on trajectories and orbits of space vehicles as well as the theory of light-weight, thin-walled structures), wave propagation in solids, structural mechanics, theory of elasticity and plasticity, and theoretical fluid mechanics.

A river model for studying hydro-power problems.



Employing critical path techniques in manufacturing operations

Aerospace Engineering

Space flight, mechanics of rockets and space vehicles, controls and communications systems for missiles—these are the newest problems confronting engineering physicists, mechanical engineers, and electrical engineers. Students with good records in these branches of engineering can obtain an unusually sound aerospace engineering education by building upon their basic programs, during the fourth and fifth years, specialized studies in the Graduate School of Aerospace Engineering.

Professional Masters' Degrees

research
ering

For students desiring to enhance their ability in the professional practice of engineering rather than in research and teaching, professional Master's degree programs are offered in chemical, civil, electrical, industrial, mechanical, and materials and metallurgical engineering.

These Master's degree programs consist of advanced course work, but no graduate thesis is required. They provide opportunity to prepare in considerable depth for work in one or more specialized areas.

Superior students often can complete their work toward the Master's degree with one additional term of study at Cornell provided they have undertaken course work, while enrolled as undergraduates, which meets some of the requirements for the degree. Professional degrees generally represent formal preparation at the five-and-one-half to six-year level of university work.

Combined Programs—

Business and Public Administration

City and Regional Planning

Law

The increasing demand for engineers as administrators in industry, business, and governmental affairs has led Cornell to institute programs which provide for this specific training and take advantage of the presence on the University campus of the Graduate School of Business and Public Administration, College of Architecture, and Law School. Qualified engineering students may apply for admission to special programs permitting completion of both a Bachelor's degree in engineering and a graduate or advanced degree in business or public administration, city and regional planning, or law in one year less than the normal period.

Ordinarily such a combined program, leading to two degrees, would constitute an eight-year course of study in the case of law and seven years in the case of business and public administration or city and regional planning. By choosing as electives courses acceptable to the other schools or colleges and by being permitted to count certain other courses as meeting requirements in both areas, students will be able to acquire the two degrees in the shortened period.

Arrangments for one or more such combined programs of study are possible for selected students in chemical, civil, electrical, industrial, mechanical, and materials and metallurgical engineering. Applications must be approved by both participating schools or colleges of the University.

Architecture and city plannin

Recreation for everybody . . . Skating at Beebe Lake

e in winter

Intramurals

Intercollegiate athletics

Sails on Cayuga Lake

Student Life

EXTRACURRICULAR ACTIVITIES

Perhaps the best way to describe the extracurricular opportunities on the campus is to say that there is literally something for anyone's interest among the great variety of organizations, clubs, publications, athletic programs, and hobbies. One may well ask, since engineering is so rigorous, whether there is really time to take advantage of all Cornell's extracurricular opportunities? Of all, no. Of some, yes. In some respects, this works to the advantage of the engineering student, for limiting himself enables him to direct his enthusiasm and energy with greater intensity and greater rewards.

Freshmen spend about fourteen hours a week in class and about twelve in laboratory—twenty-six hours in all spread over five-and-a-half days. Most freshmen find that they need two hours to prepare for each class hour, and perhaps a few hours a week for laboratory preparation. That adds up to between fifty and fifty-five hours a week for academic work alone. This pattern remains about the same during all five years: the level of courses rises at about the same rate as a student's ability to handle it.

This is not a 40-hour week by any means, and the load is heavier than that of a liberal arts student. The difference is less in real load, however, than in actual hours in class and in the minimum work required merely to "get by." The liberal arts student's class schedule is lighter so that he can do more reading; he can do it or skimp. But the engineer's load is built into his class schedule.

In general, an engineering freshman ought to allow himself one evening and one day a week (Saturday night and Sunday for instance) for recreation and entertainment. Unless he cannot avoid it, he ought to forego part-time employment during his first year, while he is getting accustomed to his course and college life. The way to the most expanded education, scholastic and extracurricular, is discipline—not discipline commanded by someone else, but discipline imposed by one's self so as to be able to begin, execute, and conclude a task well.

many campus organizations, including the Executive Committee of the Student Government, the student center in Willard Straight Hall, Cornell United Religious Work, the Freshman Class, the Navy ROTC Brigade, and Sphinx Head, the senior honor society. An engineer was editor-in-chief of the *Cornell Daily Sun*. Engineering students make up the second largest number of varsity athletes in the University; of the nine men of Cornell's 1957 crew which won the Grand Challenge Cup at Henley, England, seven were engineers. Engineers have always played leading parts in Cornell's many music organizations; in 1959-1960, for instance, an electrical engineer was president and twenty engineers were members of the University Concert Band.

rvices
Chapel

For freshmen, thoughtful planning, especially during the first weeks, is the key to entering athletics or an activity. Though they must restrict themselves during their first year, they ought to be able to take part in athletics or some one student organization without too much difficulty.

RELIGIOUS ACTIVITIES

Although Cornell has been a nonsectarian institution from its founding, it has a center for the coordination and sponsorship of religious activities. Anabel Taylor Hall, the headquarters for Cornell United Religious work, includes a staff of twelve University chaplains representing the major religious traditions, and a director and his associates. CURW's thirteen religious groups, as well as students who have no specific religious affiliation, meet for inquiry, study, worship, counsel, and fellowship. Anabell Taylor Hall has an interfaith chapel and is the center of the One World Club, a large group of American and foreign students. In addition, each Sunday distinguished visiting clergymen from throughout the world conduct interdenominational services in Sage Chapel. Ithaca churches welcome Cornellians to their congregations and offer programs of particular interest to them.

At the University golf course

Fencing in Teagle Hall

ATHLETIC ACTIVITIES

With the largest intercollegiate athletic program in the country, including twenty-two sports, anyone can go out for intercollegiate teams, and he doesn't have to be an expert. In fact in some sports, many students become varsity members after having played for the first time at Cornell.

As a member of the Ivy League, Cornell participates in its organized associations in football, hockey, soccer, basketball, wrestling, fencing, lacrosse, and squash, and is a member of the Eastern Intercollegiate associations in golf, swimming, 150-pound football, rowing, baseball, and the Heptagonal Games in track and cross country. Also on the intercollegiate program are polo, rifle, and sailing. Archery, cricket, rugby, and skiing are conducted on an informal basis.

But this is only a small part of the athletic program. Everybody always seem to be playing something—not only intramurals, in which leagues are going throughout the year, but innumerable pick-up games and matches. Students can get instruction in individual sports such as swimming, tennis, and squash, or in golf on Cornell's 18-hole course. One of Cornell's aims is to give students a chance to learn and take part in sports that can be carried on after college.

Cornell's forty-eight acres of playing fields are almost all on campus or within walking distance, with tennis courts in various locations. Teagle Hall has two swimming pools, a gymnasium, and rooms for wrestling, fencing, boxing, rowing, and exercises. Varsity and intramural basketball, wrestling, and indoor track, including the Ivy League's Heptagonal games, take place in Barton Hall, the huge armory, which also has a rifle and pistol range. Lynah Hall is for hockey and skating, and Grumman Hall has six squash courts. The Riding Hall is the scene of polo matches and instruction in horsemanship, and Bacon Cage allows indoor baseball and track practice, and instruction in golf. Off campus, Moakley House and Collyer Boat House serve golf and crew. Schoellkopf Field is the home of the Big Red football team.

This uncommonly well conceived and superbly equipped plant is given maximum usage. Over 2000 men come out for the intercollegiate teams each year, and about 4000 take part in the 78 intramural leagues, which play 2300 contests during the school year.

Basketl
Barton

Hockey in Lynah Hall Rink

Schoellkopf Field

LECTURES, CONCERTS, AND THE ARTS

Because of the setting of the College of Engineering in a large and educationally diverse university, students are able to enjoy a broad spectrum of lectures covering literally every topic of human interest and concern. Large audiences of students have followed with genuine interest a series of lectures by Kingsley Davis on sociological problems and by Philip Sporn on the philosophy of engineering, as well as co-ordinated series of events held annually, such as the Festival of Contemporary Arts.

With a Department of Music, symphony orchestras from both here and abroad, opera singers, and string quartets have enjoyed particularly enthusiastic audiences. In addition, several Cornell musical and dramatic groups sponsor programs in Bailey Hall, the University Theatre, Sage Chapel, or outdoors on the campus lawns. The University Theatre offers a broad range of films and student productions. Of particular interest this past year was the Shakespeare Celebration sponsored by the Theatre, which included films, musical presentations, and guest lecturers.

The Andrew Dickson White Museum of Art contains the University's collection of paintings, prints, and sculptures plus several areas devoted to special traveling exhibits. In addition the student center in Willard Straight Hall sponsors creative art exhibits, often the work of students, operates a music room, and has a collection of phonograph records which may be used by a student in his own residence.

