

1968 - 1969

LEHIGH
UNIVERSITY
PUBLICATIONS

UNIVERSITY CATALOG ISSUE



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LEHIGH UNIVERSITY

The charter granted Lehigh by the state of Pennsylvania states with simple directness that this University was established "for the education of youth." The institution was founded by the Honorable Asa Packer, industrialist and philanthropist, as an expression of faith in certain concepts of professional education.

Born a poor farm boy in Connecticut, in 1805, Asa Packer moved to Pennsylvania in 1822 and became one of America's pioneer captains of industry. He helped open the anthracite fields of Pennsylvania by developing a network of transportation canals and the Lehigh Valley Railroad which carried coal to market. A liberal man, his political power grew. He was elected to the state legislature, was appointed a county judge, was elected to Congress, was Pennsylvania's favorite-son candidate for president, and was Democratic candidate for governor of Pennsylvania.

In 1865, Judge Packer foresaw the great industrial development that was just beginning and which he has helped to initiate in the mineral-rich area of eastern Pennsylvania. He desired to contribute still further to the development of the region that had benefited him so much, by providing opportunities for young men to carry on the work in which he felt such a lively interest. He asked Episcopal Bishop William Bacon Stevens to help him plan a university.

Judge Packer founded his university in the midst of educational revolution. Originally, he conceived of his institution as primarily technical. Yet, its original experimental programs were greatly modified in the fourteen years in which he guided its destiny. The general plan of study when the new institution accepted students in 1866 consisted of a two-year common core of courses for all students, with a professional elective to be chosen by the student for the final two years of study. The professional elective could be in general literature, civil engineering, mechanical engineering, metallurgy, or analytical chemistry. From the beginning, Lehigh combined the traditional American college of liberal arts, the continental university, and the new technical institute of university rank.

The coincidence of Judge Packer's concepts with those popular in his day can be seen in the fact that Lehigh was founded the same year as another important technically-oriented university, Cornell, and shortly after MIT. Also, the Morrill Act, which established our land-grant colleges, was being debated when Judge Packer was a member of Congress. He fits well into the movement from the traditional liberal education of England, to the more technical German programs.

Lehigh's founder was also in the avant-garde of public industrialists. During his lifetime, and by request, he gave Lehigh over three million dollars, including land, buildings and endowment. The generosity of the Packer family and friends, the distinguished faculty originally assembled, and the prominence of early alumni firmly established the reputation of Lehigh in higher education.

Lehigh University is fully accredited by the Middle States Association of Colleges and Secondary Schools. In addition, specialized programs in business administration are accredited by the American Association of Collegiate Schools of Business, and the engineering curricula are accredited by the Engineers Council for Professional Development.

The current market value of the endowment fund of the University exceeds forty million dollars. The value of equipment, buildings, and grounds is more than thirty-nine million dollars.

ORGANIZED AS A SMALL UNIVERSITY

When Lehigh opened its doors in 1866, it was given the character of a small university. The undergraduate enrollment, restricted to men, is maintained at less than 3,000 students — Lehigh desires to remain a small university, and, with its faculty of more than 300, to provide the best possible education for a student body of its size.

Lehigh is primarily a residential university. Approximately ninety per cent of the undergraduate students reside in University-operated residence halls on the campus or in the house of national social fraternities which maintain chapters at Lehigh.

The students currently enrolled come from 900 public and private secondary schools in 40 states and 24 foreign countries. The last freshman class of 800 men was selected from over 3,200 candidates for admission.

Lehigh continues to base its program on the premise that an education for successful living must combine the acquisition of knowledge and skills fundamental in the professions with courses designed to broaden the vision and to enrich the personal life of the individual. Therefore at Lehigh requirements for graduation include studies preparatory to a career, a generous number of courses to acquaint the student with the nature and problems of the world in which he lives, and opportunities to develop himself as an individual.

CAMPUS AND COMMUNITY

Located on a 180-acre hillside campus on the south side of the Lehigh River, the towers of Lehigh University overlook the city of Bethlehem, which has a population of 76,000, is located in eastern Pennsylvania, approximately 60 miles north of Philadelphia and 90 miles west of New York City.

In founding his university, Judge Packer provided the site for the campus "in the midst of a noble park of forest trees." A century later, there remains abundant evidence of the source of Judge Packer's inspiration, for the trees continue to create the quiet campus atmosphere. Most of the University's sixty buildings are located on the north slope of South Mountain. Recently, an additional 500 acres of rolling meadows were acquired in Saucon Valley, on the south side of South Mountain. With the addition of land acquired through a cooperative venture with Bethlehem's Urban Renewal program, the University is adding new library, classroom, and laboratory facilities which will closely unite the campus with the city.

Settled in 1741 by Moravians seeking religious asylum, the city of Bethlehem is rich in historic tradition. The city became an important point for early colonial travelers stopping between New York and Philadelphia. Twenty-one remarkably preserved pre-Revolutionary War buildings remain in the heart of the city. Many have been restored and others will be reconstructed. Each spring, the city and the campus receive thousands of music lovers

who come to hear the famous Bach Choir in Lehigh's Packer Memorial Church. Situated in the center of the Lehigh Valley industrial complex, Bethlehem is preeminently a city of steel, as the home site of the main administrative offices, research laboratories, and a major production facility of the Bethlehem Steel Corporation.

RECENT DEVELOPMENTS AT LEHIGH

Certainly the most dynamic aspect of Lehigh's current growth has been the Centennial Development Program. It has been observed that no university is the same after a major fund-raising campaign, and this can be seen in the results of Lehigh's seven-year Centennial fund drive. The \$22-million raised in that drive has provided Lehigh with the Whitaker Metallurgical and Chemical Engineering Laboratory, the Centennial Residence Halls, more than \$8-million for faculty salaries and student financial assistance, new facilities or renovations for nineteen fraternities, and the Saucon Valley Playing Fields and Varsity House. The funds also will help pay for a new science-engineering library, power plant, and hall of liberal arts.

Developments in the academic program are less obvious and dramatic but even more important. Numerous honors have been bestowed upon Lehigh faculty members in recent years, including Fulbright awards, honorary degrees, Ford Foundation and Guggenheim grants, and the Pulitzer Prize in History. In 1965 and 1966 Lehigh seniors were chosen as Rhodes Scholars.

UNDERGRADUATE ADMISSION REQUIREMENTS

The enrollment of Lehigh University is strictly limited by action of its board of trustees, with a resulting limitation in the number of candidates who can be admitted each year to the several divisions of the University.

In the selective procedure necessitated by this limitation, the University, through its Office of Admission, takes into account a number of criteria which are believed to have some individual validity and in combination a high degree of validity in predicting probable success in college work.

(1) SECONDARY SCHOOL UNITS

The sixteen yearly courses or units required as entrance credit represent the quantitative equivalent of the usual four-year college preparatory program and include certain prescribed subjects and sufficient electives to make up the totals listed in the accompanying chart.

It is recommended that in addition to the minimum subject matter requirements all candidates include as many courses in science, history, mathematics, and language as their programs and schools will permit.

The *recommended program* for admission to all courses of study at Lehigh University includes (in secondary school grades nine through twelve) four years of English, two to four years of one foreign language (or two years each of two foreign languages), four years of college preparatory mathematics, two to four years of laboratory science, and two to four years of history or social studies. These will total sixteen to twenty yearly courses or units of college preparatory study.

The statement above is the recommended preparatory program and preference will be given to candidates who present such a pattern of studies, particularly to students who have taken the opportunity to go beyond minimum subject matter requirements.

The *minimum requirements* for all entering freshmen are four yearly courses or units in English, four in mathematics (including algebra, plane geometry, plane trigonometry), two years of one foreign language, and six elective units (including chemistry for candidates for science, arts-engineering, and engineering).

SUMMARY OF MINIMUM SUBJECT MATTER REQUIREMENTS

Subjects	Units
English.....	4
Foreign Language (4 units are recommended).....	2
College Preparatory Mathematics.....	4
Electives.....	6
Total	16

Note: Chemistry is required and physics is recommended for candidates planning programs in science,

arts-engineering, and engineering. Electives should include such college preparatory subjects as languages, social studies, and sciences.

(2) QUALITY OF WORK

The quality of the candidate's work is more important than merely meeting minimum subject matter requirements. The strength of his preparation is judged primarily by his rank or relative grade in class; by the extent to which he has made grades distinctly higher than the average grade; by evidence of improvement or deterioration in quality of record as he has progressed through secondary school; by his relative success or failure in the particular subjects which he proposes to continue in college; and by the comments and recommendations of his principal or headmaster.

Most secondary schools specify two minimum grades: one as the passing grade and the other as the recommending grade for admission to college. In the process of selective admission for Lehigh, particular emphasis is placed on the extent to which a candidate has significantly exceeded these minimum grades and has ranked high in his graduating class.

Today when four to five times as many candidates apply for admission to the University as can be accommodated in the freshmen class, meeting minimum standards is not sufficient. A candidate must have shown by his school record and class rank and College Board test scores that he is well prepared to do satisfactory work at Lehigh University.

(3) ENTRANCE EXAMINATIONS

All candidates for admission to the freshman class at Lehigh University are required to write entrance tests prepared and administered by the *College Entrance Examination Board*. Tests required by Lehigh University are listed below.

SCHOLASTIC APTITUDE TEST: Each candidate is required to write the Scholastic Aptitude Test (SAT) to provide the University with a measure, on a national scale, of his aptitude and readiness for college study. Lehigh prefers that this test be written either on the November, December or the January testing date of the senior year. (The 1968-69 schedule is shown below.)

ACHIEVEMENT TESTS: Each candidate is required to write *three* additional afternoon College Board Achievement Tests. One of these must be English Composition. Candidates for a science program, for engineering, and for arts-engineering are required to write Mathematics, either *Level I (Standard)* or *Level II (Intensive)*, and Chemistry or Physics Achievement Tests. Other candidates are required to write two tests which they may choose in consultation with their advisers. The Achievement Tests should be written in December, or January of the senior year unless satisfactory results were submitted to Lehigh University from junior year tests.

SCHEDULE OF COLLEGE BOARD TESTS 1968-69
November 2, 1968

December 7, 1968 *Note:* The SAT and Achievement Tests, will be offered on January 11, 1969
March 1, 1969 all testing dates, except No-
May 3, 1969 vember when only the SAT is
July 12, 1969 offered.

Information and application forms for the tests should be secured from the *College Entrance Examination Board* at one of the following addresses (whichever is closer to the candidate's home or school): *P. O. Box 592, Princeton, New Jersey 08540* or *P. O. Box 1025, Berkeley, California 94701* or from the candidate's school.

Candidates should register for the tests early in the senior year and not later than one month prior to the test date (two months for candidates who will be tested in Europe, Asia, Africa, Central and South America, and Australia).

The candidate is responsible for requesting that his test score be sent to Lehigh — either by indicating Lehigh on his College Board application blank or, if he failed to do this, by special request to the College Board office. In addition to requesting College Board scores, the candidate must submit an application for admission to the freshman class at Lehigh.

(4) OTHER CRITERIA AND INTERVIEWS

Information about other qualifications of candidates is obtained from principals, headmasters, and counselors. Such information relates to the candidate's health, emotional stability, intellectual

motivation, social adjustment, participation in school activities, and established habits of industry and dependability.

Candidates are invited to visit Lehigh so that they may see the University and talk with an officer of admission. *An appointment should be made in advance of the visit.*

The most convenient hours for admission conferences are at 1:30 on weekday afternoons and between 9:00 and 11:00 o'clock on Saturday mornings during the school year. The Office of Admission is closed Sundays, national holidays, Saturday afternoon during the school year, and all day Saturday during the summer months. A particularly good time for a candidate and his parents to visit Lehigh is during the summer between the junior and senior years in secondary school.

Although a personal interview is not required of all candidates, the University reserves the right to require an interview whenever this appears desirable or necessary and to base determination of admission in part on the report of the interviewing officer.

**UNDERGRADUATE ADMISSION
PROCEDURES**

ADMISSION TO THE FRESHMAN CLASS

If a candidate has determined that he is sincerely interested in Lehigh and if he believes that he will meet admission requirements of subject matter and school record, he should secure from the Office of Admission an application blank for the freshman class entering in September. (Lehigh does not admit a freshman class in February.)

The application should be submitted early in the last year of preparation for college. Lehigh gives first consideration to applications returned promptly after receipt. Every effort should be made to submit an application during the fall semester of the senior year and definitely not later than March first. In practice the University is sometimes forced to limit applications after January first.

The candidate should arrange with his school adviser to register for morning and afternoon tests administered by the College Entrance Examination Board. As indicated in the section on Entrance Examinations (No. 3), Lehigh recommends that the

SAT be written in November, December or January of the senior year and the three afternoon Achievement Tests in December or January.

Most important of all he should maintain a good academic record. He should learn how to budget his time. He should work hard to develop study habits which will assure a strong record in secondary school and will give him a good start in his freshman year in college.

APPLICATION FEE

Each undergraduate application for admission to the freshman class or with advanced standing or to the General College Division must be accompanied by an application fee in the amount of \$10.00. The check or money order for the application fee should be made payable to Lehigh University. The application fee is non-refundable in the event the candidate does not matriculate at Lehigh University. It is not applied toward tuition if the candidate matriculates. An application cannot be accepted without the application fee.

EARLY DECISION

Many candidates have asked about "early decision." Lehigh will give a candidate an early favorable decision on his application if he meets the following criteria:

- (1) His preliminary credentials, including Scholastic Aptitude Test scores show clear qualification for admission to Lehigh.
- (2) He is certain that Lehigh is his first choice of college.

On this basis the Committee on Admission selects candidates who have submitted requests for early decision by November, Lehigh's decisions will be made by December 1. If the decision is favorable, it is assumed the the candidate's academic strengths will continue throughout the senior year and that he will complete all normal admission requirements. On receiving a favorable decision the candidate should promptly withdraw other applications.

Early Decision candidates whose parents have submitted Parents Confidential Statements will receive notice by December 1 of the action taken on requests for financial aid.

It is important to remember that admission to

college is a "two-way street": seniors select colleges to which to apply; from these candidates colleges select their freshmen. The "early decision" plans are designed to reduce multiple applications, to encourage candidates to make early choices and to help colleges determine their freshman classes.

For instance, candidates definitely have Lehigh as their first choice, but seldom is it known who these candidates are. Lehigh's plan gives the well-qualified candidate an opportunity to make his selection known as early as possible.

However, this plan is not appropriate for all of our candidates. There are many candidates who are unable to make an early college choice. Such candidates are not penalized. Candidates who do not receive favorable replies to their requests for "early decision" should not feel discouraged. Only a portion of the class is selected under this plan, since the Committee on Admission still prefers to take action on most applications later in the year.

ACCEPTANCE OF ADMISSION AND DEPOSIT

Selection of candidates for the freshman class entering in September is made between the end of February and the first of April following receipt of January College Board scores and of preliminary secondary school records. Lehigh subscribes to the "Candidates' Reply Date," which has been set at May first.

When a candidate's preliminary credentials are complete and he has been offered formal admission to Lehigh University, he will be asked to notify the Director of Admission of his acceptance of the offer of admission by making a deposit of \$50 to hold a place for him in the limited enrollment. This deposit is not an additional fee but is applied toward tuition charges for the first semester. However, the deposit is forfeited in case of failure to enroll for the specified semester.

ADVANCED STANDING FROM SECONDARY SCHOOLS

Advanced standing for freshman courses may be earned by secondary school students in two ways: through Advanced Placement Tests administered by the College Entrance Examination Board or by

advanced standing examinations administered at Lehigh University. Both methods require that the candidate shall have studied significantly advanced work.

A few private and public secondary schools now offer truly advanced courses for limited numbers of selected students. If a candidate has completed, or expects to complete, such a course in an approved secondary school, he may establish advanced standing by taking an Advanced Placement Test or a Lehigh test in the subject. In either case he should confer with his school principal and with the Director of Admission of Lehigh University.

The privilege of taking an advanced standing examination at Lehigh is granted only on written request to the Director of Admission not later than July first of the year the student plans to enter college. Such examinations are scheduled by the University usually at the beginning of Freshman Orientation.

ADVANCED STANDING FROM ANOTHER COLLEGE

Candidates for admission by transfer from other institutions may be admitted with advanced standing subject to the enrollment limitations of the several divisions of the University. Such candidates must have met the entrance requirements prescribed for undergraduates at Lehigh and must have completed at least two semesters of study at an accredited institution of higher learning.

A candidate who has studied at another college prior to applying for admission to Lehigh will be considered on the basis of the quality of his record at that college. *A candidate who has been dropped from another college for disciplinary reasons or for poor scholarship or who is not in good standing at his former college is not eligible for admission to Lehigh University.*

A student who is planning to transfer to Lehigh University should so arrange his work in college that he will cover as many as possible of the subjects of the freshman and sophomore years of the curriculum he selects.

A student who desires to transfer to Lehigh University from another university, college, or junior college must submit an application for admission (on a special transfer form) with the \$10 applica-

tion fee. He must request each college previously attended to submit to the Office of Admission at Lehigh University an official transcript of his academic record. Such a transcript must include a complete list of all courses taken, a list of entrance credits accepted for admission, and a statement of honorable dismissal. Catalog pages describing the courses completed at other colleges should be enclosed with the application. It is not necessary to send complete catalogs.

A candidate who has attended more than one university, college, or junior college must present a record from each institution. Failure to submit a complete record of former academic experience will result in cancellation of admission or registration.

UNDERGRADUATE FEES

The tuition for undergraduates is \$1000 per semester in the College of Engineering, the College of Arts and Science, the College of Business and Economics and the General College Division. A student regularly enrolled in any of the undergraduate divisions of the University who registers for fewer than the normal hours of work will pay either \$84 for each semester-hour carried or the regular tuition, whichever amount is lower.

There are no fees for athletics, health service, library, student activities, or student concerts-lectures. In addition, there are no matriculation, graduation, or laboratory fees.

Undergraduate fees are payable prior to registration. A bill will be rendered by the Bursar's Office which will indicate the payment date. If desired, payment may be made in installments of 60 per cent, plus a service charge of \$3 per semester, due prior to registration, 20 per cent due one month after registration, and 20 per cent due two months after registration. The \$3 service charge is not refundable.

MILITARY AND BAND DEPOSITS. A deposit of \$25 is made by each student enrolling in military or air science or in band. This deposit is refunded when the property issued to the student is returned.

CHEMISTRY BREAKAGE. Students taking chemistry laboratory courses are required to reimburse the

University for returnable equipment broken or otherwise damaged and for all chemicals used in excess of reasonable amounts. To cover possible charges of this nature, all students registering for laboratory courses in chemistry purchase coupon books costing \$5, the unused portions of which are redeemed.

EXAMINATION FEES. Students who for satisfactory reasons absent themselves from final examinations will be allowed, upon petition, to take make-up examinations without payment of an examination fee. A fee of \$5 is charged for any examination subsequent to the first regular final or make-up examination allowed upon petition in any course. This regulation applies to the psychological and placement examinations required of new students if taken at some time other than those scheduled.

SHOP AND SURVEYING COURSES. A three-week shop course for industrial and mechanical engineering students is required during the summer following the sophomore year, and three-week surveying courses are required by the Department of Civil Engineering during the summer following the sophomore year. Tuition charges are made for the shop course which is given in Bethlehem under the Department of Industrial Engineering, and for the surveying courses which are conducted at camps or on campus under the auspices of the Department of Civil Engineering. The tuition charge for all of these courses is the regular summer rate per semester hour. To this is added the cost of room and board at prevailing rates.

LATE REGISTRATION FEES. The penalty for procuring a registration ticket after the time specified by the Registrar shall be \$10. A student who does not complete his registration within three days after the date of his registration ticket is subject to a penalty of \$10. No registration will be accepted later than the tenth day of instruction in a regular semester or the fifth day of instruction in any summer term.

LATE PRE-REGISTRATION FEE. The penalty for a late pre-registration or a change in pre-registration is \$10. This will be waived for cause upon the recommendation of the college dean.

CHANGE-OF-ROSTER FEE. Having once registered

in any semester, a student may not add or drop any course except on the recommendation of the director of his curriculum. There will be a \$10 change-of-roster fee for each such change unless it is waived by the college dean.

LATE INSTALLMENT PAYMENT. In certain cases, students are permitted to pay semester bills in three payments. In other cases, emergency short term loans are granted to be repaid in period installments within the semester in which the loan is granted. A penalty fee of \$10 is levied on any student who fails to make payment in accordance with the agreed schedule.

LATE PAYMENT OF FEES. University fees are payable prior to registration. If payment, or provision for payment satisfactory to the University, is not made prior to registration, a fee of \$10 will be assessed if such payments, or provisions for payments, are made after the registration date.

LATE APPLICATION FOR DEGREE FEE. Refer to General Regulations — Notice of Candidacy for Degree, page 22.

APPLICATION FOR ADMISSION FEE. A fee of \$10 is required with each application for admission to the undergraduate colleges of the University.

LISTENER'S FEE. Undergraduate students enrolled in less than a full program who wish to attend a course or courses without obtaining credit will be charged a listener's fee of \$35 for each such course attended.

TRANSCRIPTS. Each student is entitled to one copy of his record free of charge. This can be an official or unofficial transcript. Unofficial copies are released to the student; official copies are sent directly to the educational institution, company, state board, etc., as the circumstances may require. After the first copy is released a fee of \$1 is assessed for each subsequent copy.

Refunds

UNDERGRADUATE. If a student withdraws from the University, he is entitled to receive a refund of his tuition less \$50 and less a deduction of 2 per cent of the tuition for each day of instruction completed, computed from the first day of instruction

in the semester. In the event of the death of a student or his involuntary induction into the Armed Forces, tuition will be refunded in proportion to the fraction of the semester remaining at the time of his death or induction. No student who is suspended or expelled from the University shall be entitled to any refund.

A summer session student who formally withdraws from the University is entitled to receive a refund of his total tuition less \$5 for each credit hour for which he is registered and less a deduction for each day of regular instruction of 4 per cent of the total tuition paid computed from the first day of instruction in the session.

No refunds will be made to any undergraduate student for any reduction in his schedule after the tenth day of instruction in a regular semester or the corresponding relative date in a summer session.

RESIDENCE HALL RENTAL. Residence hall rental paid in advance is refundable in its entirety for any term in which the student does not register in the University or on a proportional basis for cancellation due to the student's death or involuntary induction into the armed forces. Otherwise, refunds are limited to the proportional charge for the unexpired portion of the student's lease less a charge of \$25, and to cases of (a) withdrawal from the University (for reasons not involving misconduct) or (b) transfer of lease to another student (for whom no other accommodations exist), subject to approval of the Director of Residence Halls. Refunds authorized under this regulation shall be certified to the Bursar by the Dean of Residence.

Note: Rooms are rented in September on an annual lease basis only. A freshman who does not live at home is required to live in the residence halls during his first year. An upperclassman who signs a lease is expected to occupy a room in the residence halls for the full college year.

DINING SERVICES. Refunds will be allowed only on written request to the Treasurer approved by the Dean of Residence. Normally such requests will be approved in cases of confining illness requiring absence from all University activities for a period longer than 14 consecutive days or in cases of voluntary withdrawal from the University, involuntary induction into the Armed Forces, or death of

the student. Refunds will be computed on the basis of the cost per day for the board plan involved for each full day of absence.

If a student is suspended or expelled from the University, he may be allowed as a refund 50 per cent of the amount representing the unexpired portion of his original dining service contract for the semester.

PAYMENT. All refunds, including overpayments of charges resulting from scholarship awards, loans, financing arrangements with banks, etc., will be made by check payable to the student. A minimum of ten days is normally required to process refund checks.

ESTIMATE OF EXPENSES

Items of personal expense are dependent upon each student's personal habits and circumstances. There are certain basic expenses, however, which must be met by all students. An *estimate* of annual cost is listed below:

Tuition	\$2,000
Books and Supplies	150
Room (average)	380
Subsistence (estimate)	590
	<hr/>
	\$3,120

(Note: Students taking military or air science or band are required to make a \$25 deposit which is refundable at the end of the school year.)

Books, stationery, and drawing instruments may be purchased at the Supply Bureau in the University Center.

Students living in Residence Halls are required to eat in the University Center. Board will be billed on a semester basis payable prior to registration.

LIVING ARRANGEMENTS

Lehigh undergraduates live in eleven University residence halls (50 per cent), or in 31 fraternity houses by invitation (40 per cent), or are commuters (10 per cent). All freshmen who do not live at home are required to live in the residence halls, which are staffed by a corps of carefully selected upperclass counselors responsible to the Dean of Residence.

Dining Services

Each student who lives in the Residence Halls is

provided with board in the University dining service in the new University Center. The following three board plans are available:

A. Twenty-one meals per week (3 meals daily beginning with the evening meal before the first day of classes and continuing except for announced holidays through the noon meal of the last day of the examination period each semester) — \$580 per school year.

B. Seventeen meals per week (Monday breakfast through and including Saturday lunch beginning with the evening meal before the first day of classes and continuing, except for holidays, through the last day of classes for each semester, and meals during the examination periods ending with the noon meal of the last day of examinations) — \$526 per school year.

C. Fifteen meals per week (Monday breakfast through Friday dinner beginning with the evening meal before the first day of classes and continuing, except for announced holidays, through the last day of classes each semester, and meals during the examination periods ending with the noon meal of the last day of examinations) — \$504 per school year.

Plan A is required for freshmen residing on the campus. Upperclassmen residing on the campus have the choice of any of the three plans.

The board plans and the student dining rooms are open only to students of the Residence Halls. A Snack Bar is operated in the University Center and is open to all students of the University.

Freshmen residing on the campus are required to eat their meals at the University dining service at the University Center during Freshman Orientation. There will be an additional charge of \$8 for serving the three meals per day during Freshman Orientation.

Each student who participates in one of the board plans will receive a dining service identification card which is not transferable. Use of the card by others than to whom it is issued is illegal and will result in disciplinary action. New cards will be issued to replace lost cards upon the payment of a fee of \$5.

Visitors on campus may eat in the Asa Packer Room, the faculty and guest dining room, in the University Center.

Residence Halls

Room rents in the residence halls range from \$190 to \$210 per student per semester with maid service included. Rooms are rented in September on an annual lease basis only. The typical room is shared by two students. For each student there is provided a bed, box spring, mattress, chest of drawers, desk and chair; residents supply desk lamps, waste baskets, bedding, etc. Commercial linen service is available at a rate presently \$28 per year. Personal laundry on a commercial contract basis is available at \$89.25 a year.

Residents will be held responsible for any damage done to their rooms or any other part of the Residence Halls and their equipment.

The University is not responsible for the loss or destruction of any student property whether such losses occur in the residence halls, lockers, classrooms, etc. The safekeeping of student property is the responsibility of each individual student and no reimbursement from the University can be expected for the loss of such property. Insurance protection, if desired, may be obtained by a student or his parents from an insurance broker or agent.

Information on off-campus housing may be secured from the office of the Director of Residence Halls.

STUDENT PERSONNEL SERVICES

General counseling of individual students, especially in the freshman year, is largely the responsibility of the student personnel services—a group of cooperating agents and agencies. For the new student and his parents, such services begin in their earliest discussions with the Director of Admission and his staff. Most of the student's early contacts after his entrance are with the Residence Hall Counselors. These counselors are carefully selected upperclassmen, appointed by the President of the University, who help the freshman and who direct him to more highly specialized aid when needed. The entire program is conducted under the supervision of the Dean of Residence.

Freshmen whose problems transcend the competence of the Residence Hall Counselors come to other advisers for guidance in many areas of student life and welfare and, at all levels, academic ques-

tions, personal problems, social adjustment difficulties, financial needs, and many other troubles are dealt with daily. Problems of vocational choice and academic adjustment are not uncommon during the freshman and sophomore years.

Each student in the College of Arts and Science is considered from the beginning of his course as an individual and his choice of studies is carefully organized in terms of his specific backgrounds of preparation and his future objectives. Individual counseling continues throughout the student's four years in the College. In the College of Business Administration faculty advisors work with the individual student and his individual problems for the same purposes. Similarly, the Associate Dean of the College of Engineering curriculum spends much time with the freshman engineering students in an effort to help in the adjustment of academic difficulties and in better definition of vocational objectives. These forms of advisement are carried on through the following years with the student's academic advisors.

A student's problems often reveal the need of more highly specialized attention, whereupon the student is referred to the particular service which he should consult. Problems of mental or physical well being are, of course, referred to the University Health Service which is described in another section. The University Chaplain is available for the student with religious, moral, or personal concerns that are interfering with his peace of mind and his studies.

If a student is not certain about his vocational or professional choice, he needs to know both more about his own capacities and interests and more about the professions and their demands. The Counseling and Testing Service is available without charge. A large library of occupational information is there for the student's use and study. Later, in his senior year, the question of prime importance is the decision of a position after graduation. The Director of Placement, in personal and group conferences, advises on applying for a position, on being interviewed, and on the relative advantages and disadvantages in working for the different business and industrial firms seeking the services of college graduates. (See page 16).

Financial problems can become a serious hazard

for a student. The Executive Secretary of the Committee on Undergraduate Financial Aid is always available for conference and may find other related concerns.

If the student is a veteran of military service and has questions involving relations with the Veterans Administration, he will find the Registrar informed in this field. The Registrar also is an advisor on the draft and military service, on matters of transferred credits, graduation requirements, and allied topics.

A serious hazard to success in a student's academic life may be in poor study habits or reading skills. The Reading and Study Clinic can provide help. (See page 16).

Not all student problems are individual problems. Many are group problems, having to do with group living in the residence halls, with student activities, student organizations of many kinds, fraternity life, and campus social life in general. The deans and their aides give much of their time to this area of student life.

Many members of the teaching faculty are deeply interested in students and student life and spend a great deal of time working with student groups. They contribute their services as academic advisors, activity sponsors, group sponsors and advisors, chaperones at social affairs, by entertaining in their homes, and in friendly personal relationships with students. Their contributions are invaluable and appreciated all the more because they are largely voluntary.

In these and in other ways Lehigh University endeavors to maintain the close contacts with students which characterize the smaller institutions. Services are available for all student needs, and the student need only turn to his nearest residence hall counselor, professor, or closest campus friend to learn where he can receive the help he needs.

STUDENTS' HEALTH SERVICE

A dispensary is maintained which is equipped and staffed for routine medical and minor surgical care. Twelve beds are available for short periods of observation. Dispensary hours are from 8:30 a.m. to 5 p.m. weekdays; 8:30 a.m. to 12:30 p.m. Saturdays; and 10 a.m. to 12 noon on Sundays. During vacation periods and during the summer sessions, no Sunday hours are held.

A night medical attendant is on duty through the fall and spring semesters from 5 p.m. to 8 a.m. Facilities are available during these hours for the treatment of minor injuries and illnesses. A physician is on call at all times during the fall and spring semesters.

Patients requiring more than a few days bed care are sent home or to local hospital when indicated. Any expenses so incurred must be paid by the student.

Due to limited staff and multiplicity of dispensary duties, Health Service physicians are not able to make professional calls on students in living groups or in rooms, except in cases of absolute emergency. If unable to visit the dispensary in the event of illness or injury, students are advised to call local physician for treatment. Such physicians' fees will be paid by the student, his family, or his Health Insurance Plan.

The Health Service wishes to work closely with the student's family physician and, as far as possible, will continue any treatment or follow-up requested by him.

A necessarily limited emergency service is extended by the Health Service to faculty members and other employees.

PHYSICAL EXAMINATIONS. Prior to arrival on campus each new undergraduate student is required to submit a Health History Form and Record of Physical Examination completed and signed by his own physician. At the appropriate time these forms are mailed to new students with specified date for completion and return to the Director of the Health Service.

The physicians of the Health Service carefully analyze the results of all physical examinations in order to detect any latent or obvious physical, emotional, or mental abnormality. When found, a person involved may be invited for a conference and his disability discussed with him confidentially.

All new employees are expected to have a physical examination before beginning their duties at the University. Such pre-employment examinations may be done by the Health Service Staff, or by the applicant's chosen physician (at the applicant's expense) on Health Service forms supplied for that purpose. All completed forms are to be returned

to the Director of the Health Service as soon as possible for confidential analysis and filing.

Close cooperation between the Department of Physical Education and the Health Service permits the establishment of rehabilitation measures, etc., as indicated. All students are classified for the physical education program according to their abilities to participate in physical activities.

TUBERCULOSIS SURVEY. A 70 mm. Chest X-ray is made of each incoming student. Any departure from normal noted during the reading of these films calls for a 14" x 17" chest X-ray and further investigation.

IMMUNIZATIONS. All new and transfer students are required to show evidence of vaccination against smallpox within three years, or to submit to such vaccination prior to the beginning of classes.

Immunization with Tetanus Toxoid and the Salk or oral Polio Vaccine within four years preceding admission is required.

LABORATORY. Facilities are available for routine laboratory procedures. Additional procedures are performed at a local hospital at the expense of the student.

X-RAY SERVICES. The X-ray equipment of the Health Service includes a diagnostic unit, a 70 mm. Chest X-ray unit, and necessary developing and drying apparatus. X-ray services are limited to bone and chest films. No X-rays are taken of any body organs which involve the use of dyes, barium, etc.

A small charge is made to cover the cost of reading the films by a local radiologist.

PHYSIOTHERAPY. A well-equipped physiotherapy section is a valuable adjunct to the University Health Service. A well-trained technician administers treatment under the supervision of the University physicians with such equipment as diathermy, whirlpool, ultra-violet and infra-red lamps.

PERSONNEL. Full-time Health Service personnel normally include three physicians, a physiotherapist a laboratory and X-ray technician, two nurses, a night medical attendant, a secretary, an administrative assistant, and a receptionist.

ACCIDENT AND SICKNESS REIMBURSEMENT INSURANCE. The University offers students insurance

coverage against accident and sickness at nominal cost, and on an entirely voluntary basis.

The Health Service highly recommends this insurance plan to both present and prospective students. Past experience has emphasized the importance of such protection, and we urge all students to participate in this plan throughout their college careers. The policy covers such items as prescription drugs, out-patient X-rays, and consultations which are not covered by the usual hospitalization policies.

All foreign students and others who, in the opinion of the administrative officers of the University, may not be in a position to meet the costs of accident or sickness are usually required to carry this insurance.

PLACEMENT, COUNSELING AND TESTING SERVICES

In order to prepare the student for the exigencies of college life, the University maintains a placement, counseling, and testing service. This service functions to help the student make satisfactory adjustments to his college environment and to provide counseling and aid in obtaining employment upon graduation.

COUNSELING AND TESTING SERVICES. The primary aim of counseling is to aid the student to gain a better understanding of himself and how his personal characteristics bear on his present and future adjustments. Students who avail themselves of the professionally administered techniques of psychological testing and personal counseling profit by establishing realistic guideposts by which to direct their courses of action.

Psychological tests, including those administered during Freshman Week, are used to assess a student's aptitude, achievement, skills, interests, and personality characteristics. Interpretations of these tests are made with the student to help him orient his course work, study, and campus life toward achieving his maximum effectiveness. When the student feels that a more extensive evaluation of his situation is needed, further testing and personal counseling aimed at helping him understand his direction and motivation are undertaken. Also, cross communication with other University person-

nel agencies is maintained in gathering together information and expediting plans made cooperatively with the student. The counseling service maintains a library of educational and occupational information to which students can refer as they attempt to develop a clear conception of the educational and vocational world and their place in it. These services are available, without cost, to all University students.

The counseling service is also the administrative center of a variety of local and national testing programs in which students might be asked to participate during their college career. The most frequently administered of these programs are the Graduate Records Examinations, Law School Admissions Test, Medical College Admission Test, Graduate Study in Business Tests, National Teacher Examination, and Millers Analogies Tests.

The Service also engages in research on tests, counseling, and other Personnel functions. The results of such research are ultimately useful in the counseling of individual students.

PLACEMENT. The University provides a centralized placement service to alumni, graduate students and seniors. It also serves underclassmen seeking summer employment.

Alumni are asked to register with the Placement Office if they wish assistance in changing positions or seeking new employment.

Annually several hundred industries, business firms and government agencies send representatives to the campus to interview candidates. In addition to those who visit the campus there are many employers who seek candidates by direct referral.

A well developed library of employment literature is maintained for the use of candidates.

READING AND STUDY CLINIC

There are many factors which influence the performance of college students. An important one is the expertness with which they master the skills necessary for college work. High level skills are needed in preparing assignments, note-taking, outlining, listening, recalling information and facts, taking examinations, preparing written and oral reports, and reading critically and accurately. The Reading and Study Clinic, School of Education,

offers Lehigh men an opportunity to develop satisfactory reading and study habits. The following services are available to all students:

Analysis of reading and study skills; Reading and study improvement programs; and, Individual guidance on problems of academic adjustment.

First-year students, particularly, are encouraged to arrange for a conference so that they can be assisted in making an evaluation of their learning tools and in planning for more effective work.

The improvement programs are offered periodically during the fall and spring semesters. Small group instruction is scheduled for interested students. The instruction is adapted to the needs of the individual in well-equipped facilities.

STUDENT ORGANIZATIONS

National Honor Societies—General

Beta Gamma Sigma (business administration)
Omicron Delta Kappa (student leadership)
Phi Beta Kappa (scholarship)
Phi Eta Sigma (freshman scholarship)
Sigma Xi (scientific research)
Tau Beta Pi (engineering)

National Honor Societies—Departmental

Alpha Epsilon Delta (pre-medical)
Alpha Pi Mu (industrial engineering)
Beta Alpha Psi (accounting)
Chi Epsilon (civil engineering)
Delta Phi Alpha (German)
Delta Sigma Rho-Tau Kappa Alpha (speech)
Eta Kappa Nu (electrical engineering)
Phi Alpha Theta (history)
Pi Mu Epsilon (mathematics)
Pi Sigma Alpha (government and international relations)
Pi Tau Sigma (mechanical engineering)

National Recognition Societies

Alpha Phi Omega (campus service)
Arnold Air Society (Air Force)
Eta Sigma Phi (classics)
Pershing Rifles (military)
Pi Delta Epsilon (college journalism)
Psi Chi (psychology)
Scabbard and Blade (military)

Course Societies

Intellectual interest in various fields of study and professional spirit among arts, business, and engineering students is promoted by a group of organizations commonly called course societies. The first of these organizations historically was the Chemical Society, established in 1871. The list now includes:

In Arts and Science

Delta Omicron Theta (debating)
International Relations Club

In Business and Economics

Alpha Kappa Psi (business administration)
Beta Alpha Psi (accounting)
Lambda Mu Sigma (marketing)
Student Marketing Research Corps

In Engineering

American Chemical Society (chapter of student affiliates)
American Institute of Chemical Engineers (student chapter)
Institute of Electrical and Electronic Engineers (student branch)
American Institute of Industrial Engineers (student branch)
American Institute of Physics (student section)
American Society of Civil Engineers (student branch)
American Society of Mechanical Engineers (student branch)
Howard Eckfeldt Society and Geological Society (student branch of the American Institute of Mining and Metallurgical Engineers)
Metallurgical Society
Society of American Military Engineers
Student Chemical Society
Student Investment Council

Other Student Organizations

Acolytes' Guild
A.I.E.S.E.C. (foreign job exchange)
Alpha Chi Epsilon (Episcopal pretheological honorary society)
Alpha Lambda Omega (Allentown group)
Band (including Brass Choir, Woodwind Chamber Group, etc.)
Baptist Student Group

Bethlehem Tutorial Project
Boxing Club
Bridge Club
Campus Chest (Committee of Arcadia)
Canterbury Club
Chess Club
Civil Rights Club
Circle K Club
Christian Science Organization
Computer Society
Cosmopolitan Club
Crossroads Africa Committee (of Arcadia)
Cut and Thrust Society (fencing)
Cyanide Club (junior honorary society)
Flying Club
French Club
German Club
Glee Club
Gryphon Society
Hillel Society
Hockey Club
Interfaith Council
Interfraternity Council
Jazz Moderns
Arcadia, the Student Council
Lehigh Christian Fellowship
Lehigh Valley College Volunteers
(mental hospital project)
Lutheran Student Organization
Methodist Youth Movement
Model Railroad Club
Mustard and Cheese (dramatic club)
Newman Association
Outing Club
Parnassus (fine arts, photography, films)
Residence Halls Council
Roger Williams Fellowship
Rugby Club
Sailing Club
Skiing Club
Spanish Club
Sports Car Club
Students for a Democratic Society
Student Systems Development Organization
Town Council
United Church of Christ Student Group
Westminster Fellowship
Young Americans for Freedom

Young Democrats Club
Young Republicans Club

The following Greek-letter social fraternities have chapters at Lehigh University: Alpha Chi Rho, Alpha Sigma Phi, Alpha Tau Omega, Beta Theta Pi, Chi Phi, Chi Psi, Delta Chi, Delta Phi, Delta Sigma Phi, Delta Tau Delta, Delta Upsilon, Kappa Alpha, Kappa Sigma, Lambda Chi Alpha, Phi Delta Theta, Phi Gamma Delta, Phi Kappa Theta, Phi Sigma Kappa, Pi Kappa Alpha, Pi Lambda Phi, Psi Upsilon, Sigma Alpha Mu, Sigma Chi, Sigma Nu, Sigma Phi, Sigma Phi Epsilon, Tau Delta Phi, Theta Chi, Theta Delta Chi, Tau Epsilon Phi, Theta Xi. There are also two local living groups: Das Deutsche Haus and Leonard Hall.

Student Publications and Radio

The students of Lehigh University publish a semi-weekly newspaper, *The Lehigh University Brown and White*; a literary magazine, *Paisley*, and a yearbook, *The Epitome*. The students' modern radio stations WLRN, 640 kc., and WLVR, 690 kc., (The Lehigh Radio Network) both broadcast throughout the day.

PERFORMING ARTS AND LECTURES

COMMITTEE ON PERFORMING ARTS. Founded in 1936 as the Student Concert-Lecture Series, this committee's program is a concert series presented during the academic year by the University for the student body, the faculty and staff, and the community. Included in the series are presentations by soloists, chamber and choral groups, symphonic orchestras, dramatic groups, and occasionally dance groups.

CLEAVER CONCERTS. The Cleaver Concerts, which are endowed through the gift of Mrs. Elizabeth K. Cleaver, are named for her husband, the late Albert N. Cleaver, a former trustee of the University. Some of the concerts are given by professional soloists and by chamber ensembles. Others are student performances in collaboration with professional singers and orchestra players.

POETRY READINGS. A series of poetry readings by students and faculty is offered in the University

Center on alternate Friday afternoons during most of the academic year. The series is sponsored by the Department of English and is open to the public.

BAND. The University's Concert Band, Varsity Band, and Marching Band have won national recognition for their excellence in performance and programming. Performances are given at concerts, academic convocations, and athletic events. Information on student participation in the organization is given on page 169.

GLEE CLUB. The University Glee Club has distinguished itself in performances of major choral works with orchestra, often in collaboration with choruses of women's colleges. On four different occasions the Club has visited Puerto Rico to give concerts, and it travels frequently to perform on other campuses. The Glee Club is also heard at concerts and special occasions on the Lehigh campus. Information on student participation in the organization is given on page 169.

INSTRUMENTAL ENSEMBLES. These groups consist principally of woodwind and brass players of the Band, but also include strings, piano, and voice on occasion. The concerts, which are open to the public, are presented under the sponsorship of the Department of Music and the University Center Advisory Committee.

MUSTARD AND CHEESE. The Mustard and Cheese Dramatics Club produces two major plays a year, sponsors a series of foreign-language and classic films, and occasionally presents student-produced and -directed one-act plays.

RELIGIOUS OBSERVANCES

Sunday Protestant Chapel Services are held in Packer Memorial Church under the direction of the University Chaplain.

At 9:30 A.M. there is a service of Holy Communion, according to the form contained in the Episcopal Book of Common Prayer. Everyone is invited to participate in this service, regardless of denominational affiliation.

At 11:00 A.M. services of a general Protestant character are held. Outstanding clergymen of the Church occupy the pulpit approximately once a month. On these occasions the Glee Club usually

sings. The Chaplain or a local minister delivers the sermon on the remaining Sundays.

The Roman Catholic Diocese of Allentown provides the services of a full time Chaplain to care for the spiritual life of the Catholic students. Mass is celebrated each Sunday during the academic year at 10:30 A.M. in the Osbourne Room of the University Center. Mass is also said in Packer Memorial Church on Sundays at 12:30 P.M., and at 5:00 P.M. on Mondays through Fridays.

There are also a number of special religious observances, such as the Chapel Service and Convocation at the beginning of Freshman Orientation; and the annual Christmas Vesper Choral Program on the Sunday preceding Christmas recess.

Attendance at all religious services is voluntary.

STUDY IN FOREIGN COUNTRIES

To the extent that their courses of study permit it, students maintaining a "B" average or better are encouraged to consider spending one or two semesters of study in acceptable "junior year abroad" programs or as regularly enrolled students in a foreign university. Among the accepted programs are New York University in Spain, Smith College and Wayne State University in Germany, Sweet Briar and Hamilton in France, and Dickinson College at Bologna, Italy. Students declared qualified for acceptable foreign study remain eligible to apply for financial aid from Lehigh University.

To further emphasize University interest in international study, the University has provided funds to cover transportation, tuition, and living expense stipend for a graduating senior desiring to study abroad.

COMPREHENSIVE HONORS PROGRAM

The Comprehensive Honors Program provides superior students with unusual opportunities for intellectual and scholarly development.

Freshman-Sophomore Years

These are the years in which a student normally completes his exploration of possible major fields and lays the groundwork in the chosen major and in its collateral fields. Thus, honors opportunities are limited.

Honors opportunities for freshmen consist of (1) voluntary enrollment in Honors sections of certain multi-section courses, and (2) acceleration through the attainment of advanced standing. Freshmen who qualify for enrollment in Honors sections will be notified before registration. Advanced standing may be obtained through:

- a) The CEEB Advanced Placement Program.
- b) Certification by the Office of Admission and the Registrar of college credit for certain secondary school special courses.
- c) Anticipatory Examinations during freshman week when there is substantial evidence of special achievement not covered in (a) and (b) above.

In the post-freshman summer the opportunity is offered to engage in guided but truly independent study in preparation for special examinations at the beginning of the sophomore year.

Sophomore opportunities are (1) continuation of enrollment in Honors sections and (2) automatic waiver of the junior-standing prerequisite for courses numbered "100" to "399", if the student has the course prerequisites.

Freshmen and sophomores interested in pursuing these opportunities should consult the Dean of the College in which they are registered.

Junior-Senior Years

Honor students are those students with a cumulative average of 3.0 or higher. During the junior and senior years, an honor student may choose to work for either Departmental Honors or Interdepartmental Honors. Particularly well-qualified students sometimes work for both. An honor student enrolled in one or both of these programs is designated a "University Scholar".

Students with cumulative averages of less than 3.0 may under some circumstances be permitted to work for Departmental Honors.

DEPARTMENTAL HONORS

Departmental Honors programs give the University Scholar the opportunity to study in his major field more intensively and in greater depth than the standard program provides. The precise nature of the program for each student is deter-

mined by his major department. The program may include:

- a) *Unscheduled work* (up to four hours per semester in the junior year; up to six hours per semester in the senior year).
- b) *Waiver of graduate standing to take "400" courses* if the student has the course prerequisites and if his semester schedule does not exceed fifteen hours. (Credits from such a course can be applied toward only one degree, either graduate or undergraduate.)
- c) *Honors Thesis*

A candidate for Departmental Honors must announce to his major adviser, not later than the end of his junior year, his intention to work for Departmental Honors. Each major adviser shall send the registrar, the dean of the college, and the chairman of Honors Programs, no later than the close of registration of each fall semester, the names of seniors who are working for Departmental Honors in his major. Awards are based on grades obtained in the subject chosen, the results in extra work assigned, and the general proficiency of the candidate as evidenced by either a final examination or a thesis, as the chairman of the department involved may direct.

INTERDEPARTMENTAL HONORS

The Interdepartmental Honors Program is open to undergraduates from all three Colleges. It offers to students who have demonstrated outstanding ability the opportunity to devote part of their junior and senior years to independent study through a series of limited enrollment seminars and the writing of a thesis. The seminars, one in each of the four large areas of human knowledge, combine breadth, which balances the concentration in a major, with the depth which is possible in small classes of students carefully selected from all majors. The seminars and the thesis also provide a foretaste of the kind of work and of the standards the students will encounter in graduate and professional schools.

University Scholars in this program are graduated with Interdepartmental Honors if, in addition to meeting all requirements for graduation, they have:

- (1) Completed three of the four Honors Seminars

with an average grade of at least 3.33. (University Scholars are permitted to take all four Honors Seminars in which case the required average grade for graduation with Interdepartmental Honors is 3.25.)

(2) Completed an Honors Thesis with a grade of "A".

(A University Scholar who has met all the requirements for graduation in his college but who fails to achieve the specified levels will receive his degree without Interdepartmental Honors.)

ADMISSION

Each sophomore eligible for admission to the College Honors Program will be notified of his eligibility early in his fourth semester. A student is eligible to apply for admission if he has a cumulative three-semester average of at least 3.0, or in unusual cases, has had an outstanding record in his second and third semesters.

Admission requires the approval of the chairman of the department in which an applicant is majoring and of the Honors Council.

Each applicant will be notified of the decision on his application far enough in advance of preregistration for the ensuing fall semester to make appropriate plans.

In unusual situations, an outstanding student may, with the approval of the Honors Council, schedule one or more Honors Seminars without committing himself to the whole program. Such special permission will be granted, however, only when the Council feels certain that his admission will not interfere with the maximum effectiveness of the program for those regularly enrolled.

THE PROGRAM

A student admitted to the Interdepartmental Honors Program will:

(1) Continue with his departmental major.

(2) Schedule one Creative Concepts seminar (see course offerings, page 146) each semester of his junior year and at least one seminar during his senior year. (Those University Scholars who elect to schedule only three seminars are urged to schedule those which are farthest from their major field.)

(3) Schedule Creative Concepts 190, Honors Thesis (3 to 6 credits), during one or both of the

semesters of his senior year or during the preceding summer. The work in this course will be directed by an approved member of the faculty and will culminate in the writing of an honors thesis.

University Scholars must file with the Chairman of Honors Programs a thesis proposal approved by their thesis adviser, department chairman, and the Interdepartmental Honors Council at least one week prior to the last day of registration for the semester during which Creative Concepts 190, Honors Thesis, is first scheduled.

The Interdepartmental Honors Program is administered by the Chairman of Honors Programs. The organization and conduct of the Honors Seminars will be directed by the Honors Council, which shall consist of (a) all faculty members currently teaching in the program or designated to teach in it, (b) the teacher or teachers who have conducted seminars during the preceding semester, and (c) the dean of the College, ex officio. Seminar teachers may be members of the faculty of any of the three colleges. The writing of the thesis will be directed by a member of the faculty with professorial rank.

University Scholars in the College of Arts and Science may, with the approval of the dean, substitute Creative Concepts seminars for distribution courses other than foreign languages.

GENERAL COLLEGE DIVISION

The General College Division, plans for which were approved by the faculty on April 6, 1942, was organized to supplement the work of the established undergraduate curricula by meeting the educational needs of certain special groups of students. The division aims to provide an opportunity for young men, not planning a four-year program, to pursue such work, either of a general or a more specialized nature, as their preparation and interests make desirable; a trial period for those who wish to become candidates for baccalaureate degrees but whose preparatory training does not fully satisfy the entrance requirements for the curricula of their choice; and facilities for qualified male adults to continue their education without being committed to a restricted or specialized program.

Although all work available through the General College Division will be found at present among

the regular offerings of the several departments, the work taken by students enrolled in this division is not regarded as primarily preparation for admission to the upper classes of the University; rather, the courses are looked upon as complete in themselves.

Each student in the General College Division has an individual program, one not subject to distribution or curriculum requirements, yet one limited by the student's ability to meet the prerequisites of the courses which he desires to take. With but few exceptions, the student enrolled in this division enjoys the same privileges as all other undergraduates in the University, including eligibility to unrestricted prizes, access to student aid, and the right of petition; and he is also subject to the same general regulations, those pertaining to scholastic probation not excepted. The General College Division student will not, however, be a candidate for a degree, save in those instances where transfer to one of the undergraduate programs of study leading to degrees is approved by the Committee on Standing of Students.

GENERAL INFORMATION

ACADEMIC REGULATIONS

ELIGIBILITY FOR DEGREE. In order to be graduated, a candidate for a baccalaureate degree must achieve a minimum cumulative average of 1.50. (1.70 in September, 1969).

To be eligible for a degree from Lehigh University, a student not only must have completed all of the scholastic requirements for the degree, but also he must have paid all University fees, and in addition all bills for the rental of rooms in the residence halls, or for damage to University property or equipment, or for any other indebtedness to the University. It is understood, however, that this regulation does not apply to any indebtedness for scholarship loans or for loans from trust funds administered by the University which are protected by properly executed notes approved by the Treasurer.

Unless exempted by the faculty for some special reason, such as poor health, a student must satisfy all physical education requirements in order to qualify for graduation.

FINAL DATE FOR COMPLETION OF REQUIREMENTS. For graduation all requirements, scholastic and financial, must have been met by 12 noon on the Friday preceding the graduation exercises.

NOTICE OF CANDIDACY FOR DEGREE. Candidates for graduation on University Day file with the Registrar on or before April 15 a written notice of candidacy for the degree; candidates for graduation in February file a notice of candidacy on or before January 5; candidates for graduation on Founder's Day file a notice of candidacy on or before September 10. Failure to file such notice by the dates mentioned debars the candidate from receiving the degree at the ensuing graduation exercises. If a petition for late filing is granted, a fee of \$10 is assessed.

GRADUATING THESES. Undergraduate theses, when required, are accompanied by drawings and diagrams, whenever the subjects need such illustration. The originals are kept by the University, as a part of the student's record, for future reference; but copies may be retained by students and may be published, provided permission has first been obtained from the faculty.

CREDIT AND GRADES. A semester hour of college work consists of one hour a week of lectures or class work, or two or three hours of laboratory work (or laboratory work combined with class work) a week for one semester. The normal assumption is that the student will be expected to do at least two hours of study in preparation for each hour of class work.

Final grades in courses are A, B, C, D, and F. A, B, C, and D are passing. The key to grades is as follows: A—Excellent; B—Good; C—Satisfactory; D—Passing; F—Failure. Physical education is marked P (passing) or F (failure) without hour credit.

A student who withdraws from a course during the first seven weeks of instruction will receive a grade of "W." A student who withdraws from a course after the first seven weeks of instruction will receive "WF" unless the committee on standing of students, for cause, allows a grade of "W" to be recorded.

A student officially withdrawn from the Univer-

sity after the seventh week of instruction shall receive from each instructor a "WP" or "WF."

The letters "Abs." (absent) are used to indicate absence from a final examination in a course. The grade of "Abs." is reported with a letter grade in parentheses, such letter grade representing the department's estimate of the student's work up to the close of instruction with the provision that in cases where a department does not feel justified in reporting an estimated grade, a report of "Abs. (X)" will be returned.

The letters "Inc." are used to indicate that the work in a course is incomplete. The grade is accompanied by a letter grade. A student who incurs an "incomplete" in any course and fails to remove the "incomplete" within one calendar year, loses all equity in the course.

PROBATION AND DROP REGULATIONS

GENERAL. The scholastic requirements for each student are expressed in terms of his cumulative scholastic average (the weighted point average of all grades received in residence). The cumulative scholastic average will be computed at the end of each semester (and full summer session, i.e., one in which 12 or more semester hours have been rostered). Grades are weighted as follows: A, 4; B, 3; C, 2; D, 1; F, WF, Abs.F., Inc.F., 0.

GRADUATION REQUIREMENT. A student must have a cumulative scholastic average of 1.70 or better in order to be eligible for graduation. This cumulative scholastic average includes all courses passed or failed while in residence.

PROBATION. A student will be placed on scholastic probation when either:

(a) His cumulative scholastic average falls below these levels:

	1968	1969
Freshman, 1st Semester	1.10	1.30
Freshman, 2nd Semester	1.20	1.40
Sophomore, 1st Semester	1.30	1.50
Sophomore, 2nd Semester	1.40	1.60
Junior, 1st Semester, and thereafter	1.50	1.70

(b) He fails more than 7 semester hours in one semester.

The designation "Freshman, 1st Semester," etc., is the classification officially determined by the Registrar irrespective of the number of semesters the student has attended college.

DISABILITIES OF SCHOLASTIC PROBATIONERS. A student who is on scholastic probation is ineligible for (a) intercollegiate competition and all other activities publicly representative of the University, (b) major office (elective or appointive) in any University organization, and (c) such other activity as may require more time than should be diverted from primary purposes by any student whose academic survival is at risk.

REMOVAL FROM PROBATION. A student who has been placed on scholastic probation is restored to good standing if at the end of his next semester or full summer session he meets the standards indicated.

DROPPED FOR POOR SCHOLARSHIP. A student who makes a 2.00 average or better in his probationary semester but fails to meet the standards set forth in paragraph three above is continued on scholastic probation for another semester. A student who makes less than a 2.00 average in his probationary semester and fails to meet the standards in paragraph three above is dropped for poor scholarship.

HONORS

Honors are of four kinds: class honors, graduation honors, departmental honors, and interdepartmental honors. (For interdepartmental honors, see page 20.)

CLASS HONORS. Upon completion of the work of the freshman and sophomore years, on recommendation of the Registrar and by vote of the faculty, class honors are awarded to those individuals who have made an average of 3.00 or better during the preceding year.

The names of these students are announced at the Founder's Day exercises and published in the Founder's Day Program.

GRADUATION HONORS. Degrees "with honors" are awarded by vote of the faculty to those students who have attained an average of not less than 3.00 in their last two years' work at the University.

Degrees "with high honors" are awarded by vote of the faculty to those students who have attained an average of not less than 3.50 in their last two years' work at the University.

Degrees "with highest honors" are awarded by vote of the faculty to those students who have attained 3.75 in their last two years' work at the University.

Candidates for graduation who have been in residence at the University for less than two years are not eligible for graduation honors.

Graduation honors are announced at the graduation exercises.

In computing the averages of candidates for graduation honors, semester grades are weighed according to the number of credit hours in the course concerned on the basis: A equals 4, B equals 3, C equals 2, D equals 1, and F equals 0.

DEPARTMENTAL HONORS. Special honors are awarded at the end of the senior year, on recommendation of the head of the department concerned and by vote of the faculty, to students who have done advanced work of unusual merit in some chosen field. Candidates for departmental honors must indicate to the head of the department concerned and to the Registrar during the junior year their intention to work for such honors. Awards are based on grades obtained in the subject chosen, the results in extra work assigned and the general proficiency of the candidate as evidenced either by a final examination or a thesis, as the head of the department involved may direct. Departmental honors are announced at the graduation exercises.

LATEST DATE FOR REGISTRATION. No registration is accepted later than the tenth day of instruction in any semester.

USE OF MOTOR VEHICLES

Permission for students to have and to operate motor vehicles while in residence is granted so long as there is no evidence that having such a motor vehicle interferes with academic progress and the demands of good citizenship, except that:

Any student operating a motor vehicle on the property of the University must register it with the Office of the Dean of Students and must conform to the regulations of that office.

A freshman is not permitted to have or to operate a motor vehicle while in residence.

A sophomore will be issued a motor vehicle permit provided:

- a. He has applied to the Dean of Students for the permit and has submitted a written request from his parents supporting the application.
- b. He has a cumulative average of 1.5 or better and is in good standing academically.
- c. His permanent record shows no adverse action by the University Discipline Committee.
- d. He and his motor vehicle are adequately covered by liability insurance.
- e. His application has been approved by the Dean of Students.

A sophomore permit shall automatically become invalid if changes in the student's record are such that they would have prevented the issuing of a permit originally.

Exceptions to the foregoing may be made for students living at home, for students under medical care, or in other exceptional cases upon petition by the student to the Dean of Students.

The University reserves the right, for cause, to deny to any student permission to have or to operate a motor vehicle while in residence. The University assumes no jurisdiction over the use of a motor vehicle on family business by a student living at home.

COLLEGE OF ARTS AND SCIENCE

W. Ross Yates, *Dean*
G. Mark Ellis, *Assistant Dean*

The College of Arts and Science of Lehigh University comprises the departments of biology, classical languages, English, fine arts, geology, German, government, history, international relations, mathematics and astronomy, music, philosophy, psychology, religion, romance languages and social relations. Interdepartmental programs are offered in foreign careers, Natural Science, American Studies, and natural resources. Students in Arts and Science may also major in economics, accounting, finance, physics, and chemistry.

The degree of Bachelor of Arts is conferred upon graduates of the College.

PURPOSES

Under the name "School of General Literature," the College of Arts and Science was a part of the original plan of the University, and its aims have remained constant, although the means employed have been adapted to the changing times.

The purpose of the College is to prepare a man for the exercise of his individual responsibility in the affairs of mature life. This purpose recognizes three distinguishing characteristics of an educated man: the ability to think in a disciplined manner, the ability and willingness to make discriminating judgments, and the capacity to apply his creative imagination.