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With Cornell's large population of foreign students, numbering almost a thousand, visits to the campus by foreign persons and groups are frequent and provide chances to enlarge international understanding. Many foreign student groups also conduct programs and exhibits representative of the cultures of their homelands.

elder statesman
young questions

The men's Glee Club in outdoor concert

SOCIETIES, CLUBS AND STUDENT ORGANIZATIONS

For the student interested in music, there is ample opportunity to join one of the numerous singing groups. The UNIVERSITY GLEE CLUB presents concerts on campus and on tour to such countries as Russia and England. Recently, they joined the Philadelphia Orchestra in a Beethoven concert. Every Sunday, the SAGE CHAPEL CHOIR sings at services conducted in the University chapel. The BIG RED BAND, one of the nation's renowned college bands, makes fifty appearances a year, and two CONCERT BANDS give symphonic concerts on campus—indoors during the winter months and outdoors during spring. Other musical clubs put on and sponsor musical comedies, jazz, Gilbert and Sullivan, and folk songs.

THE DEBATE ASSOCIATION, a member of the Ivy League Debate Conference, engages in nearly one hundred intercollegiate debates annually, highlighted by a debate with a British university. Each year the CORNELL DRAMATIC CLUB presents in the University Theatre six major productions of traditional, modern, and original plays, offering chances to those who want to try their hand at acting, staging, lighting, costuming, and directing.

A strong voice in University affairs is THE CORNELL DAILY SUN, a full-scale daily newspaper freely operated by students. It carries world, national, and University news. Students also publish a yearbook, THE CORNELLIAN, and literary and humor magazines. Of particular interest to the engineer who wants experience on a student publication is THE CORNELL ENGINEER, one of the finest undergraduate engineering monthlies in the country. Not only does *The Engineer* provide opportunities for editing, business management, and technical writing on the most advanced subjects, but its valuable discussions on engineering programs have kept students and faculty alert to new developments and needs in engineering education.

There are international and political clubs, service clubs, professional and departmental societies, and clubs devoted to almost anyone's hobby. Student announcers and technicians of the CORNELL

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in Archi-

owsing library
Straight Hall

RADIO GUILD staff and operate the campus station, WVBR. Radio hams of the CORNELL AMATEUR RADIO CLUB have a well-equipped radio shack and workshop, own an amateur radio station, and operate a public address system. Cayuga Lake provides excellent sailing for the fleet of the CORNELL CORINTHIAN YACHT CLUB. The PHOTO CLUB has full darkroom facilities. The OUTING CLUB not only takes advantage of Cornell's surroundings for hiking, skating, and skiing, but plans mountain climbing trips to the Adirondacks, the Green Mountains, and even Canada. Other clubs bring together those interested in skiing, polo, rifle and pistol, chess, cricket, folk dancing, and many other activities.

A large number of these clubs and organizations are centered in Willard Straight Hall. "The Straight" includes several dining rooms and cafeterias, the University Theatre, an arts and crafts workshop, game rooms, and a browsing library. Included in its facilities are guest rooms for visiting parents and friends.

MILITARY TRAINING

The ROTC programs (Army, Navy, and Air Force) offer a college student the opportunity to fulfill his military commitment as a commissioned officer. To obtain a commission in one of the services, a student must complete the basic and advanced course in one of the ROTC programs and meet certain mental and physical requirements. Upon graduation he receives a commission and, commencing within one year after graduation, serves an active duty tour of from six months to five years. Length of active service varies within each service and category.

Participation in any of the ROTC programs at Cornell is *voluntary*. While the decision is obviously a personal matter, students are encouraged to consult with their advisers and counselors or with the military personnel on campus.

RECREATION

Cornell is situated in one of the major outdoor recreational centers of the East. For the outdoor enthusiast, there are three outstanding state parks all within a ten-minute drive from the campus, which offer swimming, picnicking, hiking, and recreational sports. Taughannock Falls State Park, on Cayuga Lake, includes a 215-foot waterfall, the highest east of the Rockies. Cayuga Lake itself provides excellent boating conditions, and the University boat house is located conveniently on an inlet feeding into the lake.

In the spring, Beebe Lake offers an opportunity for canoeing or swimming right on campus and in winter for outdoor skating. For the increasing number of ski enthusiasts among the student body, Greek Peak, approximately fifteen miles from the campus, offers fine skiing for beginners or experts. Cornell's gorges and streams never cease to be fascinating. For those who prefer just relaxing, the Library Slope has grass, shade, a magnificent view of Cayuga Lake, and outdoor band concerts. There are movies downtown and on campus, concerts, and all kinds of intercollegiate athletic events. Astronomy enthusiasts can visit Fuertes Observatory and bird lovers, the famous Sapsucker Woods.

There are always things going on, planned and spontaneous, for visitors and students, for large groups and small. There is never a lack of ideas or a dull moment at Cornell!

Willard S

Upson Hall . . . for instruction in mechanic
engineering and in industrial engineering an
administration

reparation of material samples

At work in the photogrammetry laboratory

of the largest
telescope, the
nospheric Lab-
Puerto Rico

Cornell's Engineering Programs

Cornell offers undergraduate degrees in the following engineering fields:

- Agricultural Engineering (a jointly sponsored program with the College of Agriculture)
- Chemical Engineering
- Civil Engineering
- Electrical Engineering
- Engineering Physics
- Industrial Engineering and Administration
- Mechanical Engineering
- Materials and Metallurgy

Within the five-year programs are special opportunities during the fourth and fifth years to begin preparing for graduate work; to combine study and work experience in the Industrial Cooperative Program; to undertake special options in aerospace or nuclear engineering; to gain fuller preparation in one or more specialized fields in the professional Master's degree program; or to gain a year by beginning work on an advanced degree in business and public administration, city and regional planning, or law (these programs are described on page 13).

Responsibility for taking full advantage of this educational diversity offered by the engineering curricula at Cornell lies with the student. To be sure, professional advice and counsel by faculty advisers is always available providing the student seeks it. Perhaps this notion is best advanced by the remarks offered by a recent graduate: "As I look back over my five years as an engineering undergraduate and renew the personal associations that appear so clearly in my memory, I am led irretrievably to the fact that an education is determined by the individual and not by the curriculum. It is only when the individual abdicates his fundamental responsibility for choosing, and then constantly modifying his educational goals that the curriculum determines the scope of his learning."

BASIC STUDIES: THE FIRST

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ulus

All students who enroll as freshmen in Cornell's College of Engineering enter the Division of Basic Studies. During the first two years studies in mathematics, physics, chemistry, and English, and work in the engineering sciences are undertaken. In addition, a sequence of courses in engineering problems and methods is included. Basic skills needed for engineering work and the development and application of methods of thinking which lead to engineering judgments are introduced in this latter sequence. Students investigate through active participation what the problems of the engineering profession are and how to approach them. They not only learn fundamentals but have a chance to form intelligent judgments about the kind of engineering work they wish to pursue.

While no student is obliged to state a preference for a particular field of engineering until after he has spent a year in the College, anyone who enters with a preference will be assigned an adviser in the engineering field of his interest.

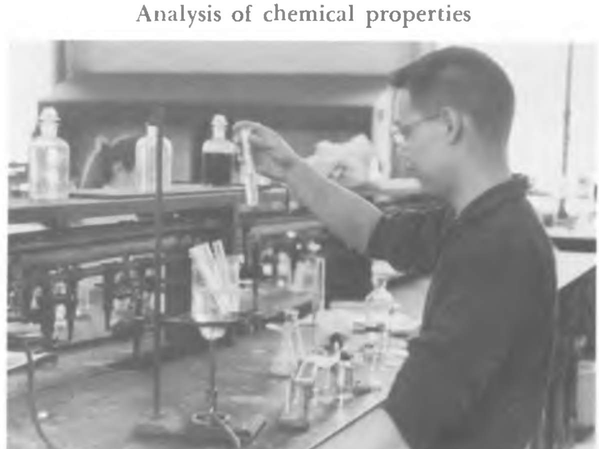
The program of the Division of Basic Studies is outlined below. For students seeking detailed descriptions of course contents or the programs of the upperclass years in the various engineering fields, the catalog *Announcement of Engineering Courses and Curricula* should be consulted.

FRESHMAN YEAR

First Term	Second Term
Calculus for Engineers	Calculus for Engineers
Analytical Physics	Analytical Physics
Chemistry	Chemistry
English	English
Engineering Problems and Methods	Engineering Problems and Methods

uring physical elongation

Analysis of chemical properties



TWO YEARS IN ENGINEERING

SOPHOMORE YEAR*

Third Term	Fourth Term
Engineering Mathematics	Engineering Mathematics
Analytical Physics	Analytical Physics
Electrical Science	Electrical Science
Mechanics of Rigid and Deformable Bodies	Mechanics of Rigid and Deformable Bodies
Liberal Elective	Introduction to Physical Chemistry

Mathema
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After having successfully completed the requirements of the Division of Basic Studies, and the sophomore course or courses required by the field of his choice, the student will be admitted to that professional field ordinarily at the end of the sophomore year. Agricultural engineering students enroll in the College of Agriculture for their first four years.

Work in the basic engineering laboratories begins in the second year and increases throughout the third and fourth. After developing a working knowledge of the systems of their chosen fields in the third and fourth years, students have the opportunity to become acquainted with the newest of systems and devices, especially if they choose to do independent work in a senior project.