In order to achieve this purpose the faculty shares with the student the range of human knowledge: the world of fact, and its counterpart, the world of ideas. The fundamentals of this experience remain what they have been for generations: a comprehensive study of all the broad areas of knowledge — the humanities, the natural and physical sciences, and the social sciences — and a rigorous training in one of them.

PREPARATION FOR GRADUATE AND PROFESSIONAL SCHOOLS

A large proportion of the graduates of the College of Arts and Science continue their work in graduate or professional schools. Students preparing for graduate or professional studies will work out a suitable program with the appropriate advisors.

PRE-MEDICAL AND PRE-DENTAL. Students preparing for medical or dental school will plan a program of studies in cooperation with the Dean or the Assistant Dean of the College, the advisor of their major program, and the pre-medical advisor. A Pre-Medical Advisory Committee assists in helping students prepare applications for medical or dental school.

PRE-LEGAL. Students interested in preparing for law school will work out a program of studies in cooperation with their major advisor. Information on requirements for entry into law school is available from Dean Ellis in the College Office or from Mr. Whitcomb in the Department of Government.

PRE-THEOLOGICAL. Students will select an appropriate major field and work out a program in connection with the major and spiritual advisors.

PRE-ARCHITECTURAL. The University offers no curriculum in architecture but can assist students in preparing for professional education in architectural schools. Professor Francis J. Quirk, Department of Fine Arts, is advisor to pre-architectural students.

GRADUATE SCHOOL. Students interested in preparing for graduate school will plan their program in collaboration with the department in which their major is located.

TEACHING. Students planning teaching careers in primary or secondary schools are encouraged to select a major in the field in which they intend to teach and to postpone their professional courses in education to the graduate level. The School of Education provides information on graduate programs in education and requirements for certification in the several states.

THE CURRICULA

The College of Arts and Science offers two curricula: the four-year curriculum with a major in one of the arts or sciences, and the five-year curriculum in Arts-Engineering. Both are based on the principles of distribution and concentration. Distribution requirements are the same for both curricula. In the Arts-Engineering program, the Engineering

general studies requirements are met by completing the Arts College distribution requirements.

This reciprocal arrangement makes it impossible for an Arts-Engineer to qualify for a B.S. in engineering before he has met all requirements for the B.A.

DISTRIBUTION REQUIREMENTS

The object of the distribution requirements is to give the student an elementary knowledge of the fields of contemporary thought and to orient him in the world of man and nature. The requirements also provide opportunities for students to take additional work in fields related to their major field of concentration.

The distribution requirements are administered by the dean of the College of Arts and Science in accord with the group regulations given below. The subjects required of the individual student depend in part upon the field in which he expects to major, in part upon his personal preference, and in part upon the subjects he has taken in secondary school.

Honors students in either curriculum may, with the approval of the dean, substitute Creative Concepts seminars for distribution courses other than foreign languages.

I. Required Courses

A. FRESHMAN ENGLISH. The normal requirement is Engl. 1 and 2, Composition and Literature. Students who demonstrate satisfactory ability in written composition in the freshman placement tests will meet this distribution requirement by passing Engl. 11 and 12, Types of World Literature.

When a freshman completes Engl. 11 and 12 with a grade of B or better, he is given, in addition to the 6 hours of credit for those courses, 6 hours of advance standing credit for Engl. 1 and 2.

B. MATH. 6, 21, or PHIL. 14. The course selected cannot also be used to satisfy the requirements enumerated under subheads III or IV below.

II. Foreign Language

Number of hours varies depending on previous language study. Each student is required to achieve third-year level proficiency in one language, as determined by the appropriate language department. Students who present at entrance three or

four years of foreign language normally are able to meet this requirement with one year of advanced college work. Eighteen hours of course work are normally taken by students who begin a new language in college.

A student is not allowed to receive college credit for course work in a language taken at a level lower than his previous study of that language warrants.

With the approval of the dean of the College, an option is offered those who find it necessary to pursue in college the study of two foreign languages, provided that neither language was studied in secondary school. Such students may offer in satisfaction of the language requirement two years (12 hours) of one foreign language and one year (6 hours) of another.

III. Humanities

Twelve semester hours, chosen from at least two of the following groups:

A. LITERATURE (Courses in English or American Literature; Greek, Latin, or modern foreign literature in translation; or literature courses at the third-year level or higher in a foreign language, provided that such courses are not also used to satisfy the Foreign Language requirement).

B. FINE ARTS, MUSIC, OR ARCHAEOLOGY (if not used for social science requirement).

C. PHILOSOPHY.

D. RELIGION.

IV. Natural Sciences and Mathematics

Twelve semester hours, chosen from at least two of the following groups:

A. ASTRONOMY.

B. BIOLOGY.

C. CHEMISTRY.

D. GEOLOGY.

E. MATHEMATICS.

F. PHYSICS.

G. PSYCHOLOGY.

V. Social Sciences

Twelve semester hours, chosen from at least two of the following groups:

A. SOCIOLOGY, CULTURAL ANTHROPOLOGY, SOCIAL PSYCHOLOGY.

- B. ANCIENT CIVILIZATION, HISTORY, ARCHAEOLOGY.
- C. GOVERNMENT, INTERNATIONAL RELATIONS, ECONOMICS.

Concentration Requirements

Concentration Requirements in Arts and Science

During the second semester of the freshman year if possible, and in any event no later than the end of the sophomore year, each student in the four-year Arts and Science curriculum must select some sequence of studies as his major field. *A major consists of at least twelve semester hours of advanced work in the field chosen.* Including preliminary college work, the minimum number of hours constituting a major is twenty-four. The actual major requirements are those stated under "Details of Major Sequences," pages 29-43.

The major work is designed to enable a student to master his chosen field so far as that is possible during undergraduate years. In all fields, certain courses are prescribed, but the mere passing of courses will not satisfy the major requirements. A student must achieve a minimum 2.0 average in his major courses. It is expected that the student will read widely in his subject and will prepare himself largely through his own reading.

When a student selects a major, the chairman of the department offering the major or the official director of a non-departmental major becomes the student's major adviser and makes out his major program. This program must have the approval of the College Office, which continues to supervise the non-major portion of the student's roster.

Concentration Requirements in Arts-Engineering

The standard major for students enrolled in the five-year Arts-Engineering curriculum is Applied Science (page 43). This major is normally completed during the first four years, during which the dean of the College of Arts and Science is the student's official adviser. At the end of the fourth year it is expected that Arts-Engineering students will have taken their B.A. degree and will transfer to the appropriate engineering curriculum for their final year. The chairman of the appropriate engineering department, who has meanwhile been acting as ad-

viser of the major sequence, becomes official adviser for the fifth year.

Pattern rosters which show the normal combination of courses for the first four years of the Arts-Engineering curriculum are given on pages 44-48.

Arts-Engineering students are encouraged to take one of the other majors offered in the College of Arts and Science. This program must have the approval of both the dean of the College of Arts and Science and the department chairman under whom work for the B.S. will be completed. In some instances it may be advisable to take the two degrees at the end of the fifth year.

To qualify for both the B.A. and the B.S. in Engineering, a student must submit for the second degree thirty credit hours in addition to the number required for the B.S. alone.

SUPERVISION AND COUNSELING

Each student in the College of Arts and Science is considered from the beginning as an individual. The College expects every student to have a well-defined purpose at entrance, but recognizes the student's right to change his objectives and for that reason gives him time in which to find himself and establish the direction of his future career. To help the student in his decision, the College provides an advisory staff consisting of the dean of the College, the assistant dean, his faculty assistants, and the directors of the major sequences. The individual program for each student is outlined tentatively in an interview with the dean of the College, the assistant dean, or one of his assistants, at or before the beginning of the first semester of the freshman year. This preliminary program is determined by the nature and quality of the student's preparation and by his personal interests. The final program, which is made out in detail no later than the end of the sophomore year, takes into account, in addition, demonstrated aptitudes and pre-professional or vocational needs.

These individual programs admit of considerable elective choice, depending upon the demands of the distribution and concentration requirements. In general the student in the College of Arts and Science may elect any undergraduate course for which he has the prerequisites.

REQUIREMENTS FOR GRADUATION

These are three basic requirements for graduation with a B.A. in either curriculum:

1. The completion with the required average of a minimum of 120 credit hours of collegiate work, apportioned so as to cover the distribution and concentration requirements. Physical education and basic courses in military or air science are carried in addition. No more than six hours of advanced air science may be counted towards graduation credit.

2. The passing of an impromptu writing test in the junior year.

3. The satisfactory completion of all requirements for one major sequence, including a 2.0 average in the major field of concentration (except the major in Applied Science).

Junior English Impromptu

Toward the end of his junior year, each student in the College of Arts and Science must report to the department of English for an exercise in impromptu writing. Students found seriously deficient in this test are reported to the dean of the College, who may require that they take additional English without credit toward graduation.

Students in the College of Arts and Science who persistently use poor English may be reported at any time to the dean of the College. He may require that they undertake additional study in English without credit toward graduation.

Comprehensive Examination

A comprehensive examination in the major field is required of students in some major fields of concentration. The student should consult the section "Details of Major Sequences", pages 29 to 43 to determine which majors require successful completion of a senior comprehensive examination. The comprehensive examination is given under the direction of the chairman of the major department. At the discretion of the various departments, the appropriate Graduate Record Examination may be made a part of the comprehensive.

No student is allowed to take the senior comprehensive examination more than twice in any one field. In case of failure on the first attempt, a second trial is not permitted until a period of three months has passed.

ARTS-M. B. A. PROGRAM

This five year, two-degree program is designed to meet the needs of competent students in any of the Arts and Science majors (other than Accounting, Economics, or Finance) who wish to supplement their liberal education with graduate training in business management.

The normal over-all time involved in the two-degree program is five years, but a certain amount of summer session work may be necessary for majors in the natural sciences. In addition to three hours in economics, which may be counted as part of the distribution requirements in Social Science, twenty-seven hours of basic business courses are necessary to meet the background requirements for the M.B.A. degree.

These background courses are:

ECO	3 PRINCIPLES OF ECONOMICS	3
FIN	125 PRINCIPLES OF CORPORATE FINANCE	3
LAW	1 BUSINESS LAW	3
ECO	45 STATISTICAL METHOD	3
ECO	306 INTERMEDIATE ECONOMIC THEORY	3
ECO	129 MONEY AND BANKING	3
ACCTG	51 ACCOUNTING AND	6
ACCTG	52 ACCOUNTING OR	
ACCTG	108 FUNDAMENTALS OF ACCOUNTING AND	6
ACCTG	324 COST ACCOUNTING	
MKT	11 MARKETING	3
ACCTG	111 BUSINESS DATA PROCESSING	3

All students enrolled in this program will be required to take the Admission Test for Graduate Study in Business.

Arts and Science students who are interested in this program should confer with Business and Economics Assistant Dean Max D. Snider for additional information.

Transfer credits from a reputable accredited college or university will be accepted for background courses. Students wishing to take some of their background work elsewhere should consult Dean Snider to obtain approval of the proposed course or courses and of the institution at which they are to be taken.

HONORS AND UNSCHEDULED WORK

Qualified students in both curricula in the College of Arts and Science may choose to work for either Departmental or Interdepartmental Honors. Par-

ticularly well-qualified students sometimes work for both.

Departmental Honors

Departmental honors are awarded at the end of the senior year, on recommendation of the chairman of the department concerned and by vote of the faculty, to students who have done advanced work of unusual merit in some chosen field. A candidate for departmental honors must announce to his major adviser, not later than the end of his junior year, his intention to work for Departmental Honors. Each major adviser shall send the registrar and the College Office, no later than the close of registration of each fall semester, the names of seniors who are working for Departmental Honors in his major. Awards are based on grades obtained in the subject chosen, the results in extra work assigned, and the general proficiency of the candidate as evidenced by a thesis.

A student in Departmental Honors is granted a waiver of graduate standing to take courses numbered 400 and above if the student has the course prerequisites and if his semester schedule does not exceed fifteen hours.

Interdepartmental Honors

The Interdepartmental Honors Program offers students who have demonstrated outstanding ability the opportunity to devote part of their junior and senior years to independent study through a series of limited enrollment seminars and the writing of a thesis. For a description of the program see p. 20.

Honor students in the College of Arts and Science may, with the approval of the dean, substitute Creative Concepts seminars for distribution courses other than foreign languages.

Unscheduled Work

On the advice of the chairman of the student's major department and with the consent of the dean of the College, a junior or a senior of unusual merit who wishes to concentrate in his chosen field may be allowed to substitute not more than four or six hours respectively of unscheduled work per semester for an equal number of hours of elective work otherwise required for graduation.

This provision is particularly useful for the honors candidate who wishes to pursue independent

study in connection with his extra work of honors thesis. Interested students should consult their department chairmen.

DETAILS OF MAJOR SEQUENCES

AMERICAN STUDIES

This is an interdepartmental major emphasizing the idea that the institutions and values of a society comprise a whole and not merely a sum of separate parts. By concentrating on the unique expressions of individuals contained in the literature of America and by studying the historical movements within which these expressions develop, American Studies reveals relationships which may not be clearly seen within the framework of a single discipline. By carefully chosen electives the student can add to the insights of literature and history. Thus, for example, a student may pursue the relationship of the behavioral sciences to history and literature or use the various disciplines to give greater comprehension of the problems of the American city. In addition, the study in depth of one's own environment provides the student with a greater awareness of the forces which have shaped his world and his character and should produce a greater sensitivity to the values of his own society.

The major consists of sequences in American history and literature, followed by eighteen hours of advanced study divided equally between American history and American literature. Six hours of either European literature or European history will be taken after consultation with the director. In his senior year the student will take two seminars, respectively, in literature and history organized around some single theme in their respective fields. The major requirements total 42 hours.

Because the emphasis is strongly placed on American history and literature, an undergraduate American Studies major will provide thorough preparation for graduate work in American Studies and, with suitable collateral courses, American literature or American history. In addition, the major may help in preparing students for advanced work in law, theology, and teaching in secondary schools and community colleges.

Required Preliminary Courses

HIST 13, 14	AMERICAN CIVILIZATION	6
ENGL 20, 21	AMERICAN LITERATURE	6

Required Major Courses

ENGL 321	20TH CENTURY AMERICAN LITERATURE	9
ENGL 341	CONTEMPORARY AMERICAN LITERATURE	
ENGL 343	AMERICAN ROMANTICISM	
ENGL 344	AMERICAN REALISM	
HIST 319	17TH CENTURY AMERICA	
HIST 320	18TH CENTURY AMERICA	
HIST 327	AMERICAN INTELLECTUAL HISTORY	9
HIST 328	AMERICAN INTELLECTUAL HISTORY	

Options*

HIST	EUROPEAN HISTORY	6
ENGL	EUROPEAN LITERATURE	6

*Choice of options and electives to be made in consultation with adviser.

Required Senior Seminars

ENGL 345	THEMES IN AMERICAN LITERATURE	3
HIST 374	THEMES IN AMERICAN HISTORY	3

A senior comprehensive examination is required.

BIOLOGY

The biology major serves several purposes. It provides training for students aiming for graduate study in any of the biological sciences. The program also exceeds the minimum science requirements for admission to medical, dental and allied professional colleges. Finally, the major offers a terminal A.B. degree for students interested in the science of life yet aiming for a career in the business world, teaching at the pre-college level, or some other profession.

To fulfill all of these functions the biology major combines a maximum choice of biology elective courses with a strong requirement in chemistry, physics and mathematics. This enables students to channel their biology training along paths suitable to their interests, aims and competence while, at the same time, it ensures adequate training in other sciences upon which much of contemporary biology is based.

The required biology courses include 7 hours scheduled in the freshman year (Biol. 21, 22, 28 — Introductory Biology and Genetics) and 3 hours scheduled in the senior year (Biol. 272 — Senior Seminar). In addition the student is required to elect 18 credits from the following list of biology courses:

Required Preliminary Courses

BIOL 34	COMPARATIVE VERTEBRATE ANATOMY	4
BIOL 35	MICROBIOLOGY	3

BIOL 221	UNDERGRADUATE RESEARCH	3
BIOL 261	SPECIAL TOPICS IN BIOLOGY	1-3
BIOL 303	ADVANCED INVERTEBRATE ZOOLOGY	3
BIOL 306	ECOLOGY	3
BIOL 313	GENERAL HISTOLOGY	3
BIOL 314	VERTEBRATE EMBRYOLOGY	3
BIOL 320	PHYSIOLOGY	3
BIOL 334	GROWTH AND DEVELOPMENT IN PLANTS	3
BIOL 336	EVOLUTION OF LAND PLANTS	3
BIOL 353	VIROLOGY	3
BIOL 361	SANITARY MICROBIOLOGY	3

For students interested in applying to medical, dental or veterinary colleges, Biol. 34, Comparative Vertebrate Anatomy, and Biol. 314, Vertebrate Embryology, are recommended electives

For students interested in graduate study, Chem. 91, Physical Chemistry, and Chem. 371, Elements of Biochemistry, are suitable electives that may be substituted for biology electives. For these students an additional mathematics course, Math. 23, is recommended, as well as substitution of Physics 3 & 4 for Physics 16 & 17.

Additional Required Courses

MATH	21	ANALYTIC GEOMETRY & CALCULUS I	
MATH	8	ELEMENTARY STATISTICS	
	OR		
MATH	22	ANALYTIC GEOMETRY & CALCULUS II	
CHEM	1 & 11	CHEMISTRY PRINCIPLES I & LABORATORY	
CHEM	3 & 13	CHEMISTRY PRINCIPLES II & LABORATORY	
CHEM	51, 52 & 53	ORGANIC CHEMISTRY & LABORATORY	
CHEM	39	ANALYTICAL CHEMISTRY	
PHYS	1, 16 & 17	MECHANICS OF MASS POINTS, GENERAL	

Recommended Sequence of Courses*Freshman Year*

BIOL	21	PRINCIPLES OF BIOLOGY	3
BIOL	22	INTRODUCTION TO BIOLOGY LABORATORY	1
CHEM	1	CHEMICAL PRINCIPLES I	3
CHEM	11	CHEMICAL PRINCIPLES I LABORATORY	1
MATH	21	ANALYTICAL GEOMETRY & CALCULUS I	4
BIOL	18	GENETICS	3
CHEM	3	CHEMICAL PRINCIPLES II	3
CHEM	13	CHEMICAL PRINCIPLES II LABORATORY	1
MATH	8	ELEMENTARY STATISTICS	3
	OR		
MATH	22	ANALYTICAL GEOMETRY & CALCULUS II	4

Sophomore Year

CHEM	51	ORGANIC CHEMISTRY	3
CHEM	53	ORGANIC CHEMISTRY LABORATORY	2
CHEM	52	ORGANIC CHEMISTRY	3
PHYS	1	MECHANICS OF MASS POINTS	3
BIOL	ELECTIVE		3 OR 6

Junior Year

CHEM	39	ANALYTICAL CHEMISTRY	3
PHYS	16	GENERAL PHYSICS	3
PHYS	17	GENERAL PHYSICS LABORATORY	2
BIOL	ELECTIVES		3 OR 6

Senior Year

BIOL 272 SENIOR SEMINAR	3
BIOL ELECTIVES	3

Biology: Natural Resources Option. Students interested in natural resources and their conservation may take the major in biology, slightly modified to permit taking collateral courses in geology and other pertinent fields.

CHEMISTRY

Students in the College of Arts and Science who wish to major in Chemistry should consult the general description given on pages 63 and 64 of this catalog. The B.A. degree with major in Chemistry permits somewhat greater latitude in the selection of courses than does the B.S. degree curriculum, but does require the student to take six more hours of language than the B.S. candidate. Adequacy in German will be found beneficial for those having a professional interest in Chemistry. (See German requirements on page 37). Premedical students should note that the B.A. program in Chemistry has sufficient latitude to permit a very strong preparation for medical school.

It is to be emphasized that both B.A. and B.S. degrees are drawn up to permit a graduate to embark immediately upon graduate school work.

Required Preliminary Courses*Freshman Year*

CHEM 1, 11; 3, 13 CHEMICAL PRINCIPLES	8
MATH 21, 22 ANALYTICAL GEOMETRY AND CALCULUS I AND II	8
PHYS 1 MECHANICS OF MASS POINTS	3

Required Major Courses*Sophomore Year*

MATH 23 ANALYTICAL GEOMETRY AND CALCULUS III	4
PHYS 3 HEAT AND ELECTRICITY	4
PHYS 4 ELECTRIC LIGHT & ATOMIC PHYSICS	4
CHEM 51, 52 ORGANIC CHEMISTRY	6
CHEM 53, 54 ORGANIC CHEMISTRY	4
CHEM 91 PHYSICAL CHEMISTRY	3

Junior Year

CHEM 190 PHYSICAL CHEMISTRY	3
CHEM 192 PHYSICAL CHEMISTRY LABORATORY	1
CHEM 193 PHYSICAL CHEMISTRY LABORATORY	1
CHEM 232 ANALYTICAL CHEMISTRY	3
CHEM 302 PRINCIPLES OF INORGANIC CHEMISTRY	
CHEM 352 HETEROCYCLIC COMPOUNDS	
CHEM 358 ADVANCED ORGANIC CHEMISTRY	

Senior Year

CHEM 234 ANALYTICAL CHEMISTRY LABORATORY	2
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CHEM 381 RADIATION AND STRUCTURE	3
CHEM 382 STRUCTURE, ELECTROCHEM & KINETICS	4

And a selection from the following

CHEM 303 NUCLEAR AND RADIOCHEMISTRY	3
CHEM 306 INORGANIC PREPARATIONS	2
CHEM 308 COORDINATION CHEMISTRY	3
CHEM 371 ELEMENTS OF BIOCHEMISTRY	3
CHEM 372 ADVANCED BIOCHEMISTRY	3
CHEM 375 RESEARCH CHEMICAL LABORATORY	3
CHEM 377 BIOCHEMISTRY LABORATORY	1-3
CHEM 378 BIOCHEMICAL PREPARATIONS	1-3
CHEM 392 POLYMER SCIENCE	3
CHEM 397 COLLOID AND SURFACE CHEMISTRY	3

A senior comprehensive examination is required.

CLASSICAL LANGUAGES

Majors in Classical Languages seek, through insight into the culture of ancient Greece and Rome, to gain an appreciation of Greco-Roman achievements in art, literature, philosophy, and science, and to formulate an evaluation of the importance of these for modern culture. Readings in the original languages of masterpieces, chosen both for their usefulness in developing skill in the languages and for their intrinsic worth and abiding importance, aim at developing an accumulative growth in the mastery of the languages and in the ability to interpret, criticize, and evaluate the achievements of classical civilization.

The basic work is supplemented by studies in the history, archaeology, art, philosophy, and literary history of Greece and Rome, and by an introduction to the basic tools and disciplines of scholarly research in this area. Students are encouraged to undertake research in fields of their own interest.

Classical Languages as a major has stood the test of time, offering a general cultural background for careers in widely diverse fields in the professions, business, and public service. It has particular relevance as a preparation for careers in teaching, law, writing, archaeology, and the church.

Lehigh University is a cooperating institution of The American School of Classical Studies at Athens. Graduates of Lehigh University receive free tuition in the School.

Group I (Emphasis upon Greek).**Required Preliminary Courses**

GK 1, 2 ELEMENTARY GREEK	6
GK 3, 4 SECOND-YEAR GREEK	6

Required Major Courses

GK	11, 12 GREEK DRAMA	6
GK	13 GREEK HISTORIANS	3
GK	16 GREEK EPIC	3
GK	311 HOMER	3
GK	316 PLATO	3
GK	21 ANCIENT HISTORY	3
LAT	22 ANCIENT HISTORY	3

Six hours of Latin language, specific courses depending on the student's preparation.

Group 2 (Emphasis upon Latin).

Required Preliminary Courses

LAT	61 ELEMENTARY LATIN	3
LAT	62 CAESAR	3
LAT	63 NEPOS AND CICERO	3
LAT	65 VERGIL	3

Required Major Courses

GK	21 ANCIENT HISTORY	3
LAT	22 ANCIENT HISTORY	3
LAT	166 HORACE	3
LAT	167 ROMAN PROSE WRITERS	3
LAT	168 LATIN DRAMA	3
LAT	169 SATIRE	3
LAT	211 READINGS	3
LAT	212 READINGS	3

Six hours of Greek language, specific courses depending on student's preparation.

Recommended Electives

ASTR	1 DESCRIPTIVE ASTRONOMY	3
ASTR	2 GENERAL ASTRONOMY	3
FA	5 FUNDAMENTALS OF ART	3
FA	3 PRE-RENAISSANCE ARCHITECTURE	3
HIST	25 EUROPEAN HISTORY	3
HIST	351 THE MIDDLE AGES	3
PHIL	331 ANCIENT PHILOSOPHY	3
SR	31 CULTURAL ANTHROPOLOGY	3

A senior comprehensive examination is required.

CONSERVATION

See Natural Resources, page 39.

ECONOMICS AND BUSINESS ADMINISTRATION

Three majors are offered in the field of economics and business administration: economics, finance, and accounting. See also the Arts-M.B.A. Program, page 28.

Economics.

Required Preliminary Courses

Freshman Year

ECO	3, 4 PRINCIPLES OF ECONOMICS	6
MATH	21 & 22 ANALYTIC GEOMETRY AND CALCULUS I & II	8

Required Major Courses

<i>Sophomore Year</i>	
ECO	206 INTERMEDIATE ECONOMIC THEORY
ECO	316 INTERMEDIATE MACRO-THEORY
ECO	45 STATISTICAL METHOD
ECO	129 MONEY & BANKING
<i>Junior Year</i>	
ECO OR FIN	ANY 300-LEVEL COURSE
<i>Senior Year</i>	
ECO OR FIN	ANY 300-LEVEL COURSE

A senior comprehensive examination is required.

Finance.

Required Preliminary Courses

ECO	3, 4 ECONOMICS	6
MATH	21, 22 ANALYTIC GEOMETRY AND CALCULUS I, II	6
FIN	125 CORPORATION FINANCING	3
ECO	129 MONEY AND BANKING	3
ECO	45 STATISTICAL METHOD	3
ACCTG	108 FUNDAMENTALS OF ACCOUNTING	3

Required Major Courses

FIN	323 INVESTMENTS	3
FIN	326 PROBLEMS IN FINANCIAL MANAGEMENT	3
ECO	351 PUBLIC FINANCE: FEDERAL	3
ECO	316 INTERMEDIATE MACRO-ECONOMIC THEORY	3
	OR	

ECO 332 MONETARY-FISCAL POLICY

<i>plus six semester hours selected from the following:</i>	
FIN	324 INVESTMENTS
ECO	316 INTERMEDIATE MACRO-ECONOMIC THEORY
	OR
ECO	332 MONETARY-FISCAL POLICY
ECO	337 INTERNATIONAL ECONOMICS
FIN	331 BANK MANAGEMENT

Accounting*

Required Preliminary Courses

ACCTG	51, 52 ESSENTIALS OF ACCOUNTING	6
ECO	3, 4 ECONOMICS	6
MATH	21, 22 ANALYTIC GEOMETRY AND CALCULUS I AND II	8

Required Major Courses

ACCTG	111 BUSINESS DATA PROCESSING	3
ACCTG	213, 214 INTERMEDIATE ACCOUNTING	6
FIN	125 CORPORATION FINANCE	3
ECO	129 MONEY AND BANKING	3
LAW	1, 102 BUSINESS LAW	6
ECO	45 STATISTICAL METHOD	3

plus six semester hours of 300-level accounting courses

*Students interested in qualifying for the CPA certificate at either the bachelor or M.B.A. level should consult the chairman of the Department of Accounting or their major adviser.

ENGLISH

Two majors are offered by the department of English: English literature, and journalism.

English Literature.

Literature is a representation of life at the level of man's individual, human dealings with his fellow men. It is man's response to the physical, emotional, intellectual, and moral conditions of his existence. A literary work is one author's ordering and interpretation of his experience, revealing whatever wisdom and beauty his vision of the universe affords him. It both illuminates human experience and is a joy forever.

When these works are seen as the diverse and yet unified expressions of an epoch, they provide insight into the human problem and solution at a particular moment in time. Put together epoch after epoch, they thus become, in a peculiarly rich and inward sense, a form of history. Among world literatures English is perhaps the most varied and splendid and, together with American literature, presents in today's international setting an unusual breadth of national, racial, regional, and cultural subjects.

The English major student will come to know the varied richness of this literature. So that he may learn how to read thoughtfully and sensitively, he will be taught how to analyze the basic processes of the literary art. His own skill in using the written word will grow as he studies intensively the writings of those who have shown themselves to be the supreme masters of the skill. Above all, he will be challenged to formulate honest reactions to his reading just as writers originally did when confronted by experience; and so, by integrating his own experience with what Matthew Arnold called "the best that has been thought and said," he will come to perceive whatever wisdom and beauty his own enriched vision will afford him. The resulting enlargement of mind and spirit not only should produce a flexible, yet well-integrated, personality but also can be put at the service of society in whatever profession or enterprise the student may undertake.

Required Preliminary Courses

ENGL 1, 2 COMPOSITION AND LITERATURE 6
OR

ENGL 11, 12 TYPES OF WORLD LITERATURE AND	6
ENGL 8, 9 ENGLISH LITERATURE	6
Required Major Courses	
ENGL 323, 324 SHAKESPEARE & ELIZABETHAN DRAMA	6
<i>and twenty-four semester hours from the following courses:</i>	
ENGL 183, 184 READINGS IN ENGLISH LITERATURE	6
ENGL 321, 322 TWENTIETH-CENTURY LITERATURE	6
ENGL 325 ENGLISH LITERATURE OF THE ROMANTIC ERA	3
ENGL 326 ENGLISH LITERATURE OF THE VICTORIAN ERA	3
ENGL 331 MILTON	3
ENGL 333 RESTORATION AND AUGUSTAN LITERATURE	3
ENGL 334 THE AGE OF JOHNSON	3
ENGL 335 HISTORY OF THE ENGLISH LANGUAGE	3
ENGL 336 WRITING FOR PUBLICATION	3
ENGL 337 THE RENAISSANCE	3
ENGL 338 THE SEVENTEENTH CENTURY	3
ENGL 339 CHAUCER	3
ENGL 340 ADVANCED COMPOSITION	3
ENGL 341, 342 CONTEMPORARY LITERATURE	6
ENGL 343 AMERICAN ROMANTICISM	3
ENGL 344 AMERICAN REALISM	3
ENGL 345 THEMES IN AMERICAN LITERATURE	3
ENGL 346 MIDDLE ENGLISH LITERATURE	3

Up to six hours related courses in other departments may be substituted with the approval of chairman of department.

A senior comprehensive examination is required.

Collateral courses are recommended in history, philosophy, history and criticism of the fine arts, and classical and modern languages and literature. Students planning to pursue graduate studies should acquire a reading knowledge of German, French, and Latin as undergraduates.

Journalism.

Journalism is concerned with the exercise of social responsibility in human affairs; the profession of journalism deals with the truthful communication of facts and their explanation. It is the purpose of the program in journalism to bring its majors: (1) to the point where they can gather significant information, organize it quickly into effective form, and communicate it clearly, accurately, and with a disciplined objectivity; and (2) to an understanding of the legitimate role of the press in society.

The first of these objectives is obtained by extensive, professionally oriented practice in the writing, reporting, and editing of public affairs. The skill thus acquired is firmly rooted in rigorous training

in vocabulary, in precision of expression, and in sophistication in style. It is concerned with clear writing and careful reporting, the kind that depicts the meaning of events. It develops from a purposeful curiosity and a capacity to be imaginatively interested in human activity. The second objective is obtained: (1) by study of the rights and responsibilities of the press under the constitution, with emphasis upon the freedom of the press as conditioned by the liberties of the individual and the needs of society; (2) by examination of the journalistic tradition in the United States in relation to the political, economic, and social progress of the population; and (3) by independent study, culminating in an undergraduate thesis, of the press and society.

The basic program in journalism provides opportunity for concentration in at least one of the following areas: ancient history, economics, government, history, international relations, literature, philosophy, science, and sociology.

While the great majority of graduates in journalism enter some phase of written communication as a career—daily newspaper, wire services, magazine, public or industrial relations, advertising, technical writing—others have used their background in journalism as a base for the study and practice of law, service in government, teaching, business management, and graduate study in a variety of disciplines.

Required Preliminary Courses

JOURN	1, 2 BROWN AND WHITE	2
JOURN	11 NEWS WRITING	3

Required Major Courses

JOURN	3, 8 BROWN AND WHITE*	2-6
JOURN	12 REPORTING OF PUBLIC AFFAIRS	3
JOURN	17 MAGAZINE ARTICLE WRITING	3
JOURN	113 EDITING	3
JOURN	115 INTERPRETIVE WRITING	3
JOURN	120 JOURNALISM PROSEMINAR	3
JOURN	121, 122 LAW OF THE PRESS	6
GK	21 ANCIENT HISTORY	3
	OR	
LAT	22 ANCIENT HISTORY	3
PHIL	15 ETHICS	3

**(Brown and White must be rostered each semester while the student is in the Journalism major. A minimum of four semesters is required.)*

Recommended Electives

Majors in journalism are advised to enroll in certain courses in economics, English, government, history, international relations, philosophy, and sociology. Electives should be chosen in consultation with the major adviser.

FINE ARTS

Throughout history each civilization has found its identity in the creative expression of its artists. By his understanding and practice of the arts, man frequently is able to lead the way to new ideas of enduring importance. We pursue the study of art with these facts in mind.

Our courses in history and appreciation of art are given in lecture form. Ten thousand slides and over eight thousand books, monographs and indexed periodicals provide reference. Current exhibitions and the Permanent Collection afford additional study and research materials.

Drawing and painting courses focus on developing technical skills, on increasing sensitivity in response to content and broadening intellectual perception, all in relation to increased creativity. For these the student must become familiar with artistic conventions of the past and with contemporary trends. Formal problems provide sequential steps and the measure of increased facility. Each student's creative expression is constantly encouraged. His understanding of man in relation to nature and society is developed to further his individual performances in art.

Architectural drafting room practices are related to the problems of man-space-function and good design. Here the concern is with the efficient and the beautiful. A study is made of the needs of man, of the effects of spatial environment and of the engineering requirements of structure and locale. The creative solution becomes a problem of integrating site, plan, and structure with all determining factors in an artistic manner.

Visiting architects, visits to in-process buildings and to architects' offices assist in comprehending the practices and practical side of architecture.

Although a student may emphasize Art or Architecture, a major is not offered in either area. The department can prepare students for study in professional schools.

Emphasis on Painting

Required Preliminary Courses

FA	5 FUNDAMENTALS OF ART	3
FA	6 BAROQUE OR ROCOCO ART	3
FA	31, 32 ELEMENTS OF ART	3
PHIL	14 LOGIC	3
	OR	

PHIL	15 ETHICS OR 1 INTRODUCTION TO PSYCHOLOGY	3
Required Major Courses		
FA	3 PRE-RENAISSANCE ARCHITECTURE	3
FA	4 ARCHITECTS AND ARCHITECTURE	3
FA	15 ITALIAN RENAISSANCE ART	3
FA	216 ART IN THE UNITED STATES	3
FA	219 NINETEENTH CENTURY ART	3
FA	220 FORM AND MILIEU IN TWENTIETH CENTURY ART	3
FA	33, 34 PAINTING PRACTICES AND PRINCIPLES	6
PHIL	100 PHILOSOPHY OF CONTEMPORARY CIVILIZATION	3
MUS	APPROVED COURSE	3
FA	131, 132 ADVANCED STUDIO PRACTICE	6

Emphasis on Architecture

Required Preliminary Courses		
FA	5 FUNDAMENTALS OF ART	3
FA	6 BAROQUE AND ROCOCO ART	3
MATH	21 ANALYTIC GEOMETRY AND CALCULUS I	4
MECH	1 STATISTICS OR	3
SR	11 PRINCIPLES OF SOCIOLOGY OR	3
SR	65 CONTEMPORARY PROBLEMS IN SOCIETY	3

Required Major Courses		
FA	3 PRE-RENAISSANCE ARCHITECTURE	3
FA	4 ARCHITECTS AND ARCHITECTURE	3
FA	216 ART IN THE UNITED STATES	3
FA	219 NINETEENTH CENTURY ART	3
FA	220 FORM AND MILIEU IN TWENTIETH CENTURY ART	3
FA	41 BASIC IN ARCHITECTURE	3
FA	42 CONTEMPORARY ARCHITECTURAL DESIGN	3
PHIL	100 PHILOSOPHY OF CONTEMPORARY CIVILIZATION	3
MATH	22 ANALYTIC GEOMETRY AND CALCULUS II	4
MATH	23 ANALYTIC GEOMETRY AND CALCULUS III	4
FA	251, 252 ARCHITECTURAL DESIGN	6

Students emphasizing Architecture will choose electives in other departments after consultation with the chairman of the Department of Fine Arts.

Collateral courses are recommended, and in instances may be substituted for certain of the above, in Business Administration, Civil Engineering, Government, Mechanics, and Social Relations.

The required Senior Comprehensive Examination comprises a two hour written, a one hour oral, and submission of work indicative of the student's progress in studio or draughting room.

FOREIGN CAREERS

The interdepartmental major in Foreign Careers

is designed to give students the grounding in language, history, economics, and related subjects needed for successful work with private industry or governmental agencies in their overseas activities. The program is under the direction of Professor Finn B. Jensen of the department of economics.

Each student in the program will schedule all courses in the Common Core and in one of the Options. In addition, he will, in consultation with the director, select courses in language, history, and other subjects which will give him an intensive knowledge of the culture of the area in which he is interested. Students are encouraged to investigate the opportunity for taking a second major in the appropriate language. Students electing the Russian area option will be expected to study Russian.

The program also affords a broad base for graduate study in social sciences and business administration. Students interested in this aspect of the major sequence should consult the director early in their college careers.

Common Core

Required Preliminary Courses

ECO	3, 4 ECONOMICS	6
GOT	3 FOREIGN GOVERNMENTS	3
MATH	21 ANALYTIC GEOMETRY AND CALCULUS I	4
ECO	45 STATISTICAL METHOD	3

Required courses for students concentrating in the Latin American area.

ECO	305 ECONOMIC DEVELOPMENT OF LATIN AMERICA	3
SR	367 LATIN AMERICAN SOCIAL INSTITUTIONS	3
HIST	SIX HOURS OF LATIN AMERICAN HISTORY	6

Required courses for students concentrating in the European area.

ECO	309 COMPARATIVE ECONOMIC SYSTEMS	3
ECO	343 EUROPEAN ECONOMIC INTEGRATION	3
HIST	SIX HOURS OF EUROPEAN HISTORY	6

Required courses for students concentrating in the Russian area.

ECO	309 COMPARATIVE ECONOMIC SYSTEMS	3
GOVT	362 THE SOVIET SYSTEM OF GOVERNMENT	3
IR	133, 134 DIPLOMACY OF RUSSIA	6
IR	334 THE SOVIET UNION IN WORLD AFFAIRS	3

Foreign Trade Option

ACCTG	5 ESSENTIALS OF ACCOUNTING OR 108 FUNDAMENTALS OF ACCOUNTING	3
ACCTG	108 FUNDAMENTALS OF ACCOUNTING	3
ECO	129 MONEY AND BANKING	3
ECO	339, 340 INTERNATIONAL ECONOMICS	6
ECO OR FIN	IN CONSULTATION WITH THE ADVISER	6

Public Administration Option

ACCTG	51 ESSENTIALS OF ACCOUNTING OR	3
ACCTG	108 FUNDAMENTALS OF ACCOUNTING	3
IR	352 INTERNATIONAL ORGANIZATION OR	3
IR	361 INTERNATIONAL LAW	3
ECO	353 PUBLIC FINANCE	3
GOVT	360 PUBLIC ADMINISTRATION	3
GOVT	363 CONTEMPORARY POLITICAL THOUGHT OR	3
GOVT	364 CONTEMPORARY POLITICAL THOUGHT	3
GOVT	361 COMPARATIVE ADMINISTRATIVE SYSTEMS OR	3
GOVT	322 DEVELOPING COUNTRIES	3

A senior comprehensive examination in the appropriate language is required.

Open Option

In place of any of the three preceding options, a student may take an Open Option by meeting the advanced course requirements for one of the other Arts College majors. The Open Option is most feasible with humanities and social science majors but will require a careful combining of distribution courses and free electives with the eighteen hours normally given to the option. Students interested in the Open Option should consult the director of the Foreign Careers major as early as possible.

GEOLOGICAL SCIENCES

Geology is the science which deals with natural phenomena on or within the earth. It is a science which makes use of most other scientific disciplines in its practice; hence the student of geology must combine thorough training in geology with a broad understanding of physical, chemical, and biological principles. The undergraduate program in geological sciences at Lehigh emphasizes this relationship. About one-half of the courses required in the major are in the geological sciences; about one-half are in the collateral sciences. Students may arrange informal options in geochemistry, geophysics, or geological engineering.

An extended field trip is held each year for advanced undergraduates in conjunction with work in advanced required major courses.

Attendance at an approved summer field camp is required for all majors. Lehigh does not operate its own field camp but arrangements are easily made for Lehigh students to attend field camps operated

by other colleges and universities. In certain cases equivalent experience is accepted in lieu of attendance at field camp.

Geological training may be utilized in industry (especially in the petroleum, mining, highway construction, ceramics, and metallurgical industries), government service and in secondary school and college teaching.

Required Preliminary Courses

Freshman Year

GEOL	1 PRINCIPLES OF GEOLOGY	3
CHEM	1 CHEMICAL PRINCIPLES I	3
CHEM	11 CHEMICAL PRINCIPLES II LABORATORY	1
MATH	21 ANALYTICAL GEOMETRY & CALCULUS I	4
GEOL	2 PRINCIPLES OF GEOLOGY	3
CHEM	3 CHEMICAL PRINCIPLES II	3
CHEM	13 CHEMICAL PRINCIPLES II LABORATORY	1
MATH	22 ANALYTIC GEOMETRY & CALCULUS II	4

Required Major Courses

Sophomore Year

GEOL	13 SEDIMENTATION	3
GEOL	23 STRUCTURAL GEOLOGY	3
CHEM	39 ANALYTICAL CHEMISTRY	3
PHYS	1 MECHANICS OF MASS POINTS	3
BIOL	21 PRINCIPLES OF BIOLOGY	3
BIOL	22 INTRODUCTION TO BIOLOGY LABORATORY	1

Junior Year

GEOL	301 INTRODUCTION TO GEOPHYSICS	3
GEOL	333 CRYSTALLOGRAPHY	3
GEOL	311 PALEONTOLOGY	3
GEOL	336 MINERAL PHASE RELATIONS	3
GEOL	310 COMPUTER APPLICATIONS	1
PHYS	16 GENERAL PHYSICS	3
PHYS	17 GENERAL PHYSICS LABORATORY	2

Senior Year

GEOL	315 REGIONAL STRATIGRAPHY	3
GEOL	334 PETROLOGY AND PETROGRAPHY	4

and a selection from the following courses with the approval of major adviser:

GEOL	14 ROCKS AND MINERALS	1
GEOL	302 GEOPHYSICAL PROSPECTING	3
GEOL	337 SEDIMENTARY GEOCHEMISTRY	3
GEOL	351 GEOLOGY OF FUELS	2
GEOL	354 ELEMENTS OF MINING	4
GEOL	357 ECONOMIC GEOLOGY	3
GEOL	390 PROBLEMS OF GEOLOGY	3

Recommended electives in collateral sciences and engineering:

MATH	23 ANALYTIC GEOMETRY AND CALCULUS III	4
PHYS	3, 4 ELECTRICITY, LIGHT, AND ATOMIC PHYSICS (MAY BE TAKEN AS SUBSTITUTE FOR PHYSICS 16, 17)	8
CHEM 91, 190	PHYSICAL CHEMISTRY OR	6
CHEM	95 PHYSICAL CHEMISTRY	3
MET	333 X-RAY METHODS	3

BIOL	306 ECOLOGY	3
CE	239 SOIL MECHANICS	3
ASTR	1 DESCRIPTIVE ASTRONOMY	3

GERMAN

In this major, required courses in the German language and literature constitute a core around which the student can build a program of study providing a broad as well as sound understanding not only of German cultural contributions per se but also as part of the culture of the Western World. Specific courses other than those listed will depend upon each student's previous educational experience; but, in general, collateral work should include ancient and modern European history, fine arts, music, and the languages and literatures of other peoples, especially the English, French, Greeks and Romans.

Required Preliminary Courses

GER	1, 2 ELEMENTARY GERMAN	6
GER	11, 12 INTERMEDIATE GERMAN	6

Required Major Courses

GER	31 CONVERSATION AND COMPOSITION	3
GER	43, 44 SURVEY OF GERMAN LITERATURE	6
GER	52 GOETHE'S FAUST	3

and at least two of the following:

GER	32 CONVERSATION AND COMPOSITION	3
GER	202 THE GERMAN NOVELLE	3
GER	203 NINETEENTH CENTURY GERMAN DRAMA	3
GER	205 TWENTIETH CENTURY GERMAN LITERATURE	3
GER	211 NINETEENTH CENTURY GERMAN LYRIC POETS	3
GER	212 MODERN GERMAN LYRIC POETRY	3
GER	250 SPECIAL TOPICS	3
GER	344 THE AGE OF GOETHE	6
GER	321 MIDDLE HIGH GERMAN	3
GER	343 RENAISSANCE-BAROQUE-ENLIGHTENMENT	3

A senior comprehensive examination is required.

GOVERNMENT

The major in government is designed to promote understanding of political ideas, institutions, and practices; to develop skill in the analysis and appraisal of political problems; and to encourage an unbiased consideration of controversial issues in the governmental field. Various courses deal with both the theoretical aspects of government in general and the machinery, processes, functions, and purposes of government in the United States and other countries.

This major is suitable for undergraduates who

may become attorneys, social science teachers, government officials, party or civic leaders, public affairs commentators, or staff members of governmental research bureaus. It provides thorough preparation for graduate work in political science and public administration. Graduate study is advisable for students contemplating certain careers, for example: the teaching of political science at the college level; research in the governmental field; and public service as city managers or as administrators at the top and middle management levels of the national and state governments.

Required Preliminary Courses

GOVT	1, 2 AMERICAN NATIONAL AND STATE GOVERNMENT	6
GOVT	3 AMERICAN POLITICAL IDEAS	3
GOVT	4 FOREIGN GOVERNMENTS	3

Required Major Courses

GOVT	101 HISTORY OF POLITICAL THEORY	3
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Plus fifteen hours from the following:

GOVT	6 DEMOCRACY	3
GOVT	304 POLITICAL PARTIES	3
GOVT	321 SCOPE AND METHODS OF POLITICAL SCIENCE	3
GOVT	322 DEVELOPING COUNTRIES	3
GOVT	351, 352 CONSTITUTIONAL LAW, CIVIL LIBERTIES	6
GOVT	354 ADMINISTRATIVE LAW	3
GOVT	357 CITY GOVERNMENT	3
GOVT	359 LAW-MAKING	3
GOVT	360 PUBLIC ADMINISTRATION	3
GOVT	361 COMPARATIVE ADMINISTRATIVE SYSTEMS	3
GOVT	362 THE SOVIET SYSTEM OF GOVERNMENT	3
GOVT	363, 364 CONTEMPORARY POLITICAL THOUGHT	6
IR	COURSE AT THE 300 LEVEL	3

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Majors in Government are advised to enroll for certain courses in the fields of economics, history, journalism, philosophy, psychology, public finance, and social relations. The particular course selections should be made in consultation with the chairman of the department or his designated representative.

A senior comprehensive examination is required.

HISTORY

History is the study of man's activities upon the planet he inhabits. As such, it encompasses not only a study of events and public policy, but the whole sweep of man's cultural achievements — his religion and philosophy, his literature and art, his economic and social life. Some of the most influential thinkers and public men of our time (Toynbee, Kennan, Churchill, and Kennedy, among others) have come to an understanding of contemporary

problems by studying the forces in the past which have shaped the world of the present.

Majors in History take courses in the history of three culture areas, examining the major developments in each in terms of the problem of cause and effect, which is the historian's central concern. These courses provide training in the disciplines of research, the analysis of historical problems, and the formulation of historical judgments, as well as in writing. Majors in history have the foundation for law school, government service, journalism, teaching, or graduate study.

A major in history consists of thirty-six hours distributed in three of the four areas in which the department offers courses: American, British, European, and Latin-American history. No more than eighteen of these hours may be in one field. In the senior year, majors in history are examined on the three fields they have chosen. Honors students in the department may plan special programs, with suitable substitutions for some of the above requirements, in consultation with the major adviser.

Required Preliminary Courses

HIST 25, 26	EUROPEAN HISTORY	6
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Plus one of the following sequences:

HIST 13, 14	AMERICAN CIVILIZATION	6
HIST 15, 16	ENGLISH HISTORY	6
HIST 49, 50	HISTORY OF LATIN AMERICA	6

Required Major Courses

Twenty-four hours chosen from the following:

HIST 319, 320	COLONIAL AMERICA	6
HIST 321, 322	UNITED STATES HISTORY SINCE 1789	6
HIST 323, 324	AMERICAN CONSTITUTIONAL HISTORY	6
HIST 325	AMERICAN IMMIGRANT HISTORY	3
HIST 326	AMERICAN URBAN HISTORY	3
HIST 327, 328	AMERICAN INTELLECTUAL HISTORY	6
HIST 329, 330	AMERICAN FOREIGN POLICY	6
HIST 347, 348	BRITISH EMPIRE, 1603 TO THE PRESENT	6
HIST 349, 350	THE MIDDLE AGES	6
HIST 357	RENAISSANCE AND REFORMATION	3
HIST 355, 356	EUROPEAN INTELLECTUAL HISTORY	6
HIST 359, 360	MODERN EUROPE	6
HIST 358	AGE OF THE BAROQUE	3
HIST 365, 366	MODERN LATIN AMERICA	6
HIST 367	THE IBERIAN PENINSULA	3
HIST 368	THE CARIBBEAN	3
HIST 371, 372	SPECIAL TOPICS IN HISTORY	6
HIST 374	THEMES IN AMERICAN HISTORY	3

A senior comprehensive examination is required.

Majors in history will find it advantageous to enroll for certain courses in economics, English and American literature, government, international

relations, philosophy, psychology, and social relations. Particular attention is called to Greek 21 and Latin 22. Students planning to pursue graduate studies should acquire a reading knowledge of at least one foreign language as undergraduates, choosing the language or languages appropriate to their area of concentration.

INTERNATIONAL RELATIONS

The field of international relations poses an unprecedented challenge to student and teacher alike and provides a stimulating focus of interest for undergraduate education. It demands full recognition and understanding of the vast forces which are shaping the world—wars, nationalism, political ideologies, and modern technology. The leadership and responsibilities of the United States in the world arena have created a need for broadly educated young men who possess a clear appreciation of the factors which influence the policies of nations.

Students will approach the study of state behavior through courses in the theory and techniques of diplomacy, the history of modern international relations, and special seminars in international law, international organization, and world politics. The ultimate objective is to shape and develop well-informed and independent observers and participants in the field of international affairs. The flexibility of the program permits added study in history, government, economics and other social sciences.

The broad knowledge and understanding acquired can be utilized in careers in teaching, the Foreign Service of the United States and other government agencies, international business, and the legal profession.

Required Preliminary Courses

IR 1, 2	WORLD POLITICS	6
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Required Major Courses

IR 341, 342	INTERNATIONAL RELATIONS	6
IR 351, 352	INTERNATIONAL INSTITUTIONS	6
IR 361, 362	INTERNATIONAL LAW	6
IR 371, 372	READINGS IN INTERNATIONAL RELATIONS	6

and twelve semester hours to be selected, with the approval of the head of the department, from international relations, history, and government. A senior essay is required.

MATHEMATICS

The major in mathematics is designed to cover each of the three main divisions of mathematics: Analysis, Geometry, and Algebra. Rigor and abstraction, properly motivated, are introduced early in the major in the firm belief that therein lies the essence of mathematics, not only as a liberal discipline studied for its own sake, but also in the deeper applications of mathematics to the sciences. On completion of the major program, it is expected that the student will have gained an appreciation of the universal character of the subject as well as the ability to think in mathematical terms. With this broad orientation, he could readily become a teacher with a penetrating knowledge of his field, a skilled user of mathematics in one of the rapidly multiplying positions in industry and government, or a student in graduate school, continuing to advance to the frontiers of study and research in mathematics.

Required Preliminary Courses

MATH 21	ANALYTIC GEOMETRY AND CALCULUS I	4
MATH 22	ANALYTIC GEOMETRY AND CALCULUS II	4
MATH 23	ANALYTIC GEOMETRY AND CALCULUS III	4

Required Major Courses

MATH 219	PRINCIPLES OF ANALYSIS	3
MATH 220	PRINCIPLES OF ANALYSIS	3
MATH 221	DIFFERENTIAL EQUATIONS	3
MATH 241	HIGHER ALGEBRA I	3
MATH 242	HIGHER ALGEBRA II	3
MATH 315	THEORY OF FUNCTIONS OF A COMPLEX VARIABLE	3
	APPROVED ELECTIVES	12

The four elective courses are to be chosen with the approval of a designated representative of the head of the department, and may, for students with an applied mathematics or other special interest, include mathematically oriented courses at the 200- or 300-level in E.E., I.E., M.E., Mech., Phil., or Phys.

Students interested in Actuarial Science can major in Mathematics, choosing appropriate courses in consultation with a representative of the chairman of the department, to prepare for certain of the actuarial examinations.

NATURAL RESOURCES

This is an interdepartmental major designed to give the student basic preparation for a career in management and conservation of natural resources

and for research and graduate work in these fields. Integrated work in biology and geology with adequate background in chemistry and physics provides the best approach to an understanding of the environment, its influence on man and man's influence upon it.

Required Preliminary Courses

Freshman Year

BIOL 21	GENERAL BIOLOGY	3
BIOL 22	INTRODUCTION TO BIOLOGY LABORATORY	1
BIOL 28	GENETICS	3
CHEM 1	CHEMICAL PRINCIPLES I	3
CHEM 11	CHEMICAL PRINCIPLES I LABORATORY	1
CHEM 3	CHEMICAL PRINCIPLES II	3
CHEM 13	CHEMICAL PRINCIPLES II LABORATORY	1
MATH 21	ANALYTICAL GEOMETRY & CALCULUS I	4
MATH 8	ELEMENTARY STATISTICS	3

Sophomore Year

CHEM 39	ANALYTICAL CHEMISTRY	3
GEOL 1	PRINCIPLES OF GEOLOGY	3
BIOL 306	ECOLOGY	3
PHYS 1	MECHANICS OF MASS POINTS	3
GEOL 2	PRINCIPLES OF GEOLOGY	3
BIOL 35	MICROBIOLOGY	3
BIOL 361	SANITARY MICROBIOLOGY	3

Junior Year

CHEM 51	ORGANIC CHEMISTRY	3
CHEM 53	ORGANIC CHEMISTRY LABORATORY	2
GEOL 13	SEDIMENTATION	3
PHYS 16	GENERAL PHYSICS	3
PHYS 17	GENERAL PHYSICS LABORATORY	2
GEOL 23	STRUCTURAL GEOLOGY	3

Senior Year

BIOL 303	ADVANCED INVERTEBRATE ZOOLOGY	3
ECO 311	ECONOMICS RESOURCE USE	3
	ELECTIVES	6 OR 9

Suggested Electives:

BIOL 34	COMPARATIVE ANATOMY	4
BIOL 320	PHYSIOLOGY	3
GEOL 311	PALEONTOLOGY	3
GEOL 315	STRATIGRAPHY	3
GEOL 357	ECONOMIC GEOLGY	3
PHIL 341	EVOLUTION OF SCIENTIFIC IDEAS	3
SPEECH 30	FUNDAMENTALS OF SPEECH	3

A student who is taking a major in biology, geology, or journalism, and who is interested in natural resources and their conservation, should consult with his major adviser. His program can be so arranged as to provide an adequate major concentration combined with appropriate collateral work so selected as to develop his knowledge of natural resources and the problems of their management.

NATURAL SCIENCE

This major provides students with a broad background in the fundamentals of mathematics and science and the opportunity to concentrate to a reasonable degree in one area of science. The program is designed especially for (1) those students who desire preparation for graduate work or careers in certain of the derivative or interdisciplinary sciences or related professional fields (oceanography, astronomy, psychophysiology, geophysics, information science, medicine or dentistry, conservation, etc.), (2) those students who plan to teach science in secondary schools or community colleges, and (3) those students without fixed career objectives who desire undergraduate training in science.

Students who register for the program are required to select an area of concentration (or option) which must be approved by the Dean of the College of Arts and Science and Professor J. Donald Ryan, Department of Geology, Director of the program. The option may be chosen in Chemistry, Biology, Geology, Psychology, or in an approved interdisciplinary area (geophysics, marine science, biochemistry, information science, etc.). Courses included in the option will be worked out individually for the student by his major adviser. A committee, of which Professor Ryan is chairman, administers the program.

Required Preliminary Courses

MATH	21, 22, 23	ANALYTICAL GEOMETRY AND CALCULUS	12
PHYS	1	MECHANICS OF MASS POINTS	3
PHYS	3	HEAT AND ELECTRICITY	4
PHYS	4	ELECTRICITY, LIGHT, AND ATOMIC PHYSICS	4
CHEM	1, 11, 3, 13	CHEMICAL PRINCIPLES	8
GEOL	1	PRINCIPLES OF GEOLOGY OR	3
ASTRO	1	DESCRIPTIVE ASTRONOMY	3
BIOL	21, 22	PRINCIPLES OF BIOLOGY OR	
PSYCH	1	INTRODUCTION TO PSYCHOLOGY	3

Required Major Courses

CHEM	51, 52, 53, 54	ORGANIC CHEMISTRY OR	6-10
CHEM	95, 195	PHYSICAL CHEMISTRY	
*MATH		ELECTIVE	3
*OPTION			24

**Math elective and courses included in option taken with the approval of major adviser.*

A student registered for this major normally is expected to choose his option no later than the beginning of his sophomore year.

A special program leading to a B.A. in Natural Science and an M.S. in Materials is available for interested students. See page 61 for prerequisites and typical program.

PHILOSOPHY

Early in the history of Western philosophy, Socrates pointed out that the unexamined life is not worth living. Philosophers of all ages and all traditions have been convinced that men are faced with the continuing challenge of emancipating themselves from the encumbrances of inherited presuppositions. They have taught that men can achieve this emancipation only to the extent that they achieve a disciplined and critical knowledge of their current situation in nature and history.

The aim of the major program in philosophy at Lehigh is to assist the student to acquire the rudiments of this critical capability, a capacity which will be of considerable value to him whatever career he might decide to pursue at a future date. This aim is implemented by assisting the student to comprehend the nature, scope and relevance of the philosophical enterprise through the courses in the required sequence. Sufficient latitude remains in the optional sequence for pursuing the developing special interests of the student.

Required Preliminary Courses

PHIL	14	LOGIC	3
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Required Major Courses

PHIL	331	ANCIENT PHILOSOPHY	3
PHIL	335	MODERN PHILOSOPHY	3
PHIL	337	NINETEENTH CENTURY PHILOSOPHY	3
PHIL	339	TWENTIETH CENTURY PHILOSOPHY	3

And fifteen additional hours to be selected with the counsel and approval of the departmental advisor from other courses in philosophy and approved from other curricula.

PHYSICS

Designed primarily for students planning professional careers in science, this sequence includes the minimum mathematical and subject matter requirements for entrance to graduate schools. Most students who proceed to graduate school in physics elect, as undergraduates, several addi-

tional mathematics, mechanics and physics courses. Graduate schools in medicine, meteorology, geo-physics, astrophysics, etc., will usually not require additional physics courses, but will require courses in electronics, biology, geology, astronomy, etc. A student interested in immediate professional employment is advised to study in an engineering curriculum. With specialization and careful planning, a student may embark on some graduate level work in his senior year, or gain an early familiarity with research techniques. Such intensive study will reduce the number of years required for study to the Ph.D. since the courses coordinate with the graduate program in physics.

Required Preliminary Courses

CHEM 1, 11; 3, 13	PRINCIPLES OF CHEMISTRY	8
MATH 21, 22; 23	ANALYTICAL GEOMETRY AND CALCULUS	12
PHYS 1	MECHANICS OF MASS POINTS	3
PHYS 3	HEAT AND ELECTRICITY	4
PHYS 4	ELECTRICITY, LIGHT AND ATOMIC PHYSICS	4

Required Major Courses

PHYS 62	CONTEMPORARY PHYSICS	3
PHYS 90	ELECTRICAL PHENOMENA	1
PHYS 171	PROSEMINAR	1
PHYS 191	LABORATORY TECHNIQUES	2
PHYS 192	ADVANCED LABORATORY	2
PHYS 212	ELECTROSTATIC	3
PHYS 213	ELECTROMAGNETISM	3
PHYS 215	PARTICLES AND FIELDS I	3
PHYS 216	PARTICLES AND FIELDS II	3
PHYS 254	OPTICS LABORATORY	2
PHYS 340	HEAT, THERMOODYNAMICS AND PYROMETRY	3
PHYS 362	ATOMIC AND MOLECULAR STRUCTURE	3
MATH 219, 220	PRINCIPLES OF ANALYSIS	6
MATH 205	LINEAR METHODS	3

PSYCHOLOGY

The sequence of basic courses in psychology and related sciences is designed to expand the student's understanding of the processes which underlie the complex and varied forms of human and animal behavior, both individual and social. Throughout the required courses, the emphasis is on quantitative and experimental analysis. However, elective courses allow further exploration and deepening of knowledge in special areas of psychological theory and application as well as in many related fields. The relatively small number of required courses makes the major program in psychology particular-

ly well suited for the student who wishes a liberal arts program focused on the natural and social sciences. The nucleus of required courses also forms the foundation for graduate work in any field of psychology, including social psychology, leading to careers in research, college teaching, and a wide variety of applied fields, including clinical, engineering and industrial psychology. In social psychology, the opportunity to augment the psychology major program with electives chosen from social relations should be used. A joint major in psychology and social relations is an increasingly common program of study.