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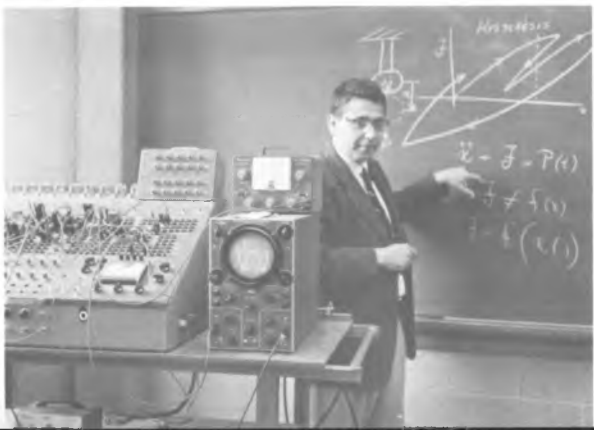
* Students planning to enroll in programs in civil engineering or engineering physics have the option of taking a liberal elective in place of the second term of electrical science. Chemical engineering designates elect a full full-year course sequence in physical chemistry and undertake two professional courses (Material and Energy Balances, and Equilibria and Staged Operations). They complete the mechanics sequence in their third year.

Chalk and instruments in the classroom



Advanced projects are based on fres

GRADUATE SCHOOL OF AEROSPACE ENGINEERING

The "aerospace" industry—the aeronautical industry in its new setting, "the space age"—has been given the *systems* responsibility for such exploratory projects as satellites, space probes, and putting man into space. *"Systems* responsibility" means the entire planning and design, beginning with the basic question "How is the mission to be accomplished?" Then it has to be decided: What component parts and subsystems are required? What shall be the size and weight? The trajectory? What power plant and guidance system will do the job?

These are questions to which there are no stereotyped answers: The aerospace industry may not be unique in its emphasis on new advances, but few others require such continuing concern with research and development. Engineers, physicists, and applied mathematicians are in tremendous demand. Men with mechanical engineering backgrounds are at work on power plants, electrical engineers on guidance systems, and engineers with strong backgrounds in physics and mathematics on problems of gasdynamics, behavior of materials, and the temperature barrier. It is hard to discern any retrenchment or leveling off.

It is the Graduate School of Aerospace Engineering's job to educate for this exciting, research-conscious industry. To do this job means, first of all, *not* to mass-produce the traditional four-year aero engineer, a fellow who knows something about airplane performance, stability, and structural loads; today the airplane itself is part of a "system" that includes power plant, armament, guidance, ground support, etc. Rather, the Graduate School of Aerospace Engineering attracts the best of that category from several colleges which mass-produce them, and some of the best electrical and mechanical engineers, plus some applied physicists (like Cornell's engineering physicists) and applied mathematics majors, and prepares them for the aerospace industry as follows:

1. They need more mathematics and physics, so these are picked up where their undergraduate programs left off.

2. Stress is put on such aerospace disciplines are aerodynamics, dynamics of flying vehicles, and propulsion, particularly as they apply to "astronautics," or space flight.

3. All get a research experience as members of a School vigorously engaged in engineering research. The School is investigating principles which apply to new kinds of propulsion systems for space rockets, changes in the composition of air over bodies travelling at space vehicle velocities, and drag on satellites with long flight periods. Studies of "magneto-fluid dynamics" concern flows of electrically conducting fluids, such as ionized air, in the presence of electromagnetic fields.

Of these the third is most important.

The aerospace engineering faculty is absolutely convinced of the value to society of a system of higher education which places students in a research environment and exposes them to teaching by men engaged in research. It is not only the *only* system that can teach research, but also the best system to educate engineers for this fast-moving, research-oriented second half of the twentieth century.

The Graduate School of Aerospace Engineering does not try to do several other educational jobs simultaneously, but only to carry out this particular responsibility well. The whole group is small and intimate. Students all know one another and discuss their problems together. Research students get almost unlimited personal attention from their professors. Office doors are open. Everyone reports on his research in seminars and colloquia, and when the whole group comes together for such a purpose it is small enough to permit informal discussion and questions.

Though the School's main concern is its graduate program, it offers excellent opportunities for mechanical engineers, electrical engineers, and engineering physics students in Cornell's five-year undergraduate program. They can elect basic aerospace training in their upperclass years, and take full advantage of the School's laboratories and professors for independent senior projects. Good students can get their Masters' degrees (M.Aero.E.) in one year of graduate study instead of the two usually required.

AGRICULTURAL ENGINEERING

Agricultural engineering entails some facets of all other engineering fields. For instance, specialists in engineering mechanics and materials study properties of construction materials and their performance under stress. The agricultural engineer must study these too, but he must also understand the properties of various seeds, fruits, and vegetables to prevent damage in handling and storage. The mechanical engineer solves vibration problems of springs and masses analytically or by analog. Vibrating cherries from a tree or grapes from a vine is a very complicated spring-mass problem which defies complete analytical or analogy solution, for nature doesn't make all vines the same or each cherry or grape with the same mass. Livestock, because it produces varying amounts of heat and may be moving about, yields a truly unsteady state condition; this poses special problems in the design of structures. No other engineer is so affected by nature with so little opportunity to control it or adapt it.

The major areas of agricultural engineering are farm power and machinery, crop processing and rural electrification, soil and water engineering, and farm structures. Engineering principles are continually being applied to agriculture in new ways. These offer intriguing and exciting challenges. Atomic energy, and solar batteries and fuel cells, are being studied as possible sources of power on the farm. Radioactive substances are used to trace the flow of nutrients in plants, wear of engine parts, the amount of moisture in the soil, and densities of materials. Electronically controlled mechanisms are being studied for uniform loading of such machines are forage harvesters and combined harvester threshers, and are being used for automation of livestock feeding. New materials are being adopted in farm structures. Cornell's agricultural engineering faculty is pursuing research on such problems as these.

Opportunties are almost unlimited. As the world population grows, land resources and farm population shrink. Fewer men with more equipment and larger land holdings have to produce more food on a smaller total land area. If our standard of living is to be maintained, more qualified men will be required to help farmers attain maximum production and higher efficiency while improving the quality of their products.

Cornell's five-year program prepares a student to work equally well in any field of agricultural engineering. Because he enters technological courses after thorough grounding in basic principles, he can look more deeply into a problem, define its limits, and proceed to a logical solution much as he would do on the job.

Cornell's curriculum includes five basic fields of learning:

1. Basic science: mathematics, chemistry, physics, biology, bacteriology.

2. Engineering science: mechanics, properties of materials, thermodynamics, heat transfer, electrical theory.

3. Engineering application: structural design, hydraulics, surveying, power units, machinery design, water control and management.

4. Agriculture: soils, field crops, livestock feeding, farm management.

5. General studies: English, social and humanistic study, public speaking, free electives.

In the fifth year students have, through technical electives, an opportunity to pursue a chosen specialty in the agricultural engineering field through directed design and analysis studies.

Students register in the College of Agriculture during the *first four years,* and in the fifth in the College of Engineering, which grants the degree. During all five years students are advised by the agricultural engineering faculty. Since no adviser has more than twenty advisees, close relationships are developed and maintained.

Their broad training allows Cornell graduates unusual freedom of choice. They are found in all phases of agricultural engineering, from design of rubber tires and farm machinery, to teaching and research, to processing and packaging fruit and vegetables. They find employment in manufacturing, marketing, public utilities, consulting firms, government agencies, and many other forms of business.

CHEMICAL ENGINEERING

Recently the chemical engineer has been deeply involved in the development of new plastics, synthetic fibers, high-energy fuels, paints, rubbers, and the reduction and use of waste materials. Jet, rocket, and atomic reactor fuels have imposed new and difficult problems still not completely solved. Disposal of atomic wastes is also an ever increasing problem. Shortage of good water, predicted to be very severe in the near future, must be relieved by large, economical installations conceived by the chemical engineer. The world's rapidly increasing population will require more processed foods, and the problem of pollution of air and water around large population centers is rapidly becoming more urgent.

Chemical engineering is chiefly concerned with the process industries. In these industries raw materials are treated to effect a change of state or of energy content, or a chemical conversion, to make useful products. The chemical engineer traditionally supplies engineers in other fields with new and structures. The electrical engineer relies on rubber and plastics for insulation, without which most electrical equipment could not exist. Such metals as titanium,

and ideas tested in the laboratories . . .

porator project

zirconium, and tantalum, produced by chem ical processes, give promise of major change in structures and machines. Fuels for rock ets and space vehicles are also products o chemical plants, as are the fuels which sup ply atomic reactors.

Among present chemical engineering re search projects at Cornell are the reclaiming of sea water by a freezing process, and im provement of the efficiency of pulsec columns in transferring a solute from one liquid phase to another for purification and recovery. Investigations of continuous fer mentation, agitation, and aeration are being carried out in the biochemical engineering laboratory. Several projects on insulating compounds, fillers, and reinforcing agents are under way in the Geer Laboratory for Rubber and Plastics.

Cornell inaugurated a five-year curriculum

Discussion of chemical engineering plant design project

n Chemical Engineering in 1932. Long experience has proved that this course permits nore thorough coverage in both chemistry nd chemical engineering, and offers opporunities to those students who wish more nontechnical education. It also provides nough electives so that students may start n a particular specialty if they so desire. Project courses in research and design, given n the fifth year, require application of much of the subject matter of previous work. They re specifically designed to develop initiative nd self-reliance.