Students interested in medicine, dentistry or law may also profitably choose psychology as their major. Students with these interests would normally augment the major program with courses chosen from other departments related to their career interests. For example, students planning a career in medicine must meet the minimum requirements for admission to medical school which are: 1 year of biology, 1 year of inorganic chemistry, 1 year of organic chemistry, and 1 year of physics.

Required Preliminary Courses

BIOL 21	PRINCIPLES OF BIOLOGY	3
BIOL 22	INTRODUCTION TO BIOLOGY LABORATORY	1
MATH 6	FINITE MATHEMATICS	3
MATH 21	ANALYTICAL GEOMETRY AND CALCULUS I	4
PHIL 14, 261	LOGIC; PHILOSOPHY OF NATURAL SCIENCE; OR	3
PHIL 301	PHILOSOPHY OF SOCIAL SCIENCE	3

Recommended Preliminary Courses

It is strongly recommended that any student considering post-graduate study in psychology take a minimum of 7 semester hours of course work in Physical Science. This recommendation would normally be met by choosing from Chem. 1, 11; 2, 12; Physics 1, 16, 17. Additional course work in Mathematics, Computer Programming, and Biology is also recommended to be chosen from Mathematics 22 and 23; Mathematics 105 or Accounting 111; Biology 28.

Required Major Courses

PSYCH 1	INTRODUCTION TO PSYCHOLOGY	3
MATH 8	ELEMENTARY STATISTICAL ANALYSIS	3
PSYCH 11	GENERAL EXPERIMENTAL PSYCHOLOGY	3
PSYCH 12	GENERAL EXPERIMENTAL PSYCHOLOGY LABORATORY	2

and two of the following courses chosen with approval:

PSYCH 363	LEARNING	4
PSYCH 364	SENSATION AND PERCEPTION	4
PSYCH 365	PHYSIOLOGICAL PSYCHOLOGY	4

PSYCH 361 PERSONALITY

4

OR

PSYCH 301 EXPERIMENTAL SOCIAL PSYCHOLOGY

3

Two courses chosen with approval of department chairman from Psych. 106, 107, 201, 203, 302, 303, 304, 369, 370; SR 302, 303, 304, 305.

A senior comprehensive examination is required.

For the student who chooses psychology as his major, early in his academic career, there will be extensive opportunities to take free electives throughout the junior and senior years. These electives may be chosen profitably from courses offered in a number of departments other than psychology. Psychology majors are encouraged to exercise this choice with the student's interests as the principal guide.

ROMANCE LANGUAGES

The Department of Romance Languages offers separate major programs in French and Spanish aiming to show the development of the culture and civilization of France, Spain, and the Spanish-speaking countries of Latin America. These programs prepare for graduate work in several related fields as well as for teaching careers.

Each candidate is assigned a departmental adviser to correlate and integrate supplementary reading and study to meet special objectives. Candidates are urged to participate in junior-year-abroad programs and in study and travel in foreign countries during summer vacations.

Although the minimum requirement is eighteen credit hours of which at least six will be chosen from "200" courses, the normal requirement consists of eight semester courses above elementary and intermediate levels, through which the candidate is expected to gain a knowledge of literature and an adequate command of the language in preparation for the oral and written departmental comprehensives and the graduate record examinations.

A senior comprehensive examination is required.

French.

Required Preliminary Courses

FR 1, 2 ELEMENTARY FRENCH

6

FR 11, 12 INTERMEDIATE FRENCH

6

Required Major Courses

Eighteen hours of which at least six hours shall be chosen from Fr. 221, 222, 223, 224:

FR 13, 14 TYPES OF FRENCH LITERATURE

6

FR 23, 24 SEVENTEENTH CENTURY FRENCH LITERATURE

6

FR 25, 26 EIGHTEENTH CENTURY FRENCH LITERATURE

6

FR 31, 32 NINETEENTH CENTURY FRENCH LITERATURE

6

FR 41, 42 FRENCH ORAL AND WRITTEN COMPOSITION

6

FR 221 FRENCH LITERATURE BEFORE SEVENTEENTH CENTURY

3

FR 222 CONTEMPORARY FRENCH LITERATURE

3

FR 223, 224 PROSEMINAR

6

FR 301 FRENCH CLASSICISM

3

FR 302 THE AGE OF ENLIGHTENMENT

3

The student will be expected to complete supplementary reading, the list of which he will receive at the beginning of his major work, and to correlate the knowledge gained in courses and readings through the use of some recommended history of French literature.

Spanish.

Required Preliminary Courses

SPAN 1, 2 ELEMENTARY SPANISH

6

SPAN 11, 12 INTERMEDIATE SPANISH

6

Required Courses in Major

Eighteen hours from the following of which at least six shall be chosen from Spanish 231, 232, 303, 304, 305, 306.

SPAN 13 CULTURAL EVOLUTION OF SPAIN

3

SPAN 14 CULTURAL EVOLUTION OF LATIN-AMERICA

3

SPAN 21 INTRODUCTION TO MODERN SPANISH FICTION

3

SPAN 22 INTRODUCTION TO MODERN SPANISH DRAMA

3

SPAN 31, 32 SPANISH CONVERSATION AND COMPOSITION

6

SPAN 231, 232 SPANISH-AMERICAN LITERATURE

6

SPAN 303 CERVANTES

3

SPAN 304 LOPE DE VEGA

3

SPAN 305 SPANISH LITERATURE IN THE MIDDLE AGES

3

SPAN 306 SPANISH LITERATURE SINCE WORLD WAR II

3

In addition to the outside reading and reports required in connection with these courses, the student will be expected to acquire a knowledge of the history of Spanish literature as a whole.

SOCIAL RELATIONS

There are three major sequences combined in the department of Social Relations: Social Psychology, Cultural Anthropology and Sociology. These disciplines involve a humanistic orientation while

regarding empirical research as the major means of extending knowledge about man. Students majoring in the department select one option given below to fulfill requirements.

With the rapid expansion of the significance of the social sciences in contemporary society, these three fields provide useful background not only for graduate work in the disciplines, but also for careers as diverse as law, government service or the ministry. As an interdisciplinary department, Social Relations provides a unique opportunity for the student to maintain a broad scope of interests within the context of his major program.

Required Preliminary Courses

SR	298 RESEARCH METHODS	3
PSYCH	3 OR 4 INTRODUCTION TO PSYCHOLOGY	3
MATH	6 FINITE MATHEMATICS	3

OR

MATH	21 ANALYTICAL GEOMETRY & CALCULUS	3
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Six hours in the following:

SR	3-4 INTRODUCTION TO SOCIAL RELATIONS	6
SR	11 PRINCIPLES OF SOCIOLOGY	3
SR	21 SOCIAL PSYCHOLOGY	3
SR	31 CULTURAL ANTHROPOLOGY	3

Recommended Courses

ECO	3, 4 ECONOMICS	6
PHIL	14 LOGIC	3
MATH	8 ELEMENTARY STATISTICS	3

Required Major Courses

SR	394 THE INDIVIDUAL, SOCIETY, AND CULTURE	3
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Option in Social Psychology:

<i>Twelve hours of the following:</i>		
SR	301 EXPERIMENTAL SOCIAL PSYCHOLOGY	3
SR	302 SEMINAR IN SOCIAL PSYCHOLOGY	3
SR	303 THE SOCIAL PSYCHOLOGY OF GROUPS	3
SR	304 HUMAN COMMUNICATION	3
SR	305 PERSONALITY AND SOCIAL PROCESSES	3
PSYCH	302 THEORIES OF PERSONALITY	3
PSYCH	APPROVED COURSES	6
<i>One course from SR 331, 333, 335, 338 or 339</i>		
<i>One course from SR 364, 366, 367, 368, 369, 373, 375 or 384</i>		

Option in Cultural Anthropology

<i>Twelve hours from the following:</i>		
SR	331 THEORIES OF CULTURAL ANTHROPOLOGY	3
SR	333 PRIMITIVE POLITICAL SYSTEMS	3
SR	335 CULTURAL DYNAMICS	3
SR	336 RELIGION AND MAGIC	3
SR	338 FOLKLORE AND CULTURE	3
SR	339 SEMINAR IN ANTHROPOLOGY	3
SR	394 THE INDIVIDUAL, SOCIETY AND CULTURE	3
IS	301 DESCRIPTIVE LINGUISTICS	3
BIOL	31 HUMAN BIOLOGY	3

<i>One course from SR 301, 302, 303, 304 or 305</i>	3
<i>One course from SR 364, 366, 367, 368, 369, 373, 375 or 381 or 384</i>	3

Option in Sociology

Twelve hours from the following:

SR	364 THE FAMILY	3
SR	366 POPULATION PROBLEMS	3
SR	367 LATIN AMERICAN SOCIAL INSTITUTIONS	3
SR	368 THE URBAN COMMUNITY	3
SR	369 SOCIAL DISORGANIZATION	3
SR	373 SEMINAR IN SOCIOLOGY	3
SR	374 SOCIAL STRATIFICATION	3
SR	375 MINORITY GROUPS	3
SR	381 DEVELOPMENT OF SOCIOLOGICAL THEORY	3
SR	384 SOCIAL STRUCTURE	3
HIST	325, 326 AMERICAN IMMIGRANT OR UREAN	3
<i>APPROVED ELECTIVES</i>		

<i>One course from SR. 301, 302, 303, 304 or 305</i>	3
<i>One course from SR 331, 333, 335, 336, 338 or 339</i>	3

A senior comprehensive examination is required.

MAJOR SEQUENCES IN ARTS-ENGINEERING

The standard major for students in the five-year Arts-Engineering curriculum is Applied Science. This major is open only to Arts-Engineers.

Applied Science

Required Preliminary Courses

CHEM	1, 11; 3, 13 PRINCIPLES OF CHEMISTRY	8
MATH	21, 22 ANALYTIC GEOMETRY AND CALCULUS I AND II	8
PHYS	1 MECHANICS OF MASS POINTS	3

Required Courses in Major

MATH	23 ANALYTIC GEOMETRY AND CALCULUS III	4
MECH	1 STATICS	3
PHYS	3 HEAT AND ELECTRICITY	4
PHYS	4 ELECTRICITY, LIGHT AND ATOMIC PHYSICS	4

A student must also complete the following requirements:

- (1) A minimum of twenty-four hours of the advanced work in the mathematical, physical, or engineering sciences required for the B.S. degree to be conferred on completion of the fifth year.
- (2) All courses in mathematics, science, and engineering required in the first three years of the chosen engineering curriculum.
- (3) Any additional courses necessary to prepare for the appropriate B.S. degree in one additional year.

Other Arts or Science Major

Able Arts-Engineers with special interests outside engineering frequently can combine another Arts or Science major with their engineering program. Interested students should consult the dean of the Arts College and the head of their engineering department.

Arts-Engineering Sequences

The following pattern rosters, prepared with the help of the heads of the several engineering departments, show the most effective way to combine arts and engineering courses to prepare for the last year in the branch of engineering chosen. (For descriptions of the engineering curricula, see pages 62-73.)

Although the minimum number of credit hours needed for the B.A. in Applied Science is 120, the student in Arts-Engineering is expected to earn more than this in order to qualify for the B.S. degree at the end of the fifth year. The number needed for both degrees is shown for each pattern roster.

ARTS—CHEMICAL ENGINEERING

Credit Hours Needed for B.A. and B.S.: 167

Freshman Year, First Semester

LANG	ELEMENTARY OR INTERMEDIATE LEVEL	3
ENGL	COMPOSITION OR LITERATURE	3
MATH	21 ANALYTICAL GEOMETRY AND CALCULUS I	4
DIST	REQUIREMENT	3
CHEM	1 CHEMICAL PRINCIPLES I	3
CHEM	11 CHEMICAL PRINCIPLES LABORATORY	1
PE	1 PHYSICAL EDUCATION	0
		17

Freshman Year, Second Semester

LANG	ELEMENTARY OR INTERMEDIATE LEVEL	3
ENGL	COMPOSITION OR LITERATURE	3
MATH	22 ANALYTICAL GEOMETRY AND CALCULUS I	4
DIST	REQUIREMENT	3
CHEM	3 CHEMICAL PRINCIPLES I	3
CHEM	13 CHEMICAL PRINCIPLES LABORATORY	1
PE	1 PHYSICAL EDUCATION	0
		17

Sophomore Year, First Semester

LANG	ELEMENTARY OR INTERMEDIATE LEVEL	3
DIST	REQUIREMENT	3
MATH	23 ANALYTICAL GEOMETRY AND CALCULUS III	4
PHYS	3 HEAT AND ELECTRICITY	4

CHE	51 CHEMICAL ENGINEERING COMPUTATION	4
		18

Sophomore Year, Second Semester

LANG	ELEMENTARY OR INTERMEDIATE LEVEL	3
MATH	205 LINEAR METHODS	3
PHYS	4 ELECTRICITY, LIGHT, AND ATOMIC PHYSICS	4

CHE	52 TRANSFORMATIONS PHENOMENA	4
CHEM	91 PHYSICAL CHEMISTRY	3
		17

Junior Year, First Semester

LANG	ELEMENTARY OR INTERMEDIATE LEVEL	3
CHEM	51 ORGANIC CHEMISTRY	3
CHEM	53 ORGANIC CHEMISTRY LABORATORY	2
ECO	3 ECONOMICS	3
CHEM	190 PHYSICAL CHEMISTRY	3
CHEM	192 PHYSICAL CHEMISTRY LABORATORY	1
DIST	REQUIREMENT	3
		18

Junior Year, Second Semester

ECO	ECONOMICS	3
LANG	ELEMENTARY OR INTERMEDIATE LEVEL	3
DIST	REQUIREMENT	3
	ELECTIVE*	6
		17

Senior Year, First Semester

DIST	REQUIREMENT	3
CHE	165 UNIT OPERATIONS I	4
	ELECTIVES*	9
		16

Senior Year, Second Semester

DIST	ELECTIVES	6
CHE	166 UNIT OPERATIONS II	4
CHE	200 THERMODYNAMICS	3
	ELECTIVES*	3
		16

*The electives indicated must be distributed as indicated for the Chemical Engineering curriculum of the Engineering College.

ARTS—CIVIL ENGINEERING

Credit Hours Needed for B.A. and B.S.: 168

Freshman Year, First Semester

LANG	ELEMENTARY OR INTERMEDIATE LEVEL	3
ENGL	COMPOSITION OR LITERATURE	3
MATH	21 ANALYTICAL GEOMETRY AND CALCULUS I	4
PHYS	1 MECHANICS OF MASS POINTS	3
CHEM	1 CHEMICAL PRINCIPLES I	3
CHEM	11 CHEMICAL PRINCIPLES I LABORATORY	1
PE	1 PHYSICAL EDUCATION	0
		17

Freshman Year, Second Semester

LANG	ELEMENTARY OR INTRODUCTORY LEVEL	3
ENGL	COMPOSITION OR LITERATURE	3
MATH	22 ANALYTICAL GEOMETRY AND CALCULUS II	4
DIST	REQUIREMENT	3
CHEM	3 CHEMICAL PRINCIPLES II	3
CHEM	13 CHEMICAL PRINCIPLES II LABORATORY	1
PE	2 PHYSICAL EDUCATION	0
		17

Sophomore Year, First Semester

LANG	ELEMENTARY OR INTERMEDIATE LEVEL	3
ECO	3 ECONOMICS	3
MATH	23 ANALYTICAL GEOMETRY AND CALCULUS III	4

PHYS DIST	3 HEAT AND ELECTRICITY REQUIREMENT	4 3 <u>17</u>	ENGL LANG	COMPOSITION OR LITERATURE ELEMENTARY OR INTERMEDIATE LEVEL	3 3 <u>17</u>			
<i>Sophomore Year, Second Semester</i>								
LANG	ELEMENTARY OR INTERMEDIATE LEVEL	3	MATH	22 ANALYTICAL GEOMETRY & CALCULUS II	4			
	ELECTIVE	3	CHEM	3 CHEMICAL PRINCIPLES II	3			
MATH DIST	205 LINEAR METHODS REQUIREMENT	3 3 <u>16</u>	CHEM	13 CHEMICAL PRINCIPLES II LABORATORY	1			
PHYS	4 ELECTRICITY, LIGHT AND ATOMIC PHYSICS	4	PE	2 PHYSICAL EDUCATION	0			
<i>Junior Year, First Semester</i>								
LANG	ELEMENTARY OR INTERMEDIATE LEVEL	3	ENGL	COMPOSITION OR LITERATURE	3			
	ELECTIVE	3	LANG	ELEMENTARY OR INTERMEDIATE LEVEL	3			
MECH CE DIST	1 STATICS	3 2 <u>18</u>	DIST	REQUIREMENT	3			
CE	11 ENGINEERING GRAPHICS REQUIREMENT	6	<i>Freshman Year, Second Semester</i>					
CE	10 PROBLEM COMPUTATION LABORATORY	1	MATH	22 ANALYTICAL GEOMETRY & CALCULUS II	4			
<i>Junior Year, Second Semester</i>			CHEM	3 CHEMICAL PRINCIPLES II	3			
LANG	ELEMENTARY OR INTERMEDIATE LEVEL	3	CHEM	13 CHEMICAL PRINCIPLES II LABORATORY	1			
	ELECTIVE	3	PE	2 PHYSICAL EDUCATION	0			
MECH	11 MECHANICS OF MATERIALS	3	ENGL	COMPOSITION OR LITERATURE	3			
MECH	13 MATERIALS TESTING LABORATORY	1	LANG	ELEMENTARY OR INTERMEDIATE LEVEL	3			
CE	12 APPLIED ENGINEERING GRAPHICS	2	MATH	23 ANALYTICAL GEOMETRY & CALCULUS III	4			
CE	40 PRINCIPLES OF SURVEYING	3	PHYS	3 HEAT & ELECTRICITY	4			
<i>Junior Year, First Semester</i>			MECH	1 STATICS	3			
LANG	ELEMENTARY OR INTERMEDIATE LEVEL	3	MET	63 ENGINEERING MATERIALS & PROCESSES OR	3			
	ELECTIVE	3	MET	91 ELEMENTS OF MATERIALS SCIENCE	3			
MECH	11 MECHANICS OF MATERIALS	3 <u>15</u>	<i>Sophomore Year, First Semester</i>					
MECH	13 MATERIALS TESTING LABORATORY	1	LANG	ELEMENTARY OR INTERMEDIATE LEVEL	3			
CE	12 APPLIED ENGINEERING GRAPHICS	2	EE	15 CIRCUIT THEORY I	3			
CE	40 PRINCIPLES OF SURVEYING	3	MATH	208 APPLIED MATHEMATICS II	3			
<i>Senior Year, First Semester</i>			MECH	102 DYNAMICS	3			
CE	121 FLUID MECHANICS	3	DIST	REQUIREMENT	3			
CE	123 FLUID MECHANICS LABORATORY	1	<i>Sophomore Year, Second Semester</i>					
CE	150 STRUCTURAL ANALYSIS I	3	LANG	ELEMENTARY OR INTERMEDIATE LEVEL	3			
MECH	102 DYNAMICS	3	MATH	205 LINEAR METHODS	3			
GEOL	1 PRINCIPLES OF GEOLOGY	3	PHYS	4 ELECTRICITY, LIGHT & ATOMIC PHYSICS	4			
MET	63 ENGINEERING MATERIALS AND PROCESSES OR	3 <u>16</u>	ECO	3 ECONOMICS	3			
	APPROVED ELECTIVE	3	DIST	REQUIREMENT	3			
<i>Senior Year, Second Semester</i>								
CE	126 WATER RESOURCES ENGINEERING	3	<i>Junior Year, Second Semester</i>					
EC	162 SANITARY ENGINEERING	3	LANG	ELEMENTARY OR INTERMEDIATE LEVEL	3			
CE	154 STRUCTURAL ANALYSIS II	3	EE	16 CIRCUIT THEORY II	4			
CE	239 SOIL MECHANICS	3	MATH	231 STATISTICAL INFERENCE OR				
MET	91 ELEMENTS OF MATERIALS SCIENCE OR	3 <u>15</u>	MATH	309 THEORY OF PROBABILITY	3			
	APPROVED ELECTIVE	3	DIST	REQUIREMENT	3			
<i>Summer</i>								
CE	100 Eight weeks of industrial employment should precede fifth year. Consult department chairman.		<i>Electives</i>					
ARTS — ELECTRICAL ENGINEERING								
Credit Hours Needed for B.A. and B.S.: 164								
<i>Freshman Year, First Semester</i>								
MATH	21 ANALYTICAL GEOMETRY & CALCULUS I	4	EE	103 PHYSICAL ELECTRONICS	3			
PHYS	1 MECHANICS OF MASS POINTS	3	EE	104 TRANSFORM METHODS	3			
CHEM	1 CHEMICAL PRINCIPLES I	3	EE	106 MACHINE THEORY	4			
CHEM	11 CHEMICAL PRINCIPLES I LABORATORY	1	DIST	REQUIREMENT	3			
PE	1 PHYSICAL EDUCATION	0	<i>Electives</i>					
<i>Senior Year, Second Semester</i>								
EE	105 ELECTRONIC CIRCUITS	4	<i>Senior Year, First Semester</i>					
EE	231 ELECTRIC AND MAGNETIC FIELDS	3	EE	104 TRANSFORM METHODS	3			
DIST	ELECTIVE	3	EE	106 MACHINE THEORY	4			
	ELECTIVES	0	DIST	REQUIREMENT	3			
		0	<i>Electives</i>					
<i>Senior Year, Second Semester</i>								
EE	105 ELECTRONIC CIRCUITS	4	<i>Electives</i>					
EE	231 ELECTRIC AND MAGNETIC FIELDS	3	<i>Electives</i>					
DIST	ELECTIVE	3	<i>Electives</i>					
	ELECTIVES	0	<i>Electives</i>					
		0	<i>Electives</i>					

Summer

EE 100 Summer employment should precede fifth year. Consult department chairman.

ARTS—ENGINEERING MECHANICS

Credit Hours Needed for B.A. and B.S.: 165

Freshman Year, First Semester

LANG	ELEMENTARY OR INTERMEDIATE LEVEL	3
ENGL	COMPOSITION OR LITERATURE	3
MATH	21 ANALYTICAL GEOMETRY AND CALCULUS I	4
PHYS	1 MECHANICS OF MASS POINTS	3
CHEM	1 CHEMICAL PRINCIPLES I	3
CHEM	11 CHEMICAL PRINCIPLES I LABORATORY	1
PE	1 PHYSICAL EDUCATION	0

17

Freshman Year, Second Semester

LANG	ELEMENTARY OR INTERMEDIATE LEVEL	3
ENGL	COMPOSITION OR LITERATURE	3
DIST	REQUIREMENT	3
MATH	22 ANALYTICAL GEOMETRY AND CALCULUS II	4
CHEM	3 CHEMICAL PRINCIPLES II	3
CHEM	13 CHEMICAL PRINCIPLES II LABORATORY	1
PE	2 PHYSICAL EDUCATION	0

17

Sophomore Year, First Semester

LANG	ELEMENTARY OR INTERMEDIATE LEVEL	3
ECO	3 ECONOMICS	3
MATH	23 ANALYTICAL GEOMETRY AND CALCULUS III	4
MECH	1 STATICS	3
PHYS	3 HEAT AND ELECTRICITY	4
ME	10 ANALYSIS OF ENGINEERING PROBLEMS I	1

18

Sophomore Year, Second Semester

LANG	ELEMENTARY OR INTERMEDIATE LEVEL	3
DIST	REQUIREMENT	3
MATH	221 DIFFERENTIAL EQUATIONS	3
CE 11	ENGINEERING GRAPHICS	2
PHYS	4 ELECTRICITY, LIGHT, AND ATOMIC PHYSICS	4

15

Junior Year, First Semester

LANG	ELEMENTARY OR INTERMEDIATE LEVEL	3
DIST	REQUIREMENT	6
MECH	1 STATICS	3
MET	63 ENGINEERING MATERIALS AND PROCESSES OR	3
MET	91 ELEMENTS OF MATERIAL SCIENCE	3

15

Junior Year, Second Semester

LANG	ELEMENTARY OR INTERMEDIATE LEVEL	3
DIST	REQUIREMENT	3
MECH	11 MECHANICS OF MATERIALS	3
MECH	13 MATERIALS TESTING LABORATORY	1
MATH	208 COMPLEX VARIABLES OR	3
MATH	231 STATISTICAL INFERENCE	
EE	160 ELECTRICAL CIRCUITS AND APPARATUS	3
EE	161 ELECTRICAL PROBLEMS	1
EE	162 DYNAMO LABORATORY	1

18

Senior Year, First Semester

ME	101 MECHANICS ENGINEERING DESIGN I	3
ME	104 THERMODYNAMICS I	3
MECH	102 DYNAMICS	3
MECH	201 ADVANCED MECHANICS OF MATERIALS	3
	ELECTIVES	3

18

Senior Year, Second Semester

ME	105 THERMODYNAMICS II	3
ME	231 FLUID MECHANICS	3
CE	123 FLUID MECHANICS LABORATORY	1
ME	242 MECHANICAL VIBRATIONS	3
	ELECTIVES	6

16

Summer

ME 100 Summer Employment should precede Fifth Year. Consult department chairman

ARTS—ENGINEERING PHYSICS

Credit Hours Needed for B.A. and B.S.: 163

Arts—Engineering Physics students will complete, during the first four years, the Physics major under the guidance of the chairman of the Department of Physics.

ARTS—INDUSTRIAL ENGINEERING

Credit Hours Needed for B.A. and B.S.: 173

Freshman Year, First Semester

LANG	ELEMENTARY OR INTERMEDIATE LEVEL	3
ENGL	COMPOSITION OR LITERATURE	3
DIST	REQUIREMENT	3
MATH	21 ANALYTICAL GEOMETRY AND CALCULUS I	4
CHEM	1 CHEMICAL PRINCIPLES I	3
CHEM	11 CHEMICAL PRINCIPLES I LABORATORY	1
PE	1 PHYSICAL EDUCATION	0

17

Freshman Year, Second Semester

LANG	ELEMENTARY OR INTERMEDIATE LEVEL	3
ENGL	COMPOSITION OR LITERATURE	3
MATH	22 ANALYTICAL GEOMETRY AND CALCULUS II	4
CHEM	3 CHEMICAL PRINCIPLES II	3
CHEM	13 CHEMICAL PRINCIPLES II LABORATORY	3
PHYS	1 MECHANICS OF MASS POINTS	3
PE	2 PHYSICAL EDUCATION	0

19

Sophomore Year, First Semester

LANG	ELEMENTARY OR INTERMEDIATE LEVEL	3
MATH	23 ANALYTICAL GEOMETRY AND CALCULUS III	4
PHYS	3 HEAT AND ELECTRICITY	4
ECO	3 ECONOMICS	3
IE	17 INTRODUCTION TO COMPUTING	3

17

Sophomore Year, Second Semester

LANG	ELEMENTARY OR INTERMEDIATE LEVEL	3
MET	63 ENGINEERING MATERIALS AND PROCESSES	3
MATH	231 STATISTICAL INFERENCE	3
PHYS	4 ELECTRICITY, LIGHT, AND ATOMIC PHYSICS	4
IE	11 APPLIED PROBABILITY LABORATORY	1
IE	18 INFORMATION PROCESSING THEORY	3
		<u>17</u>

Summer

IE 40	MACHINE SHOP PRACTICE	3
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Junior Year, First Semester

LANG	ELEMENTARY OR INTERMEDIATE LEVEL	3
IE	221 INDUSTRIAL STATISTICS	4
ECO	4 ECONOMICS	3
DIST	REQUIREMENT	3
MATH	205 LINEAR METHODS	3
MECH	1 STATICS	3
		<u>19</u>

Junior Year, Second Semester

LANG	ELEMENTARY OR INTERMEDIATE LEVEL	3
DIST	REQUIREMENT	9
IE	222 OPERATIONS ANALYSIS	4
MECH	11 MECHANICS OF MATERIALS	3
		<u>19</u>

Senior Year, First Semester

IE	121 ANALYSIS AND DESIGN I	5
DIST	REQUIREMENTS	6
PSYCH	1 ELEMENTARY PSYCHOLOGY	3
MECH	102 DYNAMICS	3
IE	140 MANUFACTURING PROCESSES LABORATORY	1
		<u>18</u>

Senior Year, Second Semester

IE	122 ANALYSIS AND DESIGN II	4
ME	168 ELEMENTS OF MECHANICAL DESIGN	4
	ELECTIVES	6
ACCTG	108 FUNDAMENTALS OF ACCOUNTING	3
		<u>17</u>

Summer

IE 100 Industrial employment should precede fifth year. Consult chairman of department.

ARTS—MECHANICAL ENGINEERING
Credit Hours Needed for B.A. and B.S.: 165
Freshman Year, First Semester

LANG	ELEMENTARY OR INTERMEDIATE LEVEL	3
ENGL	COMPOSITION OR LITERATURE	3
MATH	21 ANALYTICAL GEOMETRY AND CALCULUS I	4
DIST	REQUIREMENTS	3
CHEM	1 CHEMICAL PRINCIPLES I	3
CHEM	11 CHEMICAL PRINCIPLES I LABORATORY	1
PE	1 PHYSICAL EDUCATION	0
		<u>17</u>

Freshman Year, Second Semester

LANG	ELEMENTARY OR INTERMEDIATE LEVEL	3
ENGL	COMPOSITION OR LITERATURE	3
MATH	22 ANALYTICAL GEOMETRY AND CALCULUS II	4

PHYS 1 MECHANICS OF MASS POINTS

CHEM	3 CHEMICAL PRINCIPLES II	3
CHEM	13 CHEMICAL PRINCIPLES II LABORATORY	1
PE	2 PHYSICAL EDUCATION	0
		<u>0</u>
		<u>17</u>

Sophomore Year, First Semester

LANG	ELEMENTARY OR INTERMEDIATE LEVEL	3
DIST	REQUIREMENT	3
ECO	3 ECONOMICS	3
MATH	23 ANALYTICAL GEOMETRY AND CALCULUS III	4
PHYS	3 HEAT AND ELECTRICITY	4
ME	10 ANALYSIS OF ENGINEERING PROBLEMS	1
		<u>18</u>

Sophomore Year, Second Semester

DIST	REQUIREMENT	3
LANG	ELEMENTARY OR INTERMEDIATE LEVEL	3
MATH	221 DIFFERENTIAL EQUATIONS	3
PHYS	4 ELECTRICITY, LIGHT AND ATOMIC PHYSICS	4
CE	11 ENGINEERING GRAPHICS	2
		<u>15</u>

Junior Year, First Semester

LANG	ELEMENTARY OR INTERMEDIATE LEVEL	3
DIST	REQUIREMENT	6
MECH	1 STATICS	3
MET	63 ENGINEERING MATERIALS AND PROCESSES OR	3
MET	91 ELEMENTS OF MATERIALS SCIENCE	3
		<u>81</u>

Junior Year, Second Semester

LANG	ELEMENTARY OR INTERMEDIATE LEVEL	3
DIST	REQUIREMENT	3
MECH	11 MECHANICS OF MATERIALS	3
MECH	13 MATERIALS TESTING LABORATORY	1
MATH	208 COMPLEX VARIABLES OR	3
MATH	231 STATISTICAL INFERENCE	3
EE	160 ELECTRICAL CIRCUITS AND APPARATUS	3
EE	161 ELECTRICAL PROBLEMS	1
EE	162 DYNAMO LABORATORY	1
		<u>18</u>

Senior Year, First Semester

ME	101 MECHANICAL ENGINEERING DESIGN I	3
ME	104 THERMODYNAMICS I	3
MECH	102 DYNAMICS	3
MECH	201 ADVANCED MECHANICALS OF MATERIALS ELECTIVES	6
		<u>18</u>

Senior Year, Second Semester

ME	105 THERMODYNAMICS II	3
ME	231 FLUID MECHANICS	3
CE	123 FLUID MECHANICS LABORATORY	1
ME	242 MECHANICAL VIBRATIONS	3
	ELECTIVES	6
		<u>16</u>

Summer

ME	100 Summer Employment should precede fifth year. Consult department chairman.	
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ARTS—METALLURGY AND MATERIALS SCIENCE

Credit Hours Needed for B.A. and B.S.: 170
(Industrial and Research Option: 171)

Freshman Year, First Semester

LANG	ELEMENTARY OR INTERMEDIATE LEVEL	3
ENGL	COMPOSITION OR LITERATURE	3
MATH	21 ANALYTIC GEOMETRY AND CALCULUS I	4
CHEM	1 CHEMICAL PRINCIPLES I	3
CHEM	11 CHEMICAL PRINCIPLES I LABORATORY	1
DIST	REQUIREMENT	3
PE	1 PHYSICAL EDUCATION	0
		<hr/> 17

Freshman Year, Second Semester

LANG	ELEMENTARY OR INTERMEDIATE LEVEL	3
ENGL	COMPOSITION OR LITERATURE	3
MATH	22 ANALYTICAL GEOMETRY AND CALCULUS II	4
PHYS	1 MECHANICS OF MASS POINTS	3
CHEM	3 CHEMICAL PRINCIPLES II	3
CHEM	13 CHEMICAL PRINCIPLES II LABORATORY	1
PE	PHYSICAL EDUCATION	0
		<hr/> 17

Sophomore Year, First Semester

LANG	ELEMENTARY OR INTERMEDIATE LEVEL	3
MET	91 ELEMENTS OF MATERIALS SCIENCE	3
MATH	23 ANALYTICAL GEOMETRY AND CALCULUS II	4
PHYS	3 HEAT AND ELECTRICITY	4
ECO	3 ECONOMICS	3
		<hr/> 17

Sophomore Year, Second Semester

LANG	ELEMENTARY OR INTERMEDIATE LEVEL	3
DIST	REQUIREMENT	3
PHYS	4 ELECTRICITY, LIGHT AND ATOMIC PHYSICS	4
MET	10 METALLURGY LABORATORY	2
MECH	1 STATICS	3
ECO	4 ECONOMICS	3
		<hr/> 18

Junior Year, First Semester

LANG	ELEMENTARY OR INTERMEDIATE LEVEL	3
DIST	REQUIREMENT	3
MET	207 ELECTRON AND CRYSTAL STRUCTURE	3
CHEM	95 PHYSICAL CHEMISTRY	3
MET	210 METALLURGICAL THERMODYNAMICS	3
MECH	11 MECHANICS OF MATERIALS	3
		<hr/> 18

Junior Year, Second Semester

LANG	ELEMENTARY OR INTERMEDIATE LEVEL	3
DIST	REQUIREMENT	3
MET	208 PHASE DIAGRAM AND TRANSFORMATIONS	3
CHEM	195 PHYSICAL CHEMISTRY	3
CHE	60 ENGINEERING IN CHEMICAL MANUFACTURING	3
MET	218 MECHANICAL BEHAVIOR OF MATERIALS	3
		<hr/> 18

Senior Year, First Semester

DIST	REQUIREMENTS	6
	ELECTIVE	3
MECH	102 DYNAMICS	3
MET	307 STRUCTURE AND BEHAVIOR OF MATERIALS	3
MATH	205 LINEAR METHODS	3
	OR	
MATH	231 STATISTICAL INFERENCE	3
		<hr/> 18

*Senior Year, Second Semester**

DIST	ELECTIVES	6
	REQUIREMENT	3
ME	166 PROCEDURES FOR MECHANICAL DESIGN	2
MET	304 EXTRACTIVE METALLURGY I	4
CE	11 ENGINEERING GRAPHICS	2
MET	101 PROFESSIONAL DEVELOPMENT	1
		<hr/> 18

Summer

MET 100 Industrial Employment should precede fifth year. Consult chairman of department.

*Students selecting Research Option should also take Met. 340, Research, Techniques in the second semester of the senior year.

COLLEGE OF BUSINESS AND ECONOMICS

L. Reed Tripp, *Dean*

Max D. Snider, *Assistant Dean*

The College of Business and Economics, which is a member of the American Association of Collegiate Schools of Business, offers a program of study designed to provide thorough and systematic training in the fundamentals of business. The College aims to develop in the student an intelligent understanding of business principles, an ability to analyze industrial facts, and habits of thought which will enable him to cope with the problems that increasing executive responsibilities will bring him in later life. Stress is on building a sound foundation, since it is the firm belief of the College that no substitute can be furnished for the training and experience provided by actual contact with the complex problems of modern business. Accordingly, the student's interests are best served by equipping him with those fundamental principles and insights which will make it possible for him to profit more readily from practical experience after graduation.

In accordance with this plan of training in fundamentals, the student is required to learn the basic principles that underlie business. No student may omit basic work in the principles and problems of economics, accounting, corporation finance, money and banking, marketing, business law, management, and statistical method, which are essential for a career in all types of business enterprise. Acquaintance with the fundamentals of the broad-field not only equips the student with the elementary requisites for a career in a variety of commercial and industrial enterprises but also gives him an invaluable means of discovering his real abilities and making a sound choice of a profession. A major function of the curriculum in business and economics is to aid students in their efforts to discover their best talents, not only students who enter college uncertain of their ultimate objectives but also those whose choice of a future profession or field of business may have been determined already but predicated upon inadequate grounds.

No student may devote himself exclusively to business subjects. He must acquire at least a rudimentary acquaintance with the cultural and human-

itarian aspects of the world around him, and at least a brief contact with science. Consequently, a large part of the curriculum is devoted to work in liberal and scientific subjects. Throughout the entire four years' work there is emphasis on the social aspects of the subjects considered. If a student develops alongside his business work a special interest in some such field as languages, mathematics, or science, he is given opportunity through electives to pursue his special line. The College regards as important the principle that the training as a whole shall offer an education commensurate with the standards of a university.

An increasing number of bachelor graduates are not going directly into business but go on to law school, to graduate study in economics, or graduate schools of business, and many of the latter go on to research and analytical studies of management or economics. They become staff researchers in business or government or foundations or become college and university teachers. And increasingly today, competent and qualified individuals move back and forth, as previously in the natural sciences and engineering, between staff research in business, government or independent consulting and university teaching.

Perhaps the most distinctive feature of the work in business and economics at Lehigh is the character of the class work. Much of the work of the curriculum is taken in the College of Arts and Science, while students of this division and of the College of Engineering avail themselves of the courses given in the College of Business and Economics. There is no segregation of students by colleges, and students in business and economics take their courses in competition with students trained in liberal arts and in the exact sciences. This condition has a marked influence on the standards of work and the quality of the student. Qualified students in Business and Economics are eligible for the Inter-departmental Honors Program (see page 20). Also, on the advice of the head of the department in which the major work is being done, and with the consent of the Dean of the College, a junior or

senior of unusual merit in the College of Business and Economics who wishes to concentrate in his chosen field may be allowed to substitute not more than four hours (if a junior) or six hours (if a senior) of unscheduled work per semester for an equivalent number of hours of *elective* work otherwise required for graduation.

Although emphasis is upon broad training, rather than specialization, the College recognizes that some degree of concentration is desirable after the student's interests may reasonably be expected to have crystallized. Accordingly, in the junior and senior years, every student is required to pursue a series of related courses in some more restricted field. Seven fields of concentration are offered, viz: accounting, economics, economic statistics, finance, foreign careers, management, and marketing. The detailed programs of study in each of the above fields are set forth on the following pages.

In times of normal business activity, students who have made creditable records may reasonably expect to receive one or more offers of positions before the date of their graduation. The College of Business and Economics enjoys happy relations with many of the country's leading industries. Representatives regularly visit the campus to engage the services of students graduating in business and economics. The University assumes no responsibility for finding positions for its graduates, but every effort is made by the College and by the University placement service to put its graduating students in touch with desirable opportunities for employment.

Graduates of this curriculum receive the degree of Bachelor of Science in Business and Economics. A five-year curriculum with a bachelor's degree in industrial engineering and a bachelor's degree in business and economics is outlined on page 888.

Many students in the several branches of engineering and various majors in the College of Arts and Science will seek graduate or professional business training through pursuit of the Master of Business Administration degree. If they are eligible for admission to Lehigh's Graduate School, they may plan business electives during their bachelors work in engineering and arts to meet at best part of the background year requirements for Lehigh's MBA degree.

Graduate programs leading to the degrees of Master of Business Administration, Master of Arts in Economics, Master of Science in Business Economics, and Master of Science in Management Science are outlined on pages 54-56.

The Ph.D. degree in Business and Industrial Economics is described on page 56.

CURRICULUM FOR B. S. IN BUSINESS AND ECONOMICS

120 hours required for degree plus physical education for two semesters.

I. College Core Requirements (53 hours)

A. Freshman English and Mathematics (14 hours)

ENGL	1 COMPOSITION AND LITERATURE	3
OR		
ENGL	11 TYPES OF WORLD LITERATURE	3
ENGL	2 COMPOSITION AND LITERATURE	3
OR		
ENGL	12 TYPES OF WORLD LITERATURE	3
MATH	21 ANALYTICAL GEOMETRY AND CALCULUS I	4
MATH	22 ANALYTICAL GEOMETRY AND CALCULUS II	4

B. Business and Economics Core Requirements (39 hours)

ECO	11 INTRODUCTION TO POLITICAL-ECONOMIC THOUGHT	3
ECO	12 INTRODUCTION TO POLITICAL-ECONOMIC THOUGHT	3
ECO	3 ECONOMICS	3
ECO	4 ECONOMICS	3
ECO	45 STATISTICAL METHOD	3
ECO	129 MONEY AND BANKING	3
ECO	206 INTERMEDIATE MICRO-ECONOMIC THEORY	3
ACCTG	51 ESSENTIALS OF ACCOUNTING	3
ACCTG	52 ESSENTIALS OF ACCOUNTING	3
LAW	1 BUSINESS LAW	3
MKT	11 MARKETING	3
FIN	125 CORPORATION FINANCE	3
MGT S	313 LINEAR PROGRAMMING OR	3
MGT S	321 BUSINESS AND ORGANIZATION BEHAVIOR	3

II. Major Program (15-18 hours)

Before the end of the second semester of their sophomore year, students will select a major or field of concentration. A major program will consist of 15-18 hours of sequential or related courses in accordance with one of the designated major programs set forth below.

III. Optional Courses (33 hours)

LANGUAGE OPTION (12 HOURS)

Except for the requirement of two high school

units in one foreign language for entrance credit, students in the college are not required to take work in foreign languages. Foreign Careers students, however, will take at least 6 hours in an appropriate foreign language specialty beyond the elementary course. Credit for less than six hours in an elementary language will not be accepted in partial satisfaction of this option.

All courses offered by the Department of English which require work in composition, either oral or written, or a study of literature will be accepted in satisfaction of the English requirement. Journalism courses which do not require work in composition or study of literature will not be accepted. One-hour courses in speech and journalism will not be accepted for the English requirement but may be counted toward electives — See IV below.

OTHER ARTS OPTIONS (12 HOURS)

The Arts Options requirement may be met by taking a total of twelve hours work in the following fields, not more than six hours to be in any of the fields designated: astronomy, education, fine arts, government, history, international relations, mathematics, music, philosophy, psychology, religion, social relations. One-hour courses in music will not be accepted for the Arts Option but may be counted toward electives — See IV below.

SCIENCE OPTION (9 HOURS)

Not more than six hours from one department may be credited toward the Science Option. Courses in the following sciences are acceptable in satisfaction of this distribution requirement: Biology, Geology, Physics and Chemistry. If four-hour sciences are taken, the additional hours by which four-hour courses exceed three credit units may be counted as electives. — See IV below.

IV. ELECTIVES. (HOURS REMAINING)

Normally any courses in the University for which a student has the prerequisites may be used as electives as long as such courses carry University credits. Advanced Military Science and Aerospace Studies courses may be counted as electives up to 6 credits, but freshman and sophomore level courses in Military Science and Aerospace Studies do not carry credit against the 120 hours required for graduation.

Planning Courses of Study

In addition to freshman English and mathematics requirements (see IA above), each freshman enrolled in the College of Business and Economics will register for Economics 11 in the first semester of his freshman year. For his fourth and fifth courses, he will take optional courses toward the science and arts option requirements each semester of his freshman year, in addition to the two semesters of physical education. The normal program for freshmen is sixteen hours each semester.

Economics 3 and 4 and Accounting 51 should be completed as soon as possible in the sophomore year. Other Business and Economics Core requirements should be selected with some sampling of introductory courses that may help the student choose his major by spring pre-registration in his sophomore year.

All students in the College take Graduate Record Examinations with advanced tests in both business and economics on an institutional basis in their senior year.

ACCOUNTING

Requirement: 15 credits beyond the Core, including:

ACCTG 111 BUSINESS DATA PROCESSING	3
ACCTG 213 INTERMEDIATE ACCOUNTING	3
ACCTG 214 INTERMEDIATE ACCOUNTING	3

Students interested in qualifying for the C.P.A. Certificate at either the bachelor or M.B.A. level should consult the chairman of the department.

ECONOMICS

Requirement: 15 credits beyond the Core, including:

ECO 316 INTERMEDIATE MACRO-ECONOMIC THEORY	3
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ECONOMIC STATISTICS

Requirement: 15 credits beyond the Core as follows:

ECO 316 INTERMEDIATE MACRO-ECONOMIC THEORY	3
ECO 346 BUSINESS CYCLES AND FORECASTING	3
ECO 347 NATIONAL INCOME ANALYSIS	3
ECO 352 ADVANCED STATISTICAL METHOD	3
ACCTG 111 BUSINESS DATA PROCESSING OR MATH 105 COMPUTER PROGRAMMING	3

FINANCE

Requirement: 18 credits beyond the Core including:

FIN 323 INVESTMENTS	3
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FIN	326 PROBLEMS IN FINANCIAL MANAGEMENT	3
ECO	351 PUBLIC FINANCE-FEDERAL	3
ECO	316 MACRO-ECONOMICS OR ECO 332 MONETARY-FISCAL POLICY	3
	<i>and 6 credits from the following:</i>	
FIN	324 SECURITY ANALYSIS	3
FIN	331 BANK CREDIT MANAGEMENT	3
ECO	337 INTERNATIONAL ECONOMICS	3
ECO	316 MACRO-ECONOMICS (If not taken as a specified major course)	3
ECO	332 MONETARY-FISCAL POLICY (If not taken as a major course)	3

FOREIGN CAREERS

Requirement: 15 credits beyond the Core as follows:

ECO	303 ECONOMIC DEVELOPMENT	3
ECO	309 COMPARATIVE ECONOMIC SYSTEMS	3
ECO	339 INTERNATIONAL ECONOMICS	3
ECO	340 INTERNATIONAL ECONOMICS	3
ECO	305 THE ECONOMIC DEVELOPMENT OF LATIN AMERICA OR ECO 343 EUROPEAN ECONOMIC INTEGRATION	3

To qualify for this major, include at least one year (beyond the introductory course) of foreign language of your area in the language option as well as one year of history of your area and Government 3. Foreign Government in your Other Arts Option.

MANAGEMENT

Requirement: 15 credits beyond the Core as follows:

MGT S	321 BUSINESS AND ORGANIZATION BEHAVIOR OR MGT S 313 LINEAR PROGRAMMING (whichever was not taken in the Core)	3
ACCTG	111 BUSINESS DATA PROCESSING	3
MGT S	302 SURVEY OF MANAGEMENT SCIENCE APPLICATIONS	3
ECO	335 MANPOWER ECONOMICS OR	3
ECO	338 LABOR MARKET INSTITUTIONS	3
MGT S	301 BUSINESS MANAGEMENT POLICIES	3

Recommended electives:

PSYCH	201 INDUSTRIAL PSYCHOLOGY	3
SR	372 SPECIAL TOPICS: INDUSTRIAL SOCIOLOGY	3

MARKETING

Requirement: 15 credits beyond the Core as follows:

MKT	113 ADVERTISING	3
MKT	214 SELLING AND SALES MANAGEMENT	3
MKT	115 RETAILING OR MKT 217 INDUSTRIAL MARKETING	3
MKT	312 MARKETING AND DISTRIBUTION RESEARCH	3
MGT S	313 LINEAR PROGRAMMING OR MGT S 321 BUSINESS AND ORGANIZATION BEHAVIOR (whichever was not taken in the Core)	3

Recommended electives:

ACCTG	111 BUSINESS DATA PROCESSING	3
MGT S	301 BUSINESS MANAGEMENT POLICIES OR MGT S 302 SURVEY OF MANAGEMENT SCIENCE APPLICATIONS	3
ECO	338 LABOR MARKET INSTITUTIONS	3
PSYCH	106 MOTIVATION OR PSYCH 302 THEORIES OF PERSONALITY	3

FIVE YEAR PROGRAMS

ENGINEERING - M.B.A. PROGRAM and ENGINEERING - M.S. IN MANAGEMENT SCIENCE PROGRAM

These programs are designed to meet the needs of competent students in any of the engineering curricula who wish to add to their engineering studies training in business management at an advanced level.

The over-all time involved in each program is five years, but a certain amount of summer session work would be necessary to attain both a bachelor's degree in engineering and a master's degree in business administration or management science within that period. In addition to a course in economics, which is required of all engineering undergraduates, twenty-one or twenty-seven hours of basic business courses are necessary to meet the background requirements for both the M.S. in Management Science and the M.B.A. degrees. If as much as fifteen hours of such courses can be rostered in the student's engineering curriculum, the remaining twelve hours can be obtained in one summer. Otherwise, attendance at an additional summer session would be necessary. Candidates for each program will be required to take the Admission Test for Graduate Study in Business.

The background courses required for M.B.A. candidates are:

ECO	3 PRINCIPLES OF ECONOMICS	3
ECO	129 MONEY AND BANKING	3
FIN	125 CORPORATION FINANCE	3
LAW	1 BUSINESS LAW	3
ECO	45 STATISTICAL METHOD	3
MKT	11 MARKETING	3
ACCTG	51 ESSENTIALS OF ACCOUNTING OR ACCTG 108 FUNDAMENTALS OF ACCOUNTING AND	3
ACCTG	52 ESSENTIALS OF ACCOUNTING	3
ECO	206 INTERMEDIATE MICRO-ECONOMIC THEORY	3
ACCTG	111 BUSINESS DATA PROCESSING	3

The background required for the M.S. in Management Science is preparation in mathematics embracing a thorough knowledge of calculus (at least six credit hours) and linear algebra (at least 3 credit hours) plus basic courses in accounting, finance, computers, economics (basic level in Macro and intermediate Micro), marketing, and statistics. Candidates for this program will also be required to take the Admission Test for Graduate Study in Business (ATGSB).

Transfer credits from a reputable accredited college or university will be accepted for background courses. Students wishing to take some of their background work elsewhere should consult Professor M. D. Snider, Office of the Dean (Graduate Studies), to obtain approval of the proposed course or courses and of the institution at which they are to be taken.

It is suggested that engineering students who are interested in these programs confer with Professor Snider for additional information. The graduate programs leading to the degrees of Master of Business Administration and M.S. in Management Science are outlined on pages 54-56. The Ph.D. in Business and Industrial Economics is described on page 56.

ARTS—M.B.A. PROGRAM

This program is designed to meet the needs of competent students in any of the Arts and Science Majors who wish to add to their Arts studies training in business management at an advanced level.

The over-all time involved in the program is five years, but a certain amount of summer session work may be necessary for majors in the sciences to attain both a B.A. and a master's degree in business administration within that period. In addition to a year's work in economics, which can be counted as part of the undergraduate social science distribution requirements, twenty-seven hours of basic business courses are necessary to meet the background requirements for the M.B.A. degree.

The background courses required for the M.B.A. are:

ECO	3	PRINCIPLES OF ECONOMICS	3
ECO	129	MONEY AND BANKING	3
FIN	125	CORPORATION FINANCE	3
LAW	1	BUSINESS LAW	3
ECO	45	STATISTICAL METHOD	3
MKT	11	MARKETING	3

ACCTG	51	ESSENTIALS OF ACCOUNTING	3
	OR		
ACCTG	108	FUNDAMENTALS OF ACCOUNTING	3
	AND		
ACCTG	52	ESSENTIALS OF ACCOUNTING	3
ACCTG	111	BUSINESS DATA PROCESSING	3
ECO	206	INTERMEDIATE MICRO-ECONOMIC THEORY	3

Transfer credits from a reputable accredited college or university will be accepted for background courses. Students wishing to take some of their background work elsewhere should consult Professor M. D. Snider, Office of the Dean (Graduate Studies), to obtain approval of the proposed course or courses and of the institution at which they are to be taken.

It is suggested that Arts and Science students who are interested in this program confer with Professor Snider for additional information. The graduate program leading to the degree of Master of Business Administration is outlined on pages 54-56. The Ph.D. in Business and Industrial Economics is described on page 56.

INDUSTRIAL ENGINEERING AND BUSINESS ADMINISTRATION

Students who desire to pursue both industrial engineering and business administration may complete the required work for the degree of Bachelor of Science in Industrial Engineering by the end of the fourth year and that required for the degree of Bachelor of Science in Business Administration by the end of the fifth year. It is necessary that a student be enrolled in the curriculum in industrial engineering for the first four years and that he complete the requirements in the curriculum as outlined on page 73. At the beginning of the fifth year the student transfers to the curriculum in business administration and is required to complete thirty-three semester hours as follows:

Majors in Accounting, Economics, Economic Statistics, Finance, Management, and Marketing must complete the 15 or 18 hours required for his major in the regular four-year program in Business and Economics as listed on page 51. The balance of his program to complete the required 33 hours of the fifth year will be selected in consultation with his adviser from those college core requirements listed on page 50, which he has not already taken for the B.S. in Business and Economics.

Majors in personnel and industrial relations must pursue the following program for the Fifth Year:

Required Courses

<i>Fifth Year, First Semester</i>		
LAW	1 BUSINESS LAW	3
ECO	129 MONEY AND BANKING	3
PSYCH	201 INDUSTRIAL PSYCHOLOGY	3
		<u>9</u>

Fifth Year, Second Semester

ECO	206 INTERMEDIATE MICRO-ECONOMIC THEORY	3
ECO	338 LABOR MARKET INSTITUTIONS	3
SR	11 SOCIOLOGY	3
ECO	346 BUSINESS CYCLES	3
		<u>12</u>

and twelve semester hours to be selected from the following in consultation with the advisor:

FIN	323 INVESTMENTS	3
FIN	351 PUBLIC FINANCE: FEDERAL	3
FIN	337 INTERNATIONAL ECONOMICS	3
ECO	347 NATIONAL INCOME ANALYSIS	3
ECO	371 READINGS IN ECONOMICS	3
ECO	352 ADVANCED STATISTICAL METHOD	3
LAW	102 BUSINESS LAW	3
GOVT	360 PUBLIC ADMINISTRATION	3
ECO	372 READINGS IN ECONOMICS	3
IE	339 INDUSTRIAL MANPOWER MANAGEMENT	3
MIGT S	321 BUSINESS AND ORGANIZATION BEHAVIOR	3
SR	65 CONTEMPORARY PROBLEMS IN SOCIETY	3
		<u>39</u>

GRADUATE STUDY IN BUSINESS AND ECONOMICS

The College of Business and Economics offers four degrees at the master's level: the M.B.A., the M.S. in Management Science, the M.S. in Business Economics, and the Master of Arts in Economics. On a more advanced level, the College offers a Ph.D. in Business and Industrial Economics.

THE M.B.A. DEGREE

The M.B.A. degree is designed to give the candidate a working knowledge of the managerial problems involved in the various facets of business activity — marketing, finance, pricing, etc. — and is hence a fairly rigid program with required courses in the various areas and some opportunity for specialization.

A candidate who is a graduate, with a major in business administration, of an approved college or university, and who has had basic courses in accounting, business law, corporation finance, economics, marketing, money and banking, and sta-

tistics will usually have sufficient background work to enable him to complete the requirements for the degree in one year. For other candidates an additional semester or year devoted to prerequisite and basic courses may be necessary as indicated in the program outlined below.

All candidates for this program will be required to take the Admission Test for Graduate Study in Business.

The background courses listed below other than Economics 3, plus credit courses listed below, are available in the evening or on Saturday morning to permit qualified candidates to obtain the degree on a part-time basis. Equivalent background courses taken at other approved institutions will be accepted in lieu of those indicated. A comprehension examination will be required of all candidates for the M.B.A. degree.

Background Courses

ECO	3 PRINCIPLES OF ECONOMICS	3
FIN	125 PRINCIPLES OF CORPORATION FINANCE	3
LAW	1 BUSINESS LAW	3
ECO	45 STATISTICAL METHOD	3
ECO	206 INTERMEDIATE MICRO-ECONOMIC THEORY	3
ECO	129 MONEY AND BANKING	3
ACCTG	51 ESSENTIALS OF ACCOUNTING AND	3
ACCTG	52 ESSENTIALS OF ACCOUNTING OR	3
ACCTG	108 FUNDAMENTALS OF ACCOUNTING AND	3
ACCTG	52 ESSENTIALS OF ACCOUNTING	3
MKT	11 MARKETING	3
ACCTG	111 BUSINESS DATA PROCESSING	3

Required Courses (18 hours)

ACCTG	422 MANAGERIAL ACCOUNTING OR	3
ACCTG	431 ACCOUNTING THEORY AND THOUGHT (for Accounting Majors)	3
ECO	302 SURVEY OF MANAGEMENT SCIENCE APPLICATIONS	3
ECO	431 MANAGERIAL ECONOMICS**	3
FIN	421 FINANCIAL MANAGEMENT	3
LAW	401 LEGAL PROBLEMS IN BUSINESS	3
MKT	450 MARKETING MANAGEMENT	3

**It is recommended that this course be taken the last semester before graduation.

Elective Courses (12 hours)

The following major sequences are suggested for candidates interested in one of these areas of specialization, but the twelve elective credit hours may be selected from desired combinations of 300- and 400-level courses offered in the College of Business and Economics, as described under the various departmental listings in this Catalog.

Management Science

MGT S 313 LINEAR PROGRAMMING AND	3
MGT S 321 BUSINESS AND ORGANIZATION BEHAVIOR	3
MGT S 471 SPECIAL TOPICS OR	3
MGT S 313 LINEAR PROGRAMMING AND	3
MGT S 417 ADVANCED MATHEMATICAL PROGRAMMING	3
MGT S 418 SEMINAR IN MANAGEMENT SCIENCE	3

Forecasting

ECO 346 BUSINESS CYCLES AND FORECASTING	3
ECO 454 FORECASTING	3
ECO 471 SPECIAL TOPIC STUDY	3

Finance

FIN 323 INVESTMENTS	3
FIN 431 ADVANCED INVESTMENT ANALYSIS & MANAGEMENT	3
FIN 471 SPECIAL TOPICS	3

Labor Relations

ECO 335 MANPOWER ECONOMICS OR	3
ECO 338 LABOR MARKET INSTITUTIONS	3
ECO 437 LABOR ECONOMICS	3
ECO 438 LABOR-MANAGEMENT ADMINISTRATION	3

Transportation

ECO 337 TRANSPORTATION & SPATIAL ECONOMICS	3
ECO 440 REGIONAL SCIENCE-METROPOLITAN ANALYSIS	3
ECO 471 SPECIAL TOPICS	3

International Trade and Finance

ECO 339 INTERNATIONAL ECONOMICS	3
ECO 340 INTERNATIONAL ECONOMICS	3
ECO 441 FOREIGN TRADE MANAGEMENT	3

Accounting

ACCTG 442 PROFESSIONAL ACCOUNTING SEMINAR <i>and two of the following:</i>	3
ACCTG 307 FEDERAL TAX ACCOUNTING	3
ACCTG 315 ADVANCED ACCOUNTING	3
ACCTG 324 COST ACCOUNTING	3

MASTER OF ARTS IN ECONOMICS

Admission to the Master of Arts program in Economics normally requires a major in economics or in one of the fields of business comparable to the Lehigh University offerings. Superior students in other majors with adequate background in economics and calculus may be admitted to the program. All candidates will be required to take the Graduate Record Examination with the advanced test in economics.

Candidates for the degree may qualify by completing thirty hours of approved course work or by completing twenty-four hours in approved courses

and submitting a satisfactory thesis. A candidate not electing a thesis will be required to pass an examination covering the entire field of his graduate studies.