Chemical engineering has always been closely associated with chemistry, and undergraduates take the same courses as chemistry majors. If they elect an advanced chemistry course in the fourth or fifth year, they complete the minimum chemistry requirements for a chemistry major, making it possible to go on to graduate work in pure chemistry. For research chemists working in industry, this is frequently an ideal combination, since they are trained in the economical and applied aspects of the science, as well as the theoretical.

Courses are offered in the design and operation of processing plants, and in associated problems of economic evaluation and new product development. Students learn about the varied dimensions of chemical engineering, including petroleum refining, polymeric materials, nuclear engineering, properties of materials, and food processing. Sequences of advanced courses can be elected in biochemical engineering, plastics, rubbers, reaction kinetics, and process instrumentation and automation. There are not only the large unit operations laboratory and 25 small project rooms, but several of these fields have their own specialized laboratories.

Qualified students who seek careers in research or teaching may be admitted to a predoctoral honors programs. They prepare for doctoral studies by taking advanced theoretical subjects and engaging in original research projects.

Graduates find employment in research, development, operation, design, and administration of processes and process plants. They are frequently required to make economic evaluations of both existing and proposed processes and developments. This type of work quickly develops administrative skills. As a result, a large proportion of Cornell graduates end up in managerial positions at a relatively early age.

Civil engineering is a profession that has many facets. It is part science and part art, and deals with those material needs that are basic to community living, industry, and commerce. Water resources, rivers, harbors, irrigation, and drainage; water supplies, waste disposal, and pollution; transportation by land, water, and air; large fixed structures—bridges, dams, tunnels, buildings, and even structures for aircraft, space vehicles, radio telescopes, and nuclear power plants—and the orderly integration and operation of public works and utilities that are so vital to our burgeoning urban complexes—all include elements of civil engineering. Most of the world is still underdeveloped, and a large part of its present physical plant is inadequate and outdated. Construction, already our largest single industry, must expand still further to meet the demands of the awakening masses for better standards of living. It is a restless ever-changing world whose population may double in the next fifty years. Today, not enough civil engineers are being trained to cope with these demands.

A student conducting a triaxial soil test

Men are required who have the vision to foresee these needs and who have the imagination and the technical competence to devise means and ways to satisfy them in ample time, and with due regard to the social, political, economic, legal, and aesthetic aspects that are involved. The profession demands men who are expert in one or more subfields. It also requires expert generalists who can coordinate the work of other engineers and non-engineers into team efforts. No two civil engineering projects are alike. Each must be tailored to suit a particular site and set of conditions, and each involves men of many different occupations. To perform these duties civil engineers must be well grounded in mathematics, science, and engineering technology, and they should have a good general education. Their work varies from research and development to broad planning, technical design, construction, operation, maintenance, applications and sales, analysis and testing, and administration and management. They must be familiar with the scientific tools developed by men in other disciplines so they can use them in solving their problems. Since the necessary tools are not always available, they must often conduct their own research and develop their own basic techniques.

Investigation of the behavior of liquids in jet streams

The five-year curriculum is designed to equip students to meet those challenges. After a student has completed the two-year common program he takes courses in each of the major subfields of civil engineering—surveying, hydraulics, sanitary engineering, soils, transportation, structures, and construction and administration. This will help him determine his interests and aptitudes and enable him to handle elementary problems in each subfield. He may then devote from sixteen to twenty-five credit hours to programs of professional selections, either concentrating in one subfield or taking further work in all areas. He may include work in other parts of the University such as geology, business and public administration, and city and regional planning. A limited number of students may enter the Graduate School at the end of the fourth year to begin graduate studies which will enable them to earn their graduate degrees in a shorter period of time.

Instruction is vitalized by the School's continuous research programs. Projects at the present time include research in:

Photogrammetry

Interpretation of terrestrial conditions from aerial photographs

Strengths of soils

Pile foundation phenomena

Frost action in soils

Movement of groundwater and compaction of soil by electro-osmosis

The flow of liquids and slurries in pipes and open channels

The use of systems analysis in water resource studies and sanitary engineering

The design and behavior of bituminous concretes

Traffic analysis

New structural forms and materials which combine high strength and light weight

Thin-shell structures

The strength of structural connections

The fundamental concepts of fracture in reinforced concrete.

Apparatus for the biochemical analysis of waste water

Civil engineers have a wide choice of employment both at home and abroad. Some conduct their own consulting and construction businesses. Others work for engineering firms, contractors, industries, and utilities. Many serve important functions in federal, state, and local governments and in the military service while some go into teaching and other branches of the profession. Variety and the opportunity to achieve those inner satisfactions that stem from solving challenging problems and creating things that benefit others are offered to civil engineering graduates.

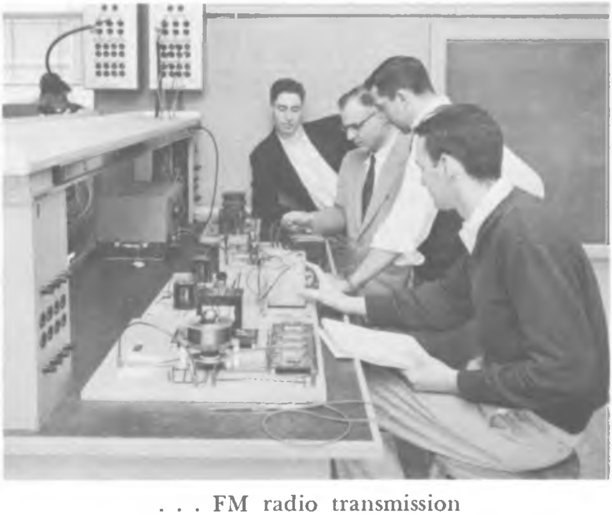
The electrical engineer makes use of a background in both electrical science and creative design to discover, build, and promote a broad spectrum of electrical devices and systems. Research in electrical engineering runs a gamut of activity from the exploitation of properties of materials for new devices to the synthesis of complex systems using the devices. The electrical engineer in research must be able to apply basic laws of physics and mathematics in working out principles governing both design and behavior of new devices and systems. In development, he must know and be able to apply these principles to produce working models, and he must have the capacity to visualize practical solutions and to exercise good engineering judgment. In other activities, electrical engineers are concerned with production, sales, and management. This work also requires an understanding of basic principles in both science and design.

Cornell's undergraduate curriculum in electrical engineering is sufficiently flexible that a student can tailor his own program to emphasize any of the types of activity described. This can be done by the proper choice of electives which build upon a core of required courses in the fundamentals of engineering, physics, and mathematics. A student may choose courses dealing with systems theory, computers and servo control theory, radio and television systems, microwaves, vacuum tubes, transistors, lasers and masers, power systems and machinery, transmission networks, high voltage phenomena, electromagnetic propagation, radio astronomy, illumination, and plasma physics.

The facilities of the School of Electrical Engineering are extensive and include laboratories in quantum electronics, physical electronics, electric energy research, plasmas, microwaves, computers, communications and antennas. In addition, there is a senior project laboratory in which students can construct and test electronic apparatus of their own design. Many of the facilities are used by undergraduates as well as by graduate students and professors for research, which promotes an ideal interaction among undergraduates and graduates.

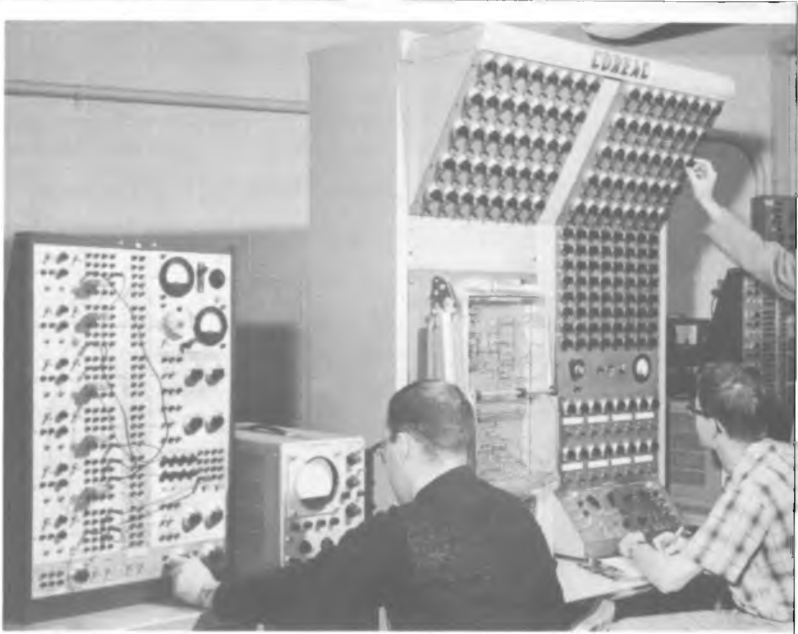
Electrical engineering is in the forefront of some of the most exciting developments in modern science and technology. Members of the faculty, for instance, have proposed and supervised the construction of the world's largest radar, whose powerful feed

. . . a senior project
in transistors



. . . FM radio transmission

EE students learn from computers designed by students and faculty



antenna and 1000-foot dish are capable of sending signals and obtaining echoes from as far away as the planet Jupiter. The Center for Radiophysics and Space Research is using it, along with other facilities in Ithaca, to expand its study of the upper atmosphere and its exploration of space by radio astronomy and radar.

Some of the most productive research is in the field of electronics. Work in microwave tubes is aimed at improving efficiency and band width in these devices. Studies involving gaseous and solid-state lasers are concerned with basic quantum-electronic phenomena. Research on microwave plasmas relates to new means for amplifying and processing microwave signals as well as to the discovery of fundamental phenomena. A recent achievement of the electronics research has been the production of extremely high electron emission currents from surfaces heated by radiation from high power lasers.

The School of Electrical Engineering at Cornell was among the first to recognize a need for education and research in systems theory. This discipline includes network, information, communication, and control and computer theories. The research in this area includes the study of linear time-varying systems, self-optimizing detection schemes, and electronically controlled communications systems. These research programs are all based upon the design of signals and networks to meet desired performance criteria. Many of these studies include the use of the digital computer for system simulation and evaluation.

This research has resulted in a significant contribution involving a new description of linear time-varying systems. Among other achievements resulting from this research was the design of an electronically tunable, wide-band oscillator and several schemes for pulse expansion and compression. These schemes are important in radar and jam-proof communication systems.

The Electric Energy Research Program is being conducted with the facilities of an extensive new laboratory equipped to handle the large power requirements of experimental plasma and arc physics. Theoretical work in plasma physics is being actively pursued to study the instabilities associated with very high temperature plasma. Other research is being conducted in semi-conductors and in underground cables.

At Cornell, emphasis is placed on properly combining the essential ingredients of modern electrical engineering—electrical science and creative design. The student is limited only by his own desire and curiosity in exploring the many opportunities which are available to him.

A thick-walled bathyscaph exploring the ocean depths, a nuclear container protecting man from danger, a thin-walled flying pressure vessel (a rocket) on a distant space adventure—all these are designed by using the same principles. Engineers realize such achievements by a process of conception, analysis, experiment, and development. Applying fundamental principles in each part of this process, they reach out in new directions to strange and unknown environments. The art and applications may vary from industry to industry, and the different branches of engineering often appear distinct. But the principles are the same, and therefore engineering education is focusing on the common aspects underlying the entire engineering profession.

Every engineer must acquire proficiency in both applied mechanics and applied mathematics. Cornell's Department of Mechanics is responsible for undergraduate instruction in these two sciences and is engaged in vigorous graduate and research programs. Professors with varied scientific and engineering backgrounds exchange ideas and plan educational programs. They are studying the mathematical principles of the perceptron, a machine which can memorize symbols and patterns and then identify them. Professors and graduate students are investigating the dynamic loading of machine parts, and the behavior of materials and physical laws under pressures thousands of times that of the atmosphere. Analysis of elastic wave propagation is being applied to studies of movements within the earth. Also being studied are the fundamental mechar isms of cracking in concrete, the trajectorie and orbits of space vehicles and satellitie: and the static and dynamic behavior of thir walled structures in unknown environment:

In their first years all engineering undei graduates take applied mathematics and ap plied mechanics. Here they learn the funda mentals which underlie later courses in struc tures, machine design, engineering analysi: fluid flow, and materials. Applied mathe matics introduces new methods of analysi: emphasizing the derivation of mathematica expressions for engineering problems. Ap plied mechanics involves the theory of stat ics, strength of materials, and dynamics.

During their fourth and fifth years stu dents who wish to pursue such topics mor deeply can elect advanced courses in vibra tion theory, crystal mechanics, or theoretica and experimental stress analysis. Or, the can study numerical methods in engineerin analysis, orbit theory, and other subject which bear on many of the unsolved prob lems at the horizon of technology. Student are encouraged to do their fifth-year proj ects under the direction of staff member who can guide them in experimental anc analytical investigations. Elective course se quences, coupled with a project, make possi ble an effective start toward graduate work

Because of excellent laboratory facilities studies can range from the microscopic tc the full-size static and dynamic testing o: structures under actual operating conditions Undergraduates use their laboratory experi ence in course work and in their projects.

Observing shock waves in a ballistics system

pplied mechanics and mathematics have before them a wide choice of job opportunities. Persons deeply rooted in fundamentals, who have analytical skill, are in continuous and great demand. They are sought by long-established industries and by newer industries whose existence depends on research and development. Students frequently pursue graduate work, which leads to research and development careers in industry or universities, or to careers in technical management.

Vibration patterns in materials

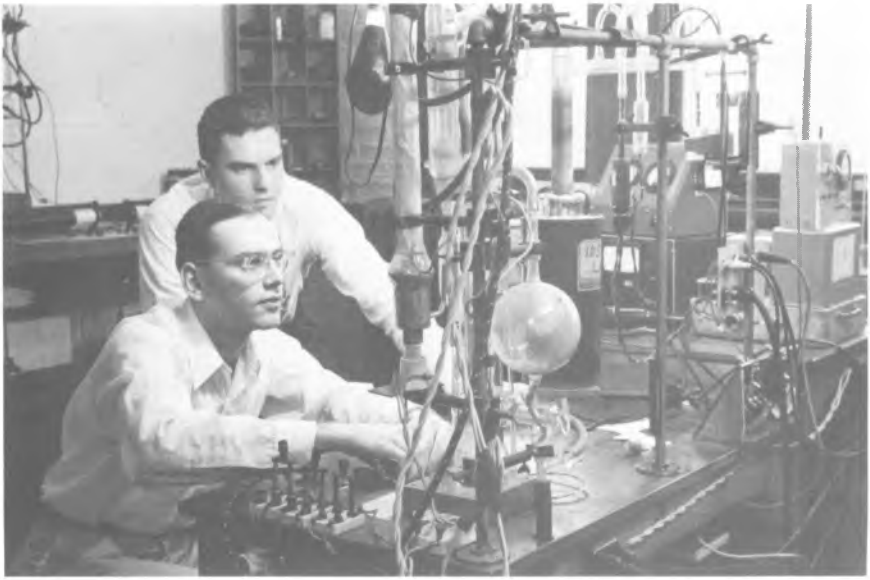
ENGINEERING PHYSICS

The advances in most engineering fields are going to come primarily from people trained very well in basic physics and mathematics, who also have considerable experience in applying the principles of these sciences to engineering technologies. What, technically, the next quarter of a century will bring, is beyond imagination. But the man solidly and broadly trained will be in a position to meet, use, and understand the new and unexpected, and, in fact, to precipitate it.

Cornell's curriculum in engineering physics provides the type of education and training which effectively bridges the gap between basic sciences and conventional engineering practice. The growth of research programs in industry, government, and educational institutions has created a still growing need for persons with such training. Cornell's program puts major emphasis on mathematics and physics. It develops understanding of the properties of materials, all the way from their constituent atoms and molecules to their bulk physical, electrical, and chemical properties. A faculty made up of members from several science departments of the College of Arts and Sciences, as well as from several of the engineering divisions, manifests the Department's emphasis on new directions which cut across traditional lines. This training enables engineering physicists to solve new types of fundamental engineering problems which may be the basis for major technological advances with far-reaching consequences.

For training in engineering research, a fifth year student carries out a research-like

. . . calibrating vacuum gages



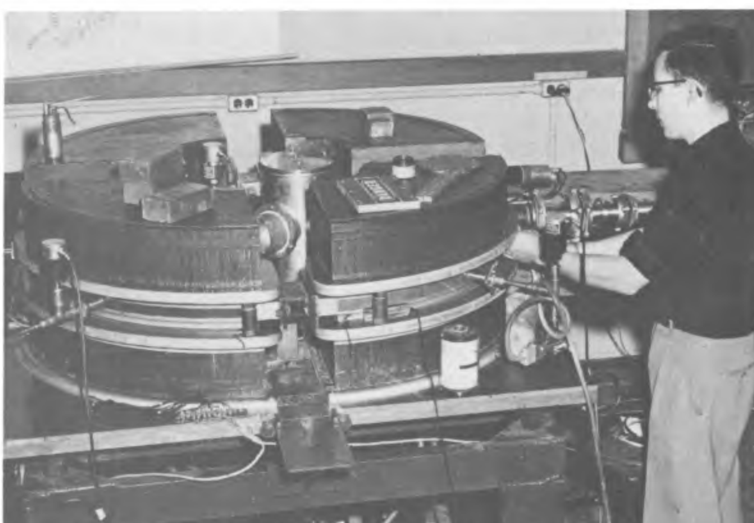
project in his chosen field under the direction of a faculty member who is an authority in it. These projects often work into new fields in which Cornell is especially strong. Sequences of advanced courses establish a substantial background for them. The program in nuclear technology, for instance, provides a sequence in reactor physics, nuclear measurements, thermonuclear power principles, advanced heat transfer, and the physics of solids underlying radiation damage. Out of such a program can come projects in atomic and nuclear physics, reactor technology, or nuclear instrumentation. The new reactor facility enhances opportunities in such studies.

Other such programs are those in materials science, space science and technology, and aerospace engineering. Cornell's interdisciplinary Materials Science Center concentrates studies in a field which can hold the key to further technological progress in any branch of engineering. Course sequences can prepare for projects in electron optics and electron microscopy, surface structure and reactions, defects in crystals, and other aspects of solid state physics. Several faculty members have strong research interests in space science and technology, and are available to supervise senior projects in gasdynamics, radio wave propagation, astronom relativity, and related subjects. Advance courses in aerospace engineering can lead t projects connected with various aspects c space flight.