The program of study will include:

- (1) six hours of required courses —Economics 432, Micro-Economics and Economics 436, Macro-Economics;
- (2) at least eighteen hours of credit (twelve hours if a thesis is written) selected from the offerings in the departments of Economics and Finance excluding marketing, management, and private finance with six hours of course work in one sequence or field if a thesis is not written;
- (3) six credit hours of optional courses may be elected from related fields in any department in the university with the consent of the director of the program.

THE M.S. IN BUSINESS ECONOMICS

The College of Business and Economics offers advanced work in Business Economics in recognition of the growing need for business and banking economists who have the training needed to interpret changes in general economic conditions. Emphasis is placed on the importance of estimation and forecasting in making business decisions. Since initiation of the program in 1962, it has come to be widely recognized in the business world. Suitable candidates will be admitted only if (a) they have had a thorough undergraduate training in economics, or (b) they have had substantial government or business experience in economic analysis, or (c) they are willing to take a substantial amount of background work in preparation. All candidates will be required to take the Graduate Record Examination with the advanced test in economics. The qualifications of each candidate will be considered on his particular merits. The great demands in industry, government, teaching, and research for trained and capable analysts necessitates a high degree of selectivity in accepting candidates.

A course of study is worked out for each student. Since the program centers on the use of futurity in interpreting general economic conditions, the following courses are recommended though substitutions are permitted:

ECO	352 ADVANCED STATISTICAL METHOD	3
ECO	447 SYSTEMS OF NATIONAL ACCOUNTS	3
ECO	432 MICRO-ECONOMICS	3
ECO	453 TIME SERIES ECONOMETRICS	3
ECO	454 FORECASTING	3
ECO	475 BUSINESS ECONOMICS SEMINAR	3

The remaining 12 hours required for the master's degree are fitted to the student's interest insofar as his set of courses clearly integrates into an oriented program. For instance, the student may wish to cover such areas as labor management, regional science-metropolitan analysis, marketing management, computer programming, banking and monetary policy, accounting, or operations research.

THE M.S. IN MANAGEMENT SCIENCE

This program is designed to provide a rigorous analytical preparation in business education emphasizing certain applied and behavioral aspects of economic theory. Management Science is an interdisciplinary program and is given in cooperation with the departments of Industrial Engineering and Mathematics.

To be eligible for this program, the applicant must have had background preparation in mathematics embracing a thorough knowledge of calculus (at least 6 credit hours) and linear algebra (at least 3 credit hours) plus basic courses in accounting, finance, computers, economics, marketing* and statistics. Candidates for this program will also be required to take the Admission Test for Graduate Study in Business (ATGSB).

Program for M.S. in Management Science Degree:

MGT S	417 ADVANCED MATHEMATICAL PROGRAMMING	3
MGT S	418 SEMINAR IN MANAGEMENT SCIENCE	3
ACCTG	422 MANAGERIAL ACCOUNTING	3
IE	408 INDUSTRIAL INFERENCE SYSTEMS	3
ECO	431 MANAGERIAL ECONOMICS	3

OR

ECO	432 MICRO-ECONOMICS	3
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One of the following I.E. courses:

IE	416 DYNAMIC PROGRAMMING	3
IE	418 SIMULATION	3

IE	420 ANALYSIS OF DECISION PROCESS	3
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One of the following courses:

IE	326 QUALITY CONTROL	3
MATH	309 THEORY OF PROBABILITY	3

ECO	352 ADVANCED STATISTICAL METHODS	3
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In addition the candidates must take 9 credit hours from the following:

MGT S	313, 321	
ECO	316, 352, 437, 454	
IE	308, 410, 416, 418, 420, 425, 426, 427, 440	

MATH	251, 309, 334, 362
EE	411, 412
SR	305, 381, 402, 465
LAW	401
FIN	421
MKT	450

*This requirement may be waived if student is taking Mkt. 450 as part of his program.

THE PH.D. IN BUSINESS AND INDUSTRIAL ECONOMICS

Candidates for the Ph.D. degree may select advanced work in the fields of economic development, forecasting and business conditions, economic systems, labor, economics, management science, accounting and finance, and regional economics. Admission to the Ph.D. program is by committee action of the College of Business and does not constitute admission to candidacy for the Ph.D. degree. Anyone planning to enter the program should have had a thorough grounding in calculus and economic theory at the undergraduate or master's level, or plan to make up any deficiencies in those areas. A student in the program who has met University doctoral requirements may apply to the Graduate Faculty for admission to candidacy when he presents an approved dissertation plan and has passed satisfactorily qualifying examinations in the following fields:

- A. MICRO-ECONOMICS
- B. MACRO-ECONOMICS
- C. QUANTITATIVE ANALYSIS AND RESEARCH METHODOLOGY, Demonstrating Competence In
 - (1) STATISTICS
 - (2) ACCOUNTING
 - (3) OPERATIONS ANALYSIS
- D. A MAJOR FIELD
- E. A MINOR FIELD—EITHER WITHIN OR OUTSIDE THE COLLEGE OF BUSINESS ADMINISTRATION

A dissertation committee comprised of at least four faculty members including the candidate's major professor as Chairman and two other members as readers is established for each candidate passing the qualifying examinations. At least one member of the Committee shall be appointed from outside the College of Business Administration, and at least two departments within the College shall be represented on the committee.

COLLEGE OF ENGINEERING

John J. Karakash, *Dean*

Robert Taylor Gallagher, *Associate Dean*

The College of Engineering offers curricula in chemical engineering, chemistry, civil engineering, electrical engineering, engineering physics, fundamental sciences, industrial engineering, mechanical engineering and engineering mechanics, and metallurgical engineering and material science.

The engineering curricula were formulated on the basis of study, by the faculty of Lehigh University, of the problems of technical education and the changing needs of modern society. This study led to the conclusion that greater emphasis than heretofore should be placed upon the fundamentals of engineering, including mathematics, physics, chemistry, and theoretical and applied mechanics and less emphasis upon the highly specialized details of engineering practice; and that the engineer must know something of the social sciences and humanities, that is, the sciences which deal with human relations. The various engineering curricula accordingly emphasize the fundamental sciences and those subjects from the social sciences and the humanities which are expected of every well-educated man. These latter are now recognized as essential to the education of engineers, not only because of their practical applications in industrial, business, and civic life, but also because they enrich the whole of a man's private life.

Recommendation is made for a uniform freshman year in the College of Engineering. The student's tentative choice of a specific engineering curriculum, as recorded at the time of entrance, may be changed (within the limitations of enrollment in the various curricula) prior to his entering upon the sophomore year without loss of time. Engineering freshmen are admitted with "open" curriculum choice. Within a year of college experience, and on the basis of conferences with members of the faculty, it is hoped that any student who is uncertain as to his curriculum choice may choose wisely. In the second semester of his freshman year, just prior to preregistration for the sophomore year, each engineering student selects a particular engineering curriculum. The sophomore year for many of the

engineering curricula are sufficiently alike so as to be "tradeable" between these curricula, and it is thus possible for a student to transfer from one curriculum to another without loss of credit or having to make up courses at the end of his sophomore year.

The work of the first two years is fairly self-contained. To those who for one reason or another are unable to complete their engineering education, it affords preparation for technical but not necessarily professional careers in industrial laboratories.

Since the University recognizes that the four-year programs are not intended to train specialists in a given area but rather to educate students in terms of principles, the degree awarded upon graduation is Bachelor of Science in the particular division of engineering. The successful completion of one year of full-time graduate study leads to the degree of Master of Science.

Students pursuing studies leading to a specific engineering degree have opportunities for elective sequences which provide the foundation for graduate work in special areas of interest. Even though elective opportunities in some curricula do not appear until the Senior year, students are urged to become aware of such opportunities as early as their Sophomore year and consult with their curriculum advisors for optimal planning of their programs.

Five-year courses combining the liberal arts and engineering, business administration and engineering, or electrical engineering and physics are also provided. In each of these combined curricula one baccalaureate degree is awarded upon the successful completion of four years of study, and a second baccalaureate degree is awarded at the end of the fifth year. Similar programs may be worked out leading to an M.S. in Materials, or an M.B.A.

GENERAL STUDIES

General Studies (GS) are non-professional, non-specialized studies in the large areas of human knowledge and experience with which any educated

man should be acquainted. These areas are three: the humanities, the natural sciences, and the social sciences. Since all engineers receive extensive training in the physical sciences, their general studies are restricted to the humanities, the life and earth sciences, and the social sciences.

The General Studies sequence starts in the freshman year with six hours of English composition and literature, six hours of social sciences, and three hours of economics. During the following six semesters, fifteen additional hours (five courses) are elected so that by the end of the senior year, a student will have completed a total of thirty credit hours—the minimum requirement in General Studies.

All courses must be on the approved list of courses for General Studies. The distribution requirements of General Studies are as follows:

General Studies (Thirty total hours required)

GROUP 1: HUMANITIES (9 hours minimum required)

Freshman English. Six semester hours (University-wide requirement). English 1 and 2, Composition and Literature. Students who complete the alternate courses English 11 and 12, Types of World Literature, will have met this requirement; those who complete English 11 and 12 with a grade of "B" or better will automatically be granted General Studies credit for English 1 and 2 as well as for English 11 and 12, for a total of 12 hours.

GROUP 2: LIFE AND EARTH SCIENCES

(No required minimum)

GROUP 3: SOCIAL SCIENCES

(9 hours minimum required)

Eco 3 ECONOMICS (3 hours)

ELECTIVES: Not more than 12 hours General Studies (GS) credit is allowed in any one department. On the recommendation of the department chairmen and with the approval of the Dean of the College of Engineering, certain courses from the General Study list, not to exceed two above the stipulated requirements, can be used toward regular curriculum requirements and also counted toward General Study requirements. Registration into any of the elective courses may be limited by the maximum class size.

The objective of the study of the humanities and

social sciences in technical schools has been stated by the American Society for Engineering Education to be the development of an "understanding of the evolution of the social organism within which we live . . .; and the development of moral, ethical, and social concepts essential to a satisfying personal philosophy, to a career consistent with the public welfare, and to a sound professional attitude." We conceive it to be the duty of the engineer to be a professional man in the broadest sense of the term, a member of a group whose primary aim is to advance human well-being.

Several of these courses (notably History 11 and 12, "Development of Western Civilization"; Biology 13, "Human Biology"; and Philosophy 100, "Philosophy of Contemporary Civilization") have been developed particularly to satisfy the objectives of general studies. They are designed to acquaint the student with some broad segment of the heritage of our civilization, thereby opening intellectual doors for the student to facilitate the self-education which will continue throughout his life. The requirements in various fields are planned to encourage the student to study as broadly as is possible yet retain the possibility that the student who has a strong interest in a field may pursue that interest to as great an extent as is reasonable within the time available. Since election of History 11 and 12 is encouraged in the freshman year, it is scheduled to fit with the normal freshman courses, whereas difficulty of schedules and conflicts may be expected in later years.

General Studies Courses

GROUP 1: HUMANITIES

Literature (English or American)

ENGL 1, 2; 11, 12 COMPOSITION AND LITERATURE
(Required)

ENGL 4, 5, 7, 8, 9,
11, 12, 18, 19,
20, 21, 35, 36, OR ANY ENGLISH LITERATURE COURSE
ABOVE 100.

Literature (Classical)

GK 50 GREEK LITERATURE IN ENGLISH TRANSLATION 3
LAT 51 LATIN LITERATURE IN ENGLISH TRANSLATION 3

Literature (Foreign Language)

Any literature course in a foreign language (i.e., must be beyond intermediate level).

Communication

SPEECH 30 FUNDAMENTALS OF SPEECH 3
SPEECH 32 CONFERENCE AND DISCUSSION 3

Foreign Language

Any language course on the intermediate or elementary level, classical or modern. (If elementary language study is elected, a minimum of six hours must be in one language in order to receive General Studies credit. A student may not elect for elementary study any language in which he has entering credit.)

Fine Arts

MUSIC 20-32 (any course)
FA (any course)
SPCH 61 (Dramatics)

Philosophy and Religion

PHIL (any course)
RELIGION (any course)

GROUP 2: LIFE AND EARTH SCIENCES

ASTRON 1	DESCRIPTIVE ASTRONOMY	3
ASTRON 2	GENERAL ASTRONOMY	3
ASTRON 104	STELLAR ASTRONOMY AND ASTROPHYSICS	3
BIOL 13	HUMAN BIOLOGY	3
BIOL 21	PRINCIPLES OF BIOLOGY	3
BIOL 22	INTRODUCTION TO BIOLOGY LABORATORY	1
BIOL 28	GENETICS	3
BIOL 34	COMPARATIVE VERTEBRATE ANATOMY	4
BIOL 35	MICROBIOLOGY	3
BIOL 221	ECOLOGY	3
BIOL 320	PHYSIOLOGY	3
GEOL 1, 2	PRINCIPLES OF GEOLGY	6
GEOL 311	PALEONTOLOGY	3
GEOL 363	INTRODUCTION TO OCEANOGRAPHY	3
PSYCH 1	INTRODUCTION TO PSYCHOLOGY	3
PSYCH 101	HISTORY OF PSYCHOLOGY	3
PSYCH 103	COMPARATIVE PSYCHOLOGY	3

GROUP 3: SOCIAL SCIENCES

ECO 3	ECONOMICS (Required)	3
ECO 4	ECONOMICS	3
ECO 129	MONEY AND BANKING	3
ECO 206	INTERMEDIATE MICRO-ECONOMIC THEORY	3
ECO 303	ECONOMICS DEVELOPMENT	3
ECO 307	HISTORY OF ECONOMIC THOUGHT	3
ECO 308	HISTORY OF ECONOMIC THOUGHT	3
ECO 309	COMPARATIVE ECONOMIC SYSTEMS	3
ECO 316	INTERMEDIATE MACRO-ECONOMIC THEORY	3
ECO 335	MANPOWER ECONOMICS	3
ECO 336	BUSINESS AND GOVERNMENT	3
ECO 338	LABOR MARKET INSTITUTIONS	3
ECO 339	INTERNATIONAL ECONOMICS	3
ECO 340	INTERNATIONAL ECONOMICS	3
ECO 353	PUBLIC FINANCE, FEDERAL	3
HIST	Any Course	
<i>or the following</i>		
GK 21	ANCIENT HISTORY	3
GK 202	GREEK ARCHAEOLOGY	3
LAT 22	ANCIENT HISTORY	3
LAT 203	ARCHAEOLOGY OF ITALY	3
SR	Any Course	

RECOMMENDED FRESHMAN YEAR

The following outline of work for the freshman year is most easily scheduled, and satisfies the appropriate requirements for all engineering students. For schedules of the work required of the upper three years, please refer to the several specialized curricula which follows.

Freshman Year (First Semester)

ENGL 1, 11	COMPOSITION AND LITERATURE*	3
CHEM 1	CHEMICAL PRINCIPLES I	3
CHEM 11	CHEMICAL PRINCIPLES I LABORATORY	1
HIST 11	DEVELOPMENT OF WESTERN CIVILIZATION	3
MATH 21	ANALYTICAL GEOMETRY & CALCULUS I	4
PHYS 1	MECHANICS OF MASS POINTS	3
<i>or</i>		
ECO 3	ECONOMICS	3
RFY	ENGINEERING ORIENTATION	0
PE 1	PHYSICAL EDUCATION	0
		<hr/>
		17

Freshman Year (Second Year)

ENGL 2, 12	COMPOSITION & LITERATURE*	3
CHEM 3	CHEMICAL PRINCIPLES II	3
CHEM 13	CHEMICAL PRINCIPLES II LABORATORY	1
HIST 12	DEVELOPMENT OF WESTERN CIVILIZATION	3
MATH 22	ANALYTICAL GEOMETRY & CALCULUS II	4
ECO 3	ECONOMICS	3
<i>or</i>		
PHYS 1	MECHANICS OF MASS POINTS	3
PE 2	PHYSICAL EDUCATION	0
		<hr/>
		17

*English 1 and 2, Composition and Literature, are the courses normally taken in the first and second semesters of the freshman year. Students who demonstrate superior ability will be offered registration in English 11 and 12, Types of World Literature.

INSPECTION TRIPS

Inspection trips to industrial plants are a required part of specific courses in the various curricula in engineering. Written reports may be required. These trips are generally held during the senior year and involve an average expense of about \$25. The location of the University in the center of industrial activities of various types furnishes unusual opportunities for visits of inspection to engineering plants.

HONORS PROGRAMS

Outstanding students in the college may participate in the Honors Program. Each department offers Honors work, with some differences in detail to adapt to the specific needs of the department.

Outstanding students may receive permission to do independent study on an unscheduled basis, thereby proceeding more rapidly and more deeply than is possible in regularly organized classes. This

permits the student who is qualified for and interested in this work to proceed in a direction agreed upon with his Honors Advisor, leading to the preparation of an undergraduate thesis.

During the first two years, the student who contemplates independent study should consult his department head to determine desirable accelerations or rearrangements in his standard program. Normally, the unscheduled work is begun in the junior year, but under conditions which vary slightly among departments.

Outstanding students are urged to consult their department chairmen concerning the requirements for independent study and the thesis which must be submitted. Within the limits of facilities and staff available special programs will be arranged for those accepted for Honors work. Students who successfully complete the program and submit an outstanding thesis are awarded Departmental Honors at graduation.

Students of the college are also eligible for Comprehensive Honors, award of which is based on a series of very broad Creative Concepts Seminars and the submission of a thesis. (See page 20-21).

COMBINED ARTS AND ENGINEERING CURRICULA

Under the five-year plan the student is in the College of Arts and Science for four years, earning the B.A. degree on completion of a program which includes, along with specific B.A. training, the fundamental mathematical, scientific, and engineering subjects of the engineering curriculum of his choice. The fifth year is spent in the College of Engineering, carrying on a program leading to the degree of B.S. in his selected branch of engineering. This is usually the senior year curriculum of the chosen branch of engineering.

An engineering student who decides at any stage of his course that he wishes to work for both the B.A. and B.S. degrees, may register in one of the colleges concerned for a period of years and complete the combined requirements of both degrees in five or six years, depending upon the program followed before the decision is made. His curriculum is so arranged that the work for one degree may be finished at the end of a four-year period and the work for the subsequent degree at the close of the fifth or sixth year.

ENGINEERING-M.B.A. PROGRAM

Qualified engineering students who wish to obtain supplementary training in business management may be interested in the Engineering—M.B.A. program described on page 52 of this Catalog. By attending one or two summer sessions, both the bachelor's degree in engineering and the master's degree in business administration may be attained in a period of five years.

COOPERATIVE PROGRAMS

Lehigh University has entered into agreements with certain industrial organizations whereby undergraduate students in various branches of engineering may pursue an interleaved course of study and industrial employment, comprising eight terms of study at Lehigh University, and two periods (each approximately equal to a term) of employment in industry, totaling four calendar years, at the successful completion of which the student will receive a B.S. degree from Lehigh University and a suitable certificate from the industrial concern.

The objective of a cooperative program is to give the student an opportunity to become familiar with industrial methods, policies, and environment to the end that he will acquire a greater degree of motivation in his academic studies.

The scope of the academic part of a cooperative program is identical with that of the standard curriculum in which the student is registered. Exactly the same courses are taken and in substantially the same sequence.

The first industrial employment period commences at the end of the sophomore year. The degree is conferred upon the completion of the senior year. Students electing a cooperative program are expected to complete it.

During the two periods of industrial employment the student is closely supervised to guarantee that he acquires a balanced training in industrial practice. Representatives from the University make periodic inspections of the industrial training part of the program for the purpose of assuring that this training is in keeping with the above objectives and that the student is receiving maximum benefits from the cooperative program. The student is required

to render a comprehensive report on his observations and work while employed in industry.

While engaged in industrial employment the student is paid at prevailing rates for the type of work in which he is engaged.

There is no obligation, either legal or moral, on the part of the student to agree to accept permanent employment with the industrial concern which sponsors his cooperative program; nor is there any obligation on the part of the industrial concern to offer him permanent employment.

The details of cooperative programs vary with different curricula and industrial organizations. Interested students should consult their curriculum directors. A typical four-year program between Electrical Engineering and the sponsoring company, which comprises ten approximately equal periods, is as follows:

1. Freshman I—First Semester
2. Freshman II—Spring Semester
3. Sophomore I—First Semester
4. Sophomore II—Spring Semester
5. Company Work—Summer Semester
6. Junior I—First Semester
7. Company Work—Spring Semester
8. Junior II—Summer Semester
9. Senior I—First Semester
10. Senior II—Spring Semester

During Period 7, while the student is with the sponsoring company, a course in Electronic Circuits (E.E. 105) is taught in the company premises.

B.S. ENGINEERING—M.S. MATERIALS

A special program leading to an M.S. degree in Materials is offered for engineering graduates who complete prerequisite courses in physical chemistry, metallurgy, mechanics, etc. Careful selection of technical electives by interested undergraduate students can provide for the required prerequisite courses in typical engineering B.S. degree programs; alternately, the prerequisite courses are taken before proceeding with the program. This program is intended to give in-depth training in one of the normal engineering disciplines during four years, combined with an understanding of materials behavior in graduate study in approximately 15 months. While intended primarily as a terminal degree for those entering industry, the M.S. in Materials provides sufficient flexibility to permit

those interested in a career in materials research to continue for a Ph.D. degree.

A typical schedule of prerequisite courses and the graduate program for mechanical engineers is given below. Graduate programs for other engineering disciplines can be developed by consultation with the appropriate department advisor and a representative of the Materials Research Center.

Science Orientation

MET	91 ELEMENTS OF MATERIALS SCIENCE	3
CHEM	95 PHYSICAL CHEMISTRY*	3
CHEM	195 PHYSICAL CHEMISTRY*	3
MET	361 PHYSICS OF MATERIALS	3
MET	362 STRUCTURE AND PROPERTIES OF MATERIALS	3
	ELECTIVES	6
		21

Engineering Orientation

MET	63 ENGINEERING MATERIALS AND PROCESSES	3
CHEM	95 PHYSICAL CHEMISTRY*	3
CHEM	195 PHYSICAL CHEMISTRY*	3
MET	207 ELECTRONIC & CRYSTAL STRUCTURE	3
MET	208 PHASE DIAGRAM & TRANSFORMATION	3
MET	218 MECHANICAL BEHAVIOR OF MATERIALS	3
	ELECTIVES	3
		21

*Alternately Chem 91 and Chem 190.

B. Recommended Electives

(1) Structure of Solids Group

MET	316 PHYSICAL PROPERTIES OF MATERIALS	3
MET	318 THEORETICAL PHYSICAL METALLURGY	3
MET	333 X-RAY METHODS	3
MET	334 ELECTRON MICROSCOPY	3
EE	304 SEMICONDUCTOR ELECTRONICS	3
EE	306 SOLID STATE MAGNETIC & DIELECTRIC DEVICES	3
GEOL	333 CRYSTALLOGRAPHY	3
PHYS	362 ATOMIC AND MOLECULAR STRUCTURE	3
PHYS	363 PHYSICS OF SOLIDS	3
MATH	APPROVED ELECTIVE	3

(2) Physical Metallurgy Group

MET	307 STRUCTURE & BEHAVIOR OF MATERIALS	3
MET	315 PHYSICAL CERAMICS	3
MET	316 PHYSICAL PROPERTIES OF MATERIALS	3
MET	318 THEORETICAL PHYSICAL METALLURGY	3
MET	313 MATERIALS FABRICATION	3
MET	333 X-RAY METHODS	3
MET	334 ELECTRON MICROSCOPY	3
MET	352 PHYSICAL METALLURGY III	3
MATH	APPROVED ELECTIVE	3
MET	358 SELECTION OF MATERIALS	3

(3) Mechanics & Mechanical Behavior Group

ME	166 PROCEDURES FOR MECHANICAL DESIGN	2
MECH	201 ADVANCED MECHANICS OF MATERIALS	3
MECH	303 MECHANICS OF CONTINUA I	3
MECH	304 MECHANICS OF CONTINUA II	3
MECH	313 FRACTURE MECHANICS	3
MET	313 MATERIALS FABRICATION	3
MATH	APPROVED ELECTIVE	

(4) *Chemical Behavior Group*

MET 210 METALLURGICAL THERMODYNAMICS	3
MET 304 EXTRACTIVE METALLURGY I	4
MET 305 EXTRACTIVE METALLURGY II	3
CHEM 381 RADIATION AND STRUCTURE	4
CHEM 382 STRUCTURE, ELECTROCHEMISTRY & KINETICS	3
CHEM 392 SCIENCE OF POLYMERS <i>same as</i>	3
CHE 392 POLYMER SCIENCE	3
CHEM 397 COLLOIDS AND SURFACE CHEMISTRY	3
MATH APPROVED ELECTIVE	

C. Typical MS. Program in Materials
(Mechanical Engineering Graduate)*Fifth Year (First Semester)*

MET 333 X-RAY METHODS	3
MET 408 TRANSFORMATION	3
MET 315 PHYSICAL CERAMICS	3
ME 441 STRESS ANALYSIS & DESIGN <i>or</i>	3
APPROVED TECHNICAL ELECTIVE MATERIALS RESEARCH	3

Fifth Year (Second Semester)

MET 412 ELECTRIC & MAGNETIC PROPERTIES OF MATERIALS	3
CHEM 392 SCIENCE OF POLYMERS <i>same as</i>	3
CHE 392 POLYMER SCIENCE	3
MET 418 DEFORMATION & FRACTURE <i>or</i>	3
APPROVED TECHNICAL ELECTIVE MATERIALS RESEARCH	3

Fifth Year (Summer Semester)
MATERIALS RESEARCH

Course Offerings in Materials

In addition to the courses noted in the list of recommended electives above, a number of other graduate courses concerned with the behavior of materials are taught in the engineering and science departments. Pertinent courses are listed below by department, number and title, and credit hours. Descriptions of these courses may be found in the respective departmental listings in this Catalog.

CHE 392 POLYMER SCIENCE <i>same as</i>	3
CHEM 392 SCIENCE OF POLYMERS	3
CHE 390 NUCLEAR REACTOR ENGINEERING	4
CHE 470 CRYOGENIC ENGINEERING	3
CHE 401 CHEMICAL ENGINEERING THERMODYNAMICS	3
CHE 413 CATALYSIS	3
CE 410 PRESTRESSED CONCRETE	3
CE 459 ADVANCED TOPICS IN PLASTIC THEORY	3
EE 404 SOLID STATE DEVICE THEORY	3
EE 406 THE PHYSICS OF MAGNETISM	3
EE 450 SPECIAL TOPICS—MAGNETIC DEVICE THEORY	3
GEOL 336 MINERAL PHASE RELATIONS	3
GEOL 433 SULPHIDE PHASE EQUILIBRIA	3
GEOL 435 ADVANCED MINERALOGY	3
IE 344 METAL CUTTING THEORY	3

ME 441 STRESS ANALYSIS IN DESIGN	3
ME 444 EXPERIMENTAL STRESS ANALYSIS IN DESIGN	3
MECH 404 ADVANCED VIBRATIONS ANALYSIS	3
MECH 409 THEORY OF ELASTICITY I	3
MECH 412 THEORY OF PLASTICITY	3
MECH 413 FRACTURE MECHANICS	3
MECH 415 STABILITY OF ELASTIC STRUCTURES	3
MECH 451 NON-LINEAR CONTINUUM MECHANICS <i>same as</i>	1-3
PHYS 471 NON-LINEAR CONTINUUM MECHANICS	1-3
MET 358 SELECTION OF MATERIALS	3
MET 406 SOLIDIFICATION	3
MET 407 THEORY OF ALLOY PHASES	3
MET 408 TRANSFORMATIONS	3
MET 410 THE PHYSICAL CHEMISTRY OF METALS I	3
ME 412 ELECTRICAL & MAGNETIC PROPERTIES OF MATERIALS	3
MET 413 ANALYSIS OF METAL FORMING PROCESSES	3
MET 415 PHYSICS OF CERAMIC SOLIDS	3
MET 416 ATOM MOVEMENTS	3
MET 417 IMPERFECTIONS IN CRYSTALS	3
MET 418 DEFORMATION AND FRACTURE	3
MET 425 SINTERING AND RELATED PHENOMENA	3
MET 433 X-RAY METALLOGRAPHY	3
PHYS 340 HEAT & THERMODYNAMICS	3
PHYS 431 THEORY OF SOLIDS	3
PHYS 442 STATISTICAL MECHANICS	3

UNDERGRADUATE CURRICULA

CHEMICAL ENGINEERING

Chemical engineers play important roles in all activities bearing on the chemical process industry. These include the functions of research, development, design, plant construction, plant operation and management, corporate planning, technical sales, and market analysis. The industries that produce chemical and/or certain physical changes in fluids including petroleum and petrochemicals, rubbers and polymers, pharmaceuticals, metals, industrial and fine chemicals, foods, and industrial gases have found chemical engineers to be vital to their success. Chemical engineers are also important participants in pollution abatement, space exploration, and national defense programs.

Preparation for this broad field requires a sound background in the fundamental sciences of physics, chemistry, and mathematics plus a general background in engineering principles and intensive training in the application of these fundamentals to carrying forward into industrial production the new products and processes discovered in the laboratory. This latter training is directly called Chemical Engineering. In accord with this philosophy, the

student is not trained for any specific industry, but the education is sufficiently broad that a graduate is competent to enter any of the chemical and allied industries.

The aim of the curriculum is to develop in the student understanding of the scientific fundamentals, an ability with mathematical tools, and the habits of precise analysis of process engineering problems that will allow him to function effectively in this broad field, and to grow into positions of responsibility. Of course these technical abilities must be coupled with an understanding of the economic, sociological, and cultural environment within which the engineer operates. The curriculum includes a relatively large commitment to education in these latter areas.

The program is also designed to prepare a student for graduate study in chemical engineering or in peripheral fields. Further study at the graduate level leading to advanced degrees is highly desirable in preparation for careers in the more highly technical aspects of manufacturing. The increasing complexity of modern manufacturing methods requires superior training for men working in the research, development, and design fields or for teaching.