The exceptional flexibility of the eng neering physics program is a result of th large number of elective hours, particularl in the fourth and fifth years. Its effectivene is demonstrated by the wide range of pro ects chosen by students, and by the succe of alumni in a variety of research and d velopment activities.

Students in engineering physics are we comed in the fully equipped laboratories i electron microscopy, solid state and surfac physics, and nuclear technology. In the project studies students also have access t other engineering laboratories. They can a so use laboratories in the University's va ious science departments.

Undergraduate projects often work i closely with research being done by facult members and graduate students. There ar opportunities for summer work on researc projects of this kind both at Cornell, an with industrial and governmental organiz tions. These stimulate students and play a important role in their training.



Research in the Laboratory of Nuclear Studies

NDUSTRIAL ENGINEERING AND ADMINISTRATION

Industrial engineering, defined in part as . . . the design, improvement, or installtion of integrated systems of men, maerials, and equipment . . ." has had a lace in engineering at Cornell since 1904 s a part of the School of Mechanical Engieering. In 1962, however, it was given lentification as a discipline distinct from he other branches of engineering. Because f rapid developments in mathematics, specially in probability, statistics, and the omputer sciences in the period following Vorld War II, and because of the many evelopments which emerged from research fforts during the war, industrial engineerng that had been largely qualitative and mpirical has given way to "new" industrial ngineering founded on quantitative bases vith more sophisticated methods of analysis nd design.

The curriculum that has been developed o train industrial engineers has its principal oundation in mathematical and statistical ciences. In addition, because of the comlexities of systems encountered, the comutational, data collection, and processing roblems are such that sound training in omputer sciences and technology is also ssential. From this framework, engineering nalysis and design courses are developed to rovide insight into the application and uses of these techniques to systems problems. Courses dealing with operating problems and the decision process are also developed. Concurrently, through elective courses the relevant social sciences can be studied in the College of Arts and Sciences.

A system of interest to industrial engineers can perhaps be distinguished from one of interest to other engineers by three characteristics: (1) the emphasis and importance of men in the system; (2) the looseness of coupling between components of the system and the great variance of response; (3) the action in the system tends to be discrete, rather than continuous.

Consider queuing systems which have in common the characteristic that there is a facility providing a service to a sequence of arriving customers. Such customers compete for the service of the facility, and the balance between capacity and demand typically is such that interference situations or delays in providing the desired service are frequent. Some examples of queuing systems include airport and airplanes, maintenance man and production machines, telephone system and subscribers, toll booths on expressway and traffic, supermarket checkout counter and customers, and machines and jobs in a manufacturing shop.

At the Computing Center

The performance of a queuing system may be studied abstractly, without direct consideration of the actual objects which act as customers and as service facilities. Results obtained from such a study—the knowledge of how the system behaves analytically—are then applied by the industrial engineer in the design of an appropriate service facility, or in the specification of an operating discipline for a facility already in existence.

Inventory systems are also of interest to industrial engineers. In such cases a "commodity" is stocked in anticipation of a demand whose magnitude is not completely known at the time the stocking decision must be made. Seats on an airplane, processing capacity of a manufacturing plant, and the life of a machine tool can each be considered a form of inventory. Costs of securing and holding inventories and in the level of customer service provided are performance parameters which are used in creating models for ultimate inventory system design.

Optimization is implied in any industrial engineering model analysis and there is now some theoretical basis for many major design decisions. Today industrial engineers are often found working in positions with other than industrial engineering designations—for example, operations research, managemen science, systems analysis, and operation analysis. They are employed in transporta tion, distribution, military logistics, weapon systems analysis, finance, public health, and the service industries, and as frequently in the process industries as with the mechan ical manufacturing industries.

Many engineers have as an ultimate goa the desire for managerial responsibilities and positions. The types of training offered in industrial engineering provide an ideal ap proach for individuals with this objective not only because of the basic engineering that is included, but also because the mod ern trends in management science and deci sion-making methodology are inherent in this modern industrial engineering program.

MATERIALS AND METALLURGY

Metallurgical engineers may before long be referred to not by their customary title, but by the title "materials engineers." In this era of nose cones, rocket motors, and nuclear reactors, familiar metals are not always adequate. For applications where metals used to be taken for granted as the only feasible material, ceramics, polymers, and other non-metals are coming more and more into use. Experimenting to discover and develop new materials, metallic and non-metallic, has become one of today's most urgent engineering problems.

Cornell's Materials Science Center, recently established, is an example of this trend. It provides advanced modern facilities for materials research and brings together solid-state physicists, chemists, and engineering scientists in the field of metallurgy and materials to enhance research and graduate training. The effects of the Center are being felt in undergraduate programs not only in fifth year projects, but in the interaction between laboratory teaching equipment and experiments, and the Center's facilities. During the summer of 1963, materials and metallurgy moved into Bard Hall, an entirely new and fully equipped building. There will be strong ties with the Materials Science Center. Already, materials and metallurgy students may receive training in materials science and technology in their upperclass years by electing courses in advanced physical chemistry, electronic structure, ceramics, alloy steels, high-temperature materials, nuclear materials, foundry engineering, polymeric materials, and advanced microscopy.

Learning the operation of a vacuum furnace

The strong emphasis on both physics and hemistry throughout the curriculum itself niquely qualifies the student in the rapidly xpanding materials science field, since the nderlying principles essential to understanding metals serve equally well for an nderstanding of materials generally. As a esult, graduates are in demand in connecion with developments of many new types f materials. An outstanding example has een the contribution to the development of emi-conducting materials of great interest or electrical and thermoelectrical devices.

After laying a firm foundation in basic nd engineering sciences, materials and netallurgy students develop both a theoetical and a practical understanding of all spects of this field. Their training is both road and deep. Physical metallurgy, the ranch most closely related to materials scince, is based upon the physics of internal tructure as it affects metallic properties. There is instruction in mechanical metallurgy; here principles of physics and engineering mechanics are applied to processing nd shaping metals to obtain useful products, and students learn of the behavior of the materials under stress in airborne devices, in chemical process plants, and in machine parts. Students also learn the principles underlying the preparation of materials.

Since metals play an important part in almost every kind of engineering activity, graduates have an unexcelled diversity of opportunities for employment. They may find positions in the basic metallurgical industries, advanced engineering and research, or technical sales. Industries which fabricate and consume metals, such as the automobile, aircraft, chemical, and electronics industries, are dependent on metallurgical engineers for proper selection and utilization of metals.

Opportunities are also excellent in nuclear engineering. There are many challenging materials problems concerned with manufacture of fuel elements and reactor vessels, as well as with piping, heat exchangers, and more conventional parts. The developing aerospace industry is making very heavy demands on the supply and quality of materials engineers and scientists as well.

Working in the metallography laboratory

Mechanical engineers are concerned with energy, with machinery, and with manufacture. Many are directly involved in developing or designing machinery which will transform heat, fluid flow, or electricity, nuclear or solar energy, or the force of gravity, into usable power. Or, they supervise and control manufacture of the necessary machines and equipment. Some are concerned with the application and sale of machinery, still others supervise its operation. Because their activities are closely related to profits, many mechanical engineers eventually assume high management posts.

Mechanical engineers also work with scientists and engineers of other fields. It is usually their job to take a device or system which has been proposed and proved in principle; to design it into an assembly of real components; to analyze and improve critical mechanical features; to make cost analysis; and to follow the parts through production: in other words, to design and produce the "hardware." This means, for instance, starting with such fundamentals as the principles of heat transfer and power generation, and evolving conventional and nuclear power plants; steam and gas turbines; reciprocating and jet and rocket engines; or devices for heating, refrigerating, and air conditioning. One of today's most pressing problems is how to design engines which can use solid and liquid propellants to drive space vehicles.

The design of strong and durable machine parts can be an extremely important part of a whole system. In the reliability of a missile, for instance, most failures are mechanical ones due to fracture, vibration, wear, or leakage; or to looseness or binding from thermal expansion or dimensional inaccuracies. The mechanical engineer must anticipate and prevent such troubles by design and control of product quality.

Because new machines, new methods, and new sources of energy are continually being required or discovered, it is not sufficient that the mechanical engineer be familiar with the existing store of knowledge in a particular field. Thus he is constantly engaged in research to obtain new design data, both for known systems and for new systems which are continually being conceived. Whatever may develop in the future in the practical application of new physical and chemical phenomena, mechanical engineers will be in at the early stages of experimentation, as they are now in thermoelectric power and solar energy. Also, new mechanical developments occur continually in established industries.

Cornell's five-year program provides a broad background in all of these aspects of mechanical engineering, as well as opportunities to concentrate in one or more during the upperclass years. The growing emphasis on engineering principles increases the possibilities for fruitful independent work in the senior project. Students who select the nuclear technology or aerospace engineering options can gain especially thorough training in the newest power field or in missiles and space flight.

Of all groups of engineers, mechanical engineers are employed in the widest range of industries; therefore it is difficult to limit and describe the opportunities available to them. Companies in the chemical process

. . . a senior mechanical engineer in an aerospace engineering lab.

Discussion in machine design

field, the electrical field, the construction field, and others, as well as the widespread mechanical field, all hire mechanical engineers. In fact, the greatest demand by industry as a whole for any single group is for mechanical engineers.

The function in industry that the young engineer will perform depends on his interests and capabilities, and the specific needs of his employer. The breadth of his education, however, is apt to lead rapidly to management responsibilities if he has the necessary personal qualifications.

The elective requirements of the mechanical engineering curriculum offer many attractive possibilities. The student may concentrate on a special field of interest within mechanical engineering, such as thermal engineering, design and development, materials processing, or industrial design. Or, if he wishes, he may expand his background in industrial engineering, electrical engineering, engineering mechanics, or materials of engineering; the required portion of the curriculum has already laid a firm foundation in all these areas. The required program of courses in mechanical engineering, supplemented by a carefully planned elective program, assures a student of a solid base for future growth and development in his chosen career.

Measuring stresses and strains on an I-beam in the mechanics laboratory

r from the Arts quad.

Fall Creek Gorge

Gorge

ORNELL EDUCATION
N PERSPECTIVE

OR the student in engineering a university like Cornell provides lucational opportunities not available in a self-contained college here engineering and science are the dominant studies. Through a enerous elective program, especially during upperclass years, engieers can explore a broad spectrum of human knowledge.

For example, Cornell students are investigating the nature of man nd his thought in such departments as philosophy and psychology, r social theories and organizations in economics, government, history, ociology, and anthropology. Strong departments of chemistry, physics, nd astronomy conduct and offer studies in the nature of the physical orld and the universe. Organic life is studied in such departments s botany, biology, entomology, and zoology, and the dimensions and ructure of the earth in geology and geography.

In departments devoted to literature, art, music, architecture, drama, nd classics, the expressions of man's spirit and his cultural heritage re explored, while other nations' languages and cultures are studied n the Division of Modern Languages.

Teachers in all Cornell departments are leaders in their field. The nlarged perspective afforded by the History Department's courses in he history of science makes it especially pertinent for engineers. Proessor Clinton Rossiter, noted authority on American government and olitical thought, draws students from all parts of the campus. Proessor Thomas Gold not only heads the Department of Astronomy, ut in the School of Electrical Engineering he teaches electromagnetic vave propagation in the ionosphere and the solar system. Students an study twentieth-century literature under Professor Arthur Mizener r receive instruction from practicing painters or graphic artists in the Department of Art of the College of Architecture. Many seek out Proessor Milton Konvitz's course, "Development of American Ideals," in he School of Industrial and Labor Relations.

There are no special electives designed for engineers. They must rst of all fulfill the exacting requirements of their own curricula and chedules, and it is true that the demands of these are more stringent han the demands confronting most students in non-professional curicula. Nevertheless, the latitude is considerable, and the list of courses lected by engineering students ranges through every college of the Jniversity.

Electrical Engineering

The engineering browsing library

Materials and Metallurgy

Chemical Engineering

The Engineering Campus

'HE new engineering campus is a symbol of Cornell's pioneering and reparation for the future, and of Cornell engineering graduates' leadrship in all fields of industry and research. Eight modern, spacious uildings bring teaching and research together in fourteen acres of oor space and house the finest equipment. In addition to laboratories vhere students themselves work on almost every conceivable type of ngineering device and instrument, there are separate small laboraories where they can conduct independent work. These small laboraories, used most often by upperclassmen working on projects and by raduate students, are serviced by shops where equipment can be onstructed.

Chemical engineering, for example, has a unit operations laboratory extending through three stories which houses, and in which can be onstructed, semi-plant-scale equipment for both instruction and reearch. Also, it has twenty-five small student laboratories. Hollister Hall, with laboratories for every branch of civil engineering, is typical of the excellence and range of laboratory facilities. Engineering physcs operates a fully equipped laboratory of electron microscopy. The Cornell Computing Center, which has recently added a Control Data 1604, one of the largest commercial computers available, enables engineering undergraduates to apply the most modern techniques to their project work. In addition, a Burroughs 220 computer is used extensively for student instruction in course work.

A Triga Swimming-pool Reactor, with a moderate power core which can be pulsed to very high power for brief periods and which affords an intense pulse of neutrons for investigation of various radiation effects, is located in the Nuclear Reactor Laboratory. Reactor design can be studied on a Zero Power Reactor. One of the main features of this equipment is that students can use it.

The eight modern buildings have been gifts of distinguished Cornell alumni:

CHEMICAL ENGINEERING: the late Franklin W. Olin '86, founder of Olin Mathieson Chemical Corporation and Olin Industries Incorporated.

Aerospace
Engineering

ELECTRICAL ENGINEERING: Ellis L. Phillips '95, founder o E. L. Phillips & Company and organizer of numerous gas and electri companies.

ENGINEERING LIBRARY AND ADMINISTRATION: Walter S Carpenter '10, Chairman of the Board, E. I. du Pont de Nemours anc Company.

MECHANICAL ENGINEERING: Maxwell M. Upson '99, Chairman of the Board, Raymond International Incorporated, one of the world's largest international construction firms.

AEROSPACE ENGINEERING: Leroy R. Grumman '16, Chairman o the Board, Grumman Aircraft Corporation, Incorporated.

CIVIL ENGINEERING: Spencer T. Olin '21, director and member of the executive board, Olin Mathieson Chemical Corporation, in memory of his father Franklin W. Olin '86, and in honor of Solomon Cady Hollister, Dean of the College of Engineering 1937-1959.

ENGINEERING MECHANICS AND MATERIALS: given by a group of alumni in honor of former deans of the College.

METALLURGICAL ENGINEERING: Francis N. Bard '04, owner of Barco Manufacturing Company. Bard Hall serves as headquarters of the Department of Engineering Physics and Materials Science.

y on the campus of the College of Agriculture.

The near-by Computing Center and several engineering physics iboratories, including the synchrotron, are closely connected with the College of Egineering's work, as are the radio astronomy and radio vave propagation laboratories, the Ionospheric Laboratory, and the High Voltage Laboratory. The new interdisciplinary Materials Science Center, presently under construction, will have extensive facilities of ts own as well as laboratories in the mechanics and materials, and netallurgical engineering buildings. Closely associated with the College of Engineering is the *Cornell Aeronautical Laboratory* at Buffalo, vhere advanced students have opportunities for summer work.

Cornell's library system, including twelve college or special subject ibraries has more than 2.4 million volumes. The new John M. Olin Research Library vastly increases its facilities. The spacious Engineering Library in Carpenter Hall includes not only a substantial number of professional books and journals but ample accommodations for tudying. It also contains the Albert W. Smith browsing library.

Civil
Engineering

Entering Cornell

APPLICANTS will be admitted to the College of Engineering who i all essential respects have demonstrated a high order of scholasti achievement and who, so far as can be determined, have a well cor sidered desire to study engineering. In addition, they must posses positive characteristics of work and study and the maturity which wil be necessary to meet the demands of living successfully in a comple and demanding university environment. Good grades or high Colleg Board scores are in themselves no guarantees of success or even of ad mission. A strong motivation and the determination to achieve ar important. The inducements and the opportunities to combine con structive extracurricular experiences with a rigorous and exactin academic program require sound health, balanced judgment, an confidence.

SCHOLASTIC BACKGROUND AND NECESSARY SPECIAL SKILLS

The specific scholastic requirements for admission are listed below A statement of the reasons for them will give them more meaning.

Mathematics is of course a primary tool of the engineer, but too fev high school students realize that competence in English is equally im portant. The engineer communicates basically in two languages English and mathematics; if he lacks skill in either, his success as a student in engineering college will be impaired. Thus, the perfectior of your skills in reading, writing, and speaking should be of principa concern, and your English, history, and social studies courses are a means to this end.

You will notice that two years of a foreign language are required; we hope you will have studied one for three or four years. As more engineering students go on to graduate school and prepare for research careers, the need to know other languages increases, and those who study for Ph.D. degrees must have a working knowledge of two for eign languages, preferably German, Russian, or French. Unless the start on this requirement is made in high school, time must grudgingly be spent learning languages at the height of one's professional training.

A love for mathematics becomes increasingly a hallmark of the en-
gineer. Some aspect of applied mathematics will characterize almost very course you will take in engineering college, noticeably so in the irst two years. Not only is it imperative that you have a natural aptiude for mathematics as demonstrated by your school grades and test cores; you must have the faculty of thinking in mathematical terms nd liking it. At the very least, you will be expected to have mastered nathematics up to, but not including, calculus; advanced placement s readily available for the increasing number who can demonstrate heir progress beyond this level.

The courses in chemistry and physics are not only a test of your kills in science, but even more a challenge to your interests. Modern engineering demands a deeper penetration into scientific theory, and ully half your engineering curriculum will involve increasing study nd use of the physical sciences. If these subjects are not "naturals" or you, forget engineering as you would be obliged to study it in the Cornell curriculum.

The Basic Studies program will test your powers of analysis, involving much theory and abstraction. If your high school has prepared you dequately, and if you possess this skill, you will be off to a good start.

REQUIREMENTS FOR ADMISSION

Sixteen units* of college preparatory subjects are required. The following fourteen units must be included:

English	4 units
History	2 units
One foreign language	2 units
Algebra (elementary and intermediate)	2 units
Plane geometry	1 unit
Trigonometry	½ unit
Advanced algebra or solid geometry	½ unit
Chemistry	1 unit
Physics	1 unit

It is recommended that the applicant offer advanced algebra, if possible, and that the elective units offered be in further study in language or history. The mathematics units listed above may be taken as separate courses or may be included within four units of comprehensive college preparatory mathematics. The Scholastic Aptitude Test of the College Entrance Examination Board is required.

* A unit is one year of study, made up of 120 hours of classroom work; that is, a minimum of 160 class periods if each is forty-five minutes long.

All applicants must take the College Board achievement tests i mathematics and in chemistry or physics. The Level I achievemen test in mathematics is required of *all* applicants and must be take not later than January of the senior year. The Level II test (if offered) may be taken *in addition* by applicants who wish placement in ad vanced sections of the first calculus course. Applicants seeking ad vanced placement for college credit should take the mathematics ad vanced placement examination in May of the senior year.

Applicants should take the achievement test in chemistry or physic in May of the junior year or in December or January of the senio year, provided they have completed one year of study in the subjec in the junior year.

FINANCIAL AID

Cornell's integrated program of scholarships, loans, and employmen helps students meet the costs of college education. Nearly a quarter o a million dollars is awarded annually by the University to engineerin freshmen alone. Recently over 65 per cent of all engineering student have held scholarships or grants-in-aid, exclusive of loans.

Scholarships are awarded for the most part to entering student whose scholastic capabilities should place them at least in the top hal of their college class. Otherwise, evidence of special professional com petence, constructive participation in school and community affairs or significant work experience are factors in selection. Stipends wil vary according to financial need and may range from as much a $2,300 to as little as $100 for honorary awards. In most instances a applicant's financial need will be met in part by the opportunity t borrow either through the University or the National Defense Studen Loan program. A descriptive list of all scholarships available to fresh men may be obtained from the Office of Scholarships and Financia Aid, 147 Day Hall.

Financial assistance to upperclassmen who are unsuccessful in win ning freshman awards is available in substantial amounts through the Office of Scholarships and Financial Aid; many students are assisted annually by grants, loans, student employment, or a combination of these resources. Few students who achieve satisfactory scholastic rank in their first year in the College find it necessary to withdraw at any time for financial reasons. Engineering students are not encouraged to undertake part-time employment in the freshman year.

IOW TO APPLY

Detailed information concerning requirements for admission and iethods of procedure are outlined in the University's *Announcement f General Information,* which every candidate should read carefully. : can be obtained by writing to the Cornell University Announce-ients Office. All correspondence concerning admission to the College of ngineering should be addressed to the Office of Admissions, Edmund zra Day Hall, Cornell University, Ithaca, New York, which will orward necessary application blanks on request. Places to write for irther information are listed inside the front cover.

'ransfer Students

Students who wish to transfer to Cornell engineering from another ollege or university should write to the Office of Admissions for spe-ial information about filing applications.

.IVING ARRANGEMENTS

Most freshmen live in dormitories which are within convenient dis-ince of academic buildings, libraries, and dining facilities. Students om the various colleges live together in the same buildings, one or two o a room. Unless they have other preferences, those who request ouble rooms are assigned a fellow student in the same college: it is ften helpful for engineers to begin their college careers living with iose taking a similar program. Rooms are bright and attractive with mple space for study.

On the ground floor of each of the freshman men's buildings is a irge social lounge with a kitchen, and on each of the other three floors separate lounge. In the central dormitory there is a cafeteria which erves all three meals and is open during the evening. Dormitory stu-ents can obtain their meals in various University cafeterias and din-ng rooms according to their own choice and schedule. Those who vish may save by prepaying for their meals for an entire semester. For vomen, most of the dormitories have dining facilities.

Though freshman men are not required to live in dormitories, most lo and all can be accommodated. About one third of *all* Cornell men ive in dormitories, one-third off campus, and one-third in fraternity iouses. Rushing for fraternities and sororities takes place during the arly weeks of the second term; bids are extended shortly thereafter.

Special Student Services

ADVISING AND COUNSELING

rviews
Cornell's
nt office

TO AID the transition from high school to college and from hom life to individual responsibility, all Cornell freshmen take part in th University's orientation program the week before classes begin. Tour discussions, and receptions are held in each of the engineering schoo in order to acquaint the freshman student with the facilities and t provide an opportunity for him to become acquainted with member of the engineering faculty.

In general, freshmen are assigned an adviser from one of the eng neering fields in which a particular interest has been indicated by th student. The advisers are interested in their students as students, a future engineers, and as persons; they want and seek to do all they ca to encourage the personal and professional growth of the students. I should be pointed out that counseling and advising are a dual relation ship—generous assistance is provided when it is sought by the studen

Students are free to consult with the Dean, directors, and other fac ulty members on any educational or personal matters. In addition, th University's Dean of Students and his staff assist students with an non-academic problems.

Students themselves find that one of the best ways to learn mor about what engineering is like and where they are headed is to tal with upperclassmen and observe what they are doing. In fact, the Engi neering Student Council, consisting of elected student representative from each division of the College, has sponsored an informal stud assistance program to help freshmen adapt themselves to the colleg experience more readily.

PROFESSIONAL GUIDANCE AND PLACEMENT

Engineering students have particularly good opportunities to dis cover what is going on in the engineering profession and where thei interests may lie. In addition to faculty and advisers, students lear much about their professional area through participation in their stu dent chapters of the various professional societies such as the America Institute of Chemical Engineers, American Society of Civil Engineers

nd American Society of Mechanical Engineers. National and local ionor societies—Tau Beta Pi, Phi Kappa Phi, Sigma Xi, Pi Tau Sigma, Chi Epsilon, Rod and Bob-Pyramid, Atmos, Kappa Tau Chi, and Eta Kappa Nu—also function in the College of Engineering.

To help students in obtaining professional employment, the Student Personnel Office of the College works with the University Placement ervice in the arrangement of interviews with employers and in the naintenance of student records. There is no charge made for this serice to the student. Cornell engineers are eagerly sought by corporaions, both large and small, and usually can select from several offers. Recently, more than 1000 employment representatives from approxinately 450 concerns visited the campus to interview candidates. One of the most frequent observations made about Cornell engineers is of their competence, breadth, and maturity, qualities, which result rom the added educational depth provided in a five-year course of tudy.

One notable thing about Cornell engineers is the frequency with which they move into leadership responsibilities in both the technical and administrative areas. This is due in part to the nature of engineering education at Cornell and of the tradition of education for eadership. The University community fosters a personal development which makes the transition from University education to career reponsibilities easier and richer in opportunity.

A 1956 study showed that ten of the nation's 100 largest industrial corporations were directed by Cornell alumni, most of them engineers, and that 809 other American companies had a Cornellian as president or chairman of the board.

PHYSICAL EDUCATION AND HEALTH SERVICES

All freshmen and sophomores are required to take physical education. The program, which for freshmen changes every six weeks, includes basketball, golf, tennis, volleyball, wrestling, and swimming. Sophomores concentrate on one or two sports which they can continue during their upperclass years and after graduation. In addition to a complete intercollegiate program, the University sponsors and directs a very active intramural program in which a majority of the upperclassmen participate.

Complete health services are available at Cornell's Gannett Medical Clinic and Sage Hospital (a fully accredited hospital). Student fees cover treatment and care at the Clinic and Hospital, with up to two weeks of hospitalization per term.

Index

HE ACADEMIC CALENDAR (Tentative)

1964-1965				1965-1966
pt. 19	S	Freshman Orientation	S	Sept. 18
pt. 21	M	Registration, new students	M	Sept. 20
pt. 22	T	Registration, old students	T	Sept. 21
pt. 23	W	Instruction begins, 1 p.m.	W	Sept. 22
ov. 11	W	Midterm grades due	W	Nov. 10
		Thanksgiving recess:		
ov. 25	W	Instruction suspended, 12:50 p.m.	W	Nov. 24
ov. 30	M	Instruction resumed, 8 a.m.	M	Nov. 29
		Christmas recess:		
ec. 19	S	Instruction suspended, 12:50 p.m.	S	Dec. 18
an. 4	M	Instruction resumed, 8 a.m.	M	Jan. 3
an. 23	S	First-term instruction ends	S	Jan. 22
an. 25	M	Second-term registration, old students	M	Jan. 24
an. 26	T	Examinations begin	T	Jan. 25
eb. 3	W	Examinations end	W	Feb. 2
eb. 4	Th	Midyear recess	Th	Feb. 3
eb. 5	F	Midyear recess	F	Feb. 4
eb. 6	S	Registration, new students	S	Feb. 5
eb. 8	M	Second-term instruction begins	M	Feb. 7
ar. 26	F	Midterm grades due	S	Mar. 26
		Spring recess:		
ar. 27	S	Instruction suspended, 12:50 p.m.	S	Mar. 26
pr. 5	M	Instruction resumed, 8 a.m.	M	Apr. 4
ay 29	S	Second-term instruction ends	S	May 28
ay 31	M	Examinations begin	M	May 30
une 8	T	Examinations end	T	June 7
une 14	M	Commencement Day	M	June 13

CORNELL UNIVERSITY • FOUNDED BY EZRA CORNELL •

I WOULD FOUND AN INSTITUTION WHERE ANY PERSON CAN FIND INSTRUCTION IN ANY STUDY