Freshman Year (See page 59)

Sophomore Year (First Semester)

MATH	23	ANALYTIC GEOMETRY AND CALCULUS III	4
PHYS	3	HEAT AND ELECTRICITY	4
ECO	4	ECONOMICS	3
CHE	51	CHEMICAL ENGINEERING COMPUTATION	4
		ELECTIVE*	3
			<u>18</u>

Sophomore Year (Second Semester)

MATH	205	LINEAR METHODS	3
PHYS	4	ELECTRICITY, LIGHT & ATOMIC PHYSICS	4
CHEM	91	PHYSICAL CHEMISTRY	3
CHE	52	TRANSPORT PHENOMENA	4
		ELECTIVE*	3
			<u>17</u>

Junior Year (First Semester)

CHEM	190	PHYSICAL CHEMISTRY	3
CHEM	192	PHYSICAL CHEMISTRY LABORATORY	1
CHEM	51	ORGANIC CHEMISTRY	3
CHEM	53	ORGANIC CHEMISTRY LABORATORY	2
CHE	165	UNIT OPERATIONS I	4
GS		REQUIREMENT	3
			<u>16</u>

Junior Year (Second Semester)

CHE	166	UNIT OPERATIONS II	4
CHE	200	THERMODYNAMICS	3

GS	REQUIREMENT	3
	ELECTIVES*	6
		<u>16</u>

Senior Year (First Semester)

GS	REQUIREMENT	3
	ELECTIVES*	15
		<u>18</u>

Senior Year (Second Semester)

GS	REQUIREMENT	3
	ELECTIVES*	15
		<u>18</u>

*The electives indicated above must be distributed as follows:

CHEMISTRY, PHYSICS, MATHEMATICS	9 hours
ADVANCED CHEMICAL ENGINEERING	9 hours
EXTRA-DEPARTMENTAL ENGINEERING AND SCIENCE	12 hours
FREE ELECTIVES	12 hours

CHEMISTRY

Chemists constitute nearly one-half of all professional research personnel in industry as shown by a report of the Nation Resources Planning Board. The American Chemical Society, which requires professional training and experience for eligibility, has a present membership of over 110,000. The consistently rapid increase in the membership of this society in recent years may be taken as an index of the expanding opportunities in the chemical profession.

The curriculum in chemistry provides a thorough grounding in the fundamentals of this science, with the requisite collateral training in physics and mathematics, and gives some consideration to industrial and engineering principles. As a curriculum in the engineering school leading to a bachelor of science degree, the fundamentals of chemistry as well as engineering are stressed. In addition to the liberal allotment of time to courses in English, German, economics, history and other non-professional studies, provision is made for twelve semester hours (ordinarily four courses) of professional electives in a minor field of concentration. The tabulation below indicates some of the possibilities of this guided selection of elective courses.

PREPARATION FOR

Executive or sales departments of chemical industry

Plant operation

Food and pharmaceutical industries

ELECTIVE SEQUENCE IN
 Business administration
 Chemical engineering
 Biochemistry and bacteriology

PREPARATION FOR
 Medicine
 Graduate study or research in chemistry
 Teaching, especially in public schools
 Metals industries and Polymer Science

ELECTIVE SEQUENCE IN
 Biology
 Physics and mathematics
 Education
 Metallurgy

Since the freshman year of this curriculum is identical with that of chemical engineering, and the sophomore years in the two curricula are nearly the same, it is possible, by a slight rearrangement, for the student to transfer from one curriculum to the other before the beginning of the junior year without a considerable sacrifice of credits. In a transfer from chemical engineering to chemistry, the chemical engineering courses may be utilized as electives.

A special program leading to a B.S. in Chemistry and an M.S. in Materials is available for interested students. See page 61.

Freshman Year (See page 59)

Sophomore Year (First Semester)

MATH 23 ANALYTICAL GEOMETRY AND CALCULUS III	4
PHYS 3 HEAT & ELECTRICITY	4
CHEM 51 ORGANIC CHEMISTRY	3
CHEM 53 ORGANIC CHEMISTRY LABORATORY	2
GER 1 GERMAN	3
	16

Sophomore Year (Second Semester)

CHEM 91 PHYSICAL CHEMISTRY	3
PHYS 4 ELECTRICITY, LIGHT, & ATOMIC PHYSICS	4
CHEM 52 ORGANIC CHEMISTRY	3
CHEM 54 ORGANIC CHEMISTRY LABORATORY	2
GER 2 GERMAN	3
	15

Junior Year (First Semester)

CHEM 190 PHYSICAL CHEMISTRY	3
CHEM 302 INORGANIC CHEMISTRY	3
CHEM 358 ADVANCED ORGANIC CHEMISTRY	3
GER 27 SCIENTIFIC GERMAN	3
GS REQUIREMENT	3
CHEM 192 PHYSICAL CHEMISTRY LABORATORY	1
	16

Junior Year (Second Semester)

CHEM 193 PHYSICAL CHEMISTRY LABORATORY	1
CHEM 232 ANALYTICAL CHEMISTRY	3
CHEM 234 ANALYTICAL CHEMISTRY LABORATORY	2
CHEM 352 ORGANIC CHEMISTRY, HETEROCLIC COMPOUNDS	3
ECO 4 ECONOMICS or	3
CHEM 308 ELECTIVE	3
	15

Senior Year (First Semester)

CHEM 381 RADIATION AND STRUCTURE	4
GS REQUIREMENT	6
ELECTIVES	6

Senior Year (Second Semester)

CHEM 382 STRUCTURE, ELECTROCHEMISTRY & KINETICS	4
CHEM 375 RESEARCH CHEMISTRY	3
GS REQUIREMENT	3
ELECTIVE or	6
CHEM 308 COORDINATION CHEMISTRY and ELECTIVE	3
	16

CIVIL ENGINEERING

Civil Engineering, the original stem from which have branched the other types of engineering, continues to meet the demands of those branches of business, industry and government which prefer a broad, fundamental education to a more specialized training. The curriculum, however, develops depth in the various professional areas of civil engineering.

Civil Engineers create the monuments of civilization. The professional practice of a civil engineer includes the conception, design, construction, operation, and maintenance of private and public projects, including bridges, buildings, highways, airports, railroads, harbors, docks, subways, tunnels, water supply and purification systems, sewage collection and treatment facilities, water power developments, the making of surveys, and research. Many civil engineers are associated with consulting engineering firms, contractors, industrial concerns, or various governmental subdivisions.

The work of the first three years deals chiefly with the scientific and mathematical basis of engineering practice, with emphasis upon the applica-

tion of these principles during the fourth year. All students receive instruction in surveying, geology, fluid mechanics, soil mechanics, structural theory and design, transportation engineering, foundation engineering, hydraulic engineering, and sanitary engineering. Opportunity is provided through an elective for a student to determine whether he has an interest in and aptitude for research. Development of abilities in self-expression is stressed throughout the curriculum.

Special five-year combined programs leading to the degrees B.S. in C.E. and either B.A. or B.S. in M.E. can be arranged. Also a combined program leading to the degree B.S. in C.E. and B.S. in Bus. Adm., (five and one-half years), M.B.A. in Management Science, or M.S. in Foreign Studies can be arranged.

Engineers, through their professional societies, have urged that the engineering student be trained as a professional man with a sound understanding of his place in society, so that he can direct the technician and tradesman as he creates the Monuments of Civilization. This training is provided through a well planned Civil Engineering program enriched by the humanistic-social courses taken during the four years, and selected with the advice and approval of the curriculum director.

Freshman Year (See page 59)

Sophomore Year (First Semester)

CE	10	PROBLEM COMPUTATION LABORATORY	1
CE	11	ENGINEERING GRAPHICS	2
MATH	23	ANALYTIC GEOMETRY & CALCULUS III	4
MECH	1	STATICS	3
PHYS	3	HEAT & ELECTRICITY	4
GS		REQUIREMENT	3
			17

Sophomore Year (Second Semester)

CE	12	APPLIED ENGINEERING GRAPHICS	2
CE	40	PRINCIPLES OF SURVEYING	3
MATH	205	LINEAR METHODS	3
MECH	11	MECHANICS OF MATERIALS	3
MECH	13	MATERIALS TESTING LABORATORY	1
PHYS	4	ELECTRICITY, LIGHT & ATOMIC PHYSICS	4
			16

Summer

CE	41	ENGINEERING SURVEYS	3
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Junior Year (First Semester)

CE	121	MECHANICS OF FLUIDS	3
CE	123	FLUID MECHANICS LABORATORY	1
CE	150	STRUCTURAL ANALYSIS I	3

MECH	102	DYNAMICS	3
GEOL	1	PRINCIPLES OF GEOLOGY	3
MET	63	ENGINEERING MATERIALS & PROCESSES <i>or</i>	3
MET	91	ELEMENTS OF MATERIALS <i>or</i>	3
		APPROVED ELECTIVE	3
			16

Junior Year (Second Semester)

CE	126	WATER RESOURCES ENGINEERING	3
CE	154	STRUCTURAL ANALYSIS II	3
CE	62	SANITARY ENGINEERING	3
CE	239	SOIL MECHANICS	3
MET	63	ENGINEERING MATERIALS & PROCESSES <i>or</i>	3
MET	91	ELEMENTS OF MATERIALS <i>or</i>	3
		APPROVED ELECTIVE	3
		REQUIREMENT	3
			18

Summer

CE	100	INDUSTRIAL EMPLOYMENT
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Senior Year (First Semester)

CE	102	PROSEMINAR	1
CE	145	TRANSPORT ENGINEERING	3
CE	151	STRUCTURAL THEORY	3
CE	153	REINFORCED CONCRETE THEORY	3
CE	157	CONCRETE LABORATORY <i>or</i> APPROVED ELECTIVE	1
GS		REQUIREMENT	3
			17

Senior Year (Second Semester)

EE	160	ELECTRICAL CIRCUITS & APPARATUS	3
EE	161	ELECTRICAL PROBLEMS	1
EE	162	DYNAMO LABORATORY	1
ME	160	THERMODYNAMICS <i>or</i> APPROVED ELECTIVES	3
GS		REQUIREMENT	3
			17

ELECTRICAL ENGINEERING

The curriculum has been formulated to provide a foundation for competence and growth in the many challenging areas related to electrical engineering and electronics. These include electrical communication, information and computing systems, control systems, electronic instrumentation, and electrical power systems.

The principles underlying these areas are derived from the basic sciences and mathematics. The physical sciences provide a foundation for theoretical and experimental studies of devices such as solid state devices and energy converters. Mathematics provides the basis for the analytical studies related to the models of the devices, to the analysis, design

and exploitation of systems such as analog and digital computers, communication networks and information or control systems.

In addition to the requirements of the General Study Program, which deals with the humanities and social sciences, the electrical engineering program includes required courses in allied engineering fields such as mechanics, thermodynamics and materials science. The first three years of the four year program are devoted to the study of science, mathematics, physical electronics, principles of electronic computation and introductory work in linear circuits, electronic circuits and electro-mechanical machines. During the fourth year departmental electives provide opportunities for studies in those areas in which the student has interest and ability. Elective courses in other departments are also encouraged, especially when such electives are chosen on the basis of an educational objective.

An undergraduate will eventually identify his interests in terms of one or two functions—such as research, development, design or management. Irrespective of his decision, his ultimate success will depend upon the breadth of his background and the effectiveness with which his knowledge is incorporated into his ability to analyze and resolve problems. This is the basic assumption upon which the four-year curriculum is based.

Students interested in developing necessary background for graduate work in areas related to electrical engineering such as computing science, engineering materials, biomedical science, business administration, may do so through judicious choice of electives within the University as a whole. For example, a program in computing sciences might include courses in Mathematics (Math. 219, Math. 362), Information Science (I.S. 202), Philosophy (Phil. 364), in addition to departmental electives, E.E. 241 and E.E. 201. Programs of this nature directed to an area of interest to a student should be planned through conference with a departmental advisor, as early as the fourth semester or as soon as student has found an area of interest.

The experimental aspects of the undergraduate program are supported by the following laboratory facilities: Circuits Laboratory, Electronics Laboratory, Solid State Device Laboratory, Electrical

Machine and Transient Laboratories, Network Analyzer, Digital Systems Laboratory, and Microwave Laboratory.

A cooperative program combining academic work and industrial experience is available for those who are interested and can qualify.

Freshman Year (See page 59)

Sophomore Year (First Semester)

EE	15	CIRCUIT THEORY I	3
MATH	23	ANALYTICAL GEOMETRY & CALCULUS III	4
MECH	1	STATISTICS	3
MET	63	ENGINEERING MATERIALS & PROCESSES <i>or</i>	
MET	91	ELEMENTS OF MATERIALS SCIENCE	3
PHYS	3	HEAT & ELECTRICITY	4
			<u>17</u>

Sophomore Year (Second Semester)

EE	16	CIRCUIT THEORY II	4
MATH	205	LINEAR METHODS	3
PHYS	4	ELECTRICITY, LIGHT & ATOMICS PHYSICS	4
GS		REQUIREMENT	3
		APPROVED ELECTIVE	<u>2 OR 3</u>
			<u>16 or 17</u>

Junior Year (First Semester)

EE	103	PHYSICAL ELECTRONICS	3
EE	104	LINEAR SYSTEMS ANALYSIS	3
EE	106	MACHINE THEORY	4
MATH	208	COMPLEX VARIABLES	3
GS		REQUIREMENT	3
			<u>16</u>

Junior Year (Second Semester)

EE	105	ELECTRONIC CIRCUITS	4
EE	231	ELECTRIC & MAGNETIC FIELDS	3
MATH	231	STATISTICAL INFERENCE <i>or</i>	3
MATH	309	THEORY OF PROBABILITY	3
MECH	102	DYNAMICS	3
GS		REQUIREMENT	3
			<u>16</u>

Summer

EE	100	INDUSTRIAL EMPLOYMENT
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Senior Year (First Semester)

EE	111	PROSEMINAR	1
EE	151	SENIOR LABORATORY	2
EE	245	ELECTROMAGNETIC THEORY	3
		APPROVED ELECTIVES	9
GS		REQUIREMENT	3
			<u>18</u>

Senior Year (Second Semester)

EE	152	SENIOR LABORATORY	2
ME	220	THERMODYNAMICS	3
		APPROVED ELECTIVES	9
GS		REQUIREMENT	3

INDUSTRIAL ENGINEERING

The curriculum is designed with the principal aim of industrial engineering in view, which is the design, improvement, and installation of integrated systems of men, materials, and equipment for operations by the application of the principles of the mathematical, physical, and behavioral sciences.

Throughout the program there is an integrated series or sequence in the major field which includes not only basic and fundamental courses but specialized courses as well, in the fields of production planning and control, quality control, production engineering, information systems, methods engineering, operations research, and industrial manpower management. These specialized courses reflect the impact of recent developments in operations research, information processing, and automation, and considerable course work involves use of a high-speed digital computer.

There is a growing tendency on the part of industries to select young men from their engineering departments for managerial positions. Because of this the industrial engineering courses are oriented to the principles of scientific management to enable the industrial engineering graduate to accept and succeed in these opportunities.

It is the aim of the industrial engineering program to develop for industry a potential manager, a graduate well grounded in the fundamentals of science, trained in the principles and methods of engineering analysis and design, and adequately prepared to practice the profession of industrial engineering.

Freshman Year (See page 59)

Sophomore Year (First Semester)

IE	18	INTRODUCTION TO COMPUTING	3
MATH	23	ANALYTIC GEOMETRY AND CALCULUS III	4
MECH	1	STATICS	3
MET	63	ENGINEERING MATERIALS AND PROCESSES	3
PHYS	3	HEAT AND ELECTRICITY	4
			17

Sophomore Year (Second Semester)

IE	11	APPLIED PROBABILITY LABORATORY	1
IE	19	INFORMATION PROCESSING THEORY	3
ECO	4	ECONOMICS	3
MATH	231	STATISTICAL INFERENCE	3
MECH	11	MECHANICS OF MATERIALS	3
PHYS	4	ELECTRICITY, LIGHT AND ATOMIC PHYSICS	4
			17

Summer

IE	40	MACHINE SHOP PRACTICE	3
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Junior Year (First Semester)

IE	121	ANALYSIS & DESIGN I	5
IE	221	INDUSTRIAL STATISTICS	4
MECH	102	DYNAMICS	3
MATH	204	LINEAR ANALYSIS	3
PSYCH	1	ELEMENTARY PSYCHOLOGY	3
IE	140	MANUFACTURING PROCESSES LABORATORY	1
			19

Junior Year (Second Semester)

IE	122	ANALYSIS & DESIGN II	4
IE	222	OPERATIONS ANALYSIS & DESIGN	4
ACCTG	108	FUNDAMENTALS OF ACCOUNTING	3
ME	168	ELEMENTS OF MACHINE DESIGN	4
GS		REQUIREMENT	3
			18

Summer

IE	100	INDUSTRIAL EMPLOYMENT
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Senior Year (First Semester)

EE	160	ELECTRICAL CIRCUITS & APPARATUS	3
EE	161	ELECTRICAL PROBLEMS	1
EE	162	DYNAMO LABORATORY	1
ME	160	THERMODYNAMICS	3
		APPROVED TECHNICAL ELECTIVES	6
GS		REQUIREMENT	3
			17

Senior Year (Second Semester)

IE	152	INDUSTRIAL ENGINEERING PROJECT	2
CHE	60	UNIT OPERATIONS SURVEY	3
ME	161	ENGINEERING LABORATORY	1
		APPROVED TECHNICAL ELECTIVE	9
GS		REQUIREMENT	3
			18

FUNDAMENTAL SCIENCES

The curriculum in Fundamental Sciences, is designed to permit students to achieve a breadth of experience in the basic fields of modern science and at the same time, through an option, to acquire the discipline of one of them, about to the level of a minimum bachelors program. The options and electives offer the student the flexibility by which he may prepare himself for work in industry or government, requiring wide understanding of the basic sciences but not the depth in a single field equalling that of a standard major, or he may approach adequacy for graduate study in a field.

The program offers excellent opportunity for a student who is uncertain of his firm desire for a career in a particular standard major to proceed on a broad program which can lead him to a bachelors degree. If his interest crystallizes in an established field in which he has been taking courses, transfer

to that major will normally be possible with only a minimum of dislocation.

Fundamental Sciences majors are required to concentrate in an option or recognized hybrids of them: chemistry, physics and mathematics, biology, earth and space science, and science of living systems, materials.

Work in the major science subjects is continuous through all four years. The freshman year is identical with that required of all engineering students. The general studies requirements of the engineering college must also be completed. The discipline of a science will be provided by the inclusion of at least 15 semester hours in his option or from a combination which constitutes the core of one of the inter-disciplinary fields, for example, geophysics or biochemistry.

The details of the student's program will be worked out by the student with the advice of the curriculum advisor, and with the approval of the department heads concerned with the major field of his option.

Freshman Year (See page 59)

Sophomore Year (First Semester)

BIOL	21 PRINCIPLES OF BIOLOGY and	3
BIOL	22 BIOLOGY LABORATORY or	1
GEOL	1 PRINCIPLES OF GEOLOGY	3
CHEM	51 ORGANIC CHEMISTRY	3
MATH	23 ANALYTICAL GEOMETRY & CALCULUS III	4
PHYS	3 HEAT & ELECTRICITY	4
		<u>15 or 14</u>

Sophomore Year (Second Semester)

ECO	4 ECONOMICS	3
MATH	205 LINEAR METHODS	3
BIOL	28 GENETICS or	1
GEOL	2 PRINCIPLES OF GEOLOGY	3
PHYS	4 ELECTRICITY, LIGHT & ATOMIC PHYSICS ELECTIVE	4
		<u>16</u>

Junior Year (First Semester)

ASTR	104 STELLAR ASTRONOMY	3
GEOL	1 PRINCIPLES OF GEOLOGY or	1
BIOL	21 PRINCIPLES OF BIOLOGY and	3
BIOL	22 BIOLOGY LABORATORY	1
PSYCH	3 PSYCHOLOGY—NATURAL SCIENCE ELECTIVE OPTION	3
		<u>15 or 16</u>

Junior Year (Second Semester)

GEOL	2 PRINCIPLES OF GEOLOGY or	3
BIOL	28 GENETICS	3
PSYCH	4 PSYCHOLOGY-SOCIAL SCIENCE	3
GS	REQUIREMENT	3
	ELECTIVES	3
	OPTION	3
		<u>18</u>

SUMMER
INDUSTRIAL EMPLOYMENT

Senior Year (First Semester)

MATH	231 STATISTICAL INFERENCE	3
GS	REQUIREMENT	3
	ELECTIVES	6
	OPTION	6
		<u>18</u>

Senior Year (Second Semester)

PHIL	261 PHILOSOPHY OF NATURAL SCIENCE	3
GS	REQUIREMENT	3
	ELECTIVES	6
	OPTION	6
		<u>18</u>

**MECHANICAL ENGINEERING AND
ENGINEERING MECHANICS**

The curriculum in Mechanical Engineering and Engineering Mechanics consists of a common freshman, sophomore and junior years, and a senior year offering a wide selection of courses. Depending upon the program chosen during the senior year, the students are graduated with either the B.S. in Mechanical Engineering or the B.S. in Engineering Mechanics.

The core of the program includes courses in mathematics and the physical sciences, in mechanics of solids and fluids, in dynamics, vibrations analysis, thermodynamics, and design. Candidates for the B.S. in Mechanical Engineering take an additional course in thermodynamics and are required to take at least two professional M.E. courses during their senior year. They should use the technical electives to develop competence in design, thermo-fluid sciences, or some other approved area. Candidates for the B.S. in Engineering Mechanics must include in their program advanced courses in mathematics, dynamics and mechanics of continua. They should use the technical electives to develop additional competence in a related area, such as applied mathematics thermo-fluid sciences, or materials science.

The field of mechanical engineering is wide and challenging. Conventionally mechanical engineering deals with the design and production of machines and their power sources, but the field has broadened to include many applications of the engineering sciences to a variety of engineering systems for the benefit of mankind.

The mechanical engineer has played an essential role in the exploitation of new engineering frontiers such as nuclear power, cryogenic systems, rocketry, satellite guidance systems, and systems at very high and very low pressures and temperatures.

There is an increasing demand in industry and government service for men with a broad training in the fundamentals of engineering, rather than in a given specific field. Such a training, in which engineering mechanics and applied mathematics play an important part, is provided by this curriculum. It emphasizes the analytical approach to engineering problems and the application to their solution of the basic methods and principles of mechanics.

Graduates in either disciplines are equipped for immediate work in engineering or research and development in government service or industry. Those with ability and interest have suitable backgrounds for further studies at the graduate level.

Freshman Year (See page 59)

Sophomore Year (First Semester)

MATH 23	ANALYTICAL GEOMETRY & CALCULUS III	4
MECH 1	STATICS	3
PHYS 3	HEAT AND ELECTRICITY	4
CE 11	ENGINEERING GRAPHICS	2
ME 10	ANALYSIS OF ENGINEERING PROBLEMS I	1
GS	REQUIREMENT	3
		17

Sophomore Year (Second Semester)

MATH 205	LINEAR METHODS	3
MECH 11	MECHANICS OF MATERIALS	3
MECH 13	MATERIALS TESTING LABORATORY	1
PHYS 4	ELECTRICITY, LIGHT & ATOMIC PHYSICS	4
MET 91	ELEMENTS OF MATERIALS SCIENCE	3
	or	
MET 63	ENGINEERING MATERIALS	3
GS	REQUIREMENT	3
		17

Junior Year (First Semester)

ME 101	MECHANICAL ENGINEERING DESIGN I	3
ME 104	THERMODYNAMICS I	3
MECH 102	DYNAMICS	3
MECH 201	ADVANCED MECHANICS OF MATERIALS	3

EE	160	ELECTRICAL CIRCUITS & APPARATUS	3
EE	161	ELECTRICAL PROBLEMS	1
EE	162	ELECTRICAL LABORATORY	1
			17

Junior Year (Second Semester)

ME	105	THERMODYNAMICS II*	3
	or		
		APPROVED ELECTIVE	3
ME	231	FLUID MECHANICS	3
CE	123	FLUID MECHANICS	3
CE	123	FLUID MECHANICS LABORATORY	1
ME	242	MECHANICAL VIBRATIONS ANALYSIS	3
MATH	208	COMPLEX VARIABLES**	3
	or		
MATH	231	STATISTICAL INFERENCE	3
GS		REQUIREMENT	3
			16

*Candidates for the B.S. in ME will take M.E. 105.

**Candidates for the B.S. in Eng. Mech. will take Math. 208.

Summer

ME	100	INDUSTRIAL EMPLOYMENT	0
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Candidates for B.S. in M.E.

Senior Year (First Semester)

ME	108	LABORATORY I	2
ME		ELECTIVE	3
		APPROVED ELECTIVES*	9
GS		REQUIREMENT	3
			17

Senior Year (Second Semester)

ME	109	LABORATORY II	2
ME		ELECTIVE	3
		APPROVED ELECTIVES*	9
GS		REQUIREMENT	3
			17

Candidates for B.S. in Eng. Mechanics

Senior Year (First Semester)

ME	108	LABORATORY I	2
MECH	302	ADVANCED DYNAMICS	3
MECH	303	MECHANICS OF CONTINUA I	3
		APPROVED ELECTIVES*	6
GS		REQUIREMENT	3
			17

Senior Year (Second Semester)

ME	109	LABORATORY II	2
MATH	322	METHODS OF APPLIED ANALYSIS I	3
MECH	304	MECHANICS OF CONTINUA II	3
		APPROVED ELECTIVES*	6
GS		REQUIREMENT	3
			17

*The Approved Electives must represent a coherent group of approved courses such as 200 and 300-level courses in Mathematics, Mechanical Engineering, Mechanics, Physics and Chemistry, and a limited number of other approved electives.

ENGINEERING PHYSICS

The curriculum in engineering physics is designed to prepare men for careers in scientific work. The first two years of work are similar to those in the other engineering curricula, and some further engineering study in circuits is included. Physics 62 in the fourth semester provides the student with a perspective of the subject matter of contemporary physics before he begins the intensive intermediate level sequences.

A sequence of courses in theory starting in the fifth semester with Physics 212 and 215 presents mechanics, electricity and light in a unified modern form. Thermodynamics and statistical mechanics in the senior year completes the intermediate level study of unified physical theory. Concurrent laboratory courses starting with Physics 90 in the fourth semester give familiarity with research procedures and techniques in vacuum, optics and atomic and nuclear physics, as well as in mechanics, electricity and heat. The subject matter courses Physics 362, 363, 364 and 365 comprise a concentrated look at four of the currently most active research areas in physics. Any or all of the latter three can be elected. Election of Physics 369, Introduction to Quantum Mechanics, is advised for those who will go on to graduate study in physics or in the electrical or aerospace sciences.

A liberal number of electives in the senior year provides flexibility in allowing the curriculum to be adapted to the needs and interests of the individual student. Those whose interests lie in the theoretical or analytical aspects or who are preparing for graduate study, elect additional courses in mathematics and physics. Others elect additional work in chemistry, engineering, geophysics, or business, or further studies in the social sciences and the humanities. The latter are equipped for work in business or applied science; they can undertake the solution of problems which have not yet been reduced to engineering practice.

Specialization within the curriculum permits the very capable student to embark on some graduate level work in the senior year, or to gain an early familiarity with research techniques. Such intensive study will reduce the number of years required for study to the Ph.D. since the courses coordinate with the graduate program in physics.

Freshman Year (See page 59)**Sophomore Year (First Semester)**

MET	91	ELEMENTS OF MATERIALS <i>or</i> LANGUAGE	3
PHYS	3	HEAT AND ELECTRICITY	4
MATH	23	ANALYTICAL GEOMETRY & CALCULUS III	4
ECO	4	ECONOMICS ELECTIVE	3

17

Sophomore Year (Second Semester)

CE	11	ENGINEERING GRAPHICS <i>or</i> LANGUAGE	2
PHYS	4	ELECTRICITY, LIGHT & ATOMIC PHYSICS	4
MATH	205	LINEAR METHODS	3
PHYS	62	CONTEMPORARY PHYSICS	3
PHYS	90	ELECTRICAL PHENOMENA	1
GS		REQUIREMENT	3

16 or 17

Junior Year (First Semester)

EE	14	CIRCUIT THEORY I	3
PHYS	191	LABORATORY TECHNIQUES	2
PHYS	212	ELECTROSTATICS	3
PHYS	215	PARTICLES & FIELDS I	3
MATH	322	METHODS OF APPLIED ANALYSIS I	3
GS		REQUIREMENT	3

17

Junior Year (Second Semester)

EE	105	ELECTRONIC CIRCUITS <i>or</i>	4
CHEM	91	PHYSICAL CHEMISTRY <i>and</i> APPROVED ELECTIVE	3
PHYS	254	OPTICS LABORATORY	2
PHYS	213	ELECTROMAGNETISM	3
PHYS	216	PARTICLES & FIELDS II ELECTIVE	3

15

Summer

PHYS	100	INDUSTRIAL EMPLOYMENT	0
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Senior Year (First Semester)

PHYS	192	ADVANCED LABORATORY	2
PHYS	340	HEAT, THERMODYNAMICS & PYROMETRY	3
PHYS	362	ATOMIC AND MOLECULAR STRUCTURE APPROVED ELECTIVE*	3
GS		ELECTIVE	3
GS		REQUIREMENT	3

17

Senior Year (Second Semester)

PHYS	171	PROSEMINAR APPROVED ELECTIVE*	1
GS		ELECTIVES	9
GS		REQUIREMENT	3

16

*Two of Phys. 363, 364, 365, 369 and Met. 362 are to be elected.

METALLURGY AND MATERIALS SCIENCE

Progress in many fields of engineering depends upon discovery of new materials and a better understanding of the behavior of existing materials. Interest in new materials for solid-state devices, for application of nuclear energy and for space technology, as well as a better understanding of the behavior of materials in the design of structures, automobiles and aircraft, plant processing equipment, electrical machinery, etc., have increased the need for men trained in the science and technology of metals and other materials. The curriculum in metallurgy and materials sciences is designed to train graduates for research, development, operations, management and sales careers in industry or for graduate study in metallurgy and materials science.

Training for this field of engineering requires basic studies in mathematics, chemistry, physics, and mechanics, plus a general background in engineering principles, followed by intensive training in the application of scientific and engineering principles to the development and use of materials in a technological society. In addition, the curriculum offers an introduction to humanistic and social studies which broaden the student's outlook and enhance his professional development after graduation.

The objective of the program is to combine a fundamental understanding of the behavior of materials from the electronic, atomic, crystallographic, microstructural and macrostructural viewpoints with knowledge of the technology of materials preparation and processing. The metallurgical engineering student will thus receive a broad education with emphasis on the factors which govern the mechanical, physical and chemical properties of materials to aid him in the analysis, development, selection and use of materials for all types of industries. While some graduates go directly into metal producing companies, a larger proportion serve as metallurgists or materials engineers in the chemical, electrical, transportation, communications, space and other metal and materials consumer industries. A number of students pursue graduate study for university teaching and research careers.

In addition to the regular program, there are two options in the curriculum oriented to emphasize (1) industrial metallurgy, and (2) preparation for graduate research in materials.

INDUSTRIAL METALLURGY OPTION

The Industrial Metallurgy Option is designed to prepare men in a four-year program as a plant metallurgist or materials engineer. To assist in this objective, students electing the option take a special course, Met. 325, Industrial Metallurgy (8), in the first semester of the senior year in place of an equivalent number of other specified courses. The emphasis in this course is a team approach to solution of actual plant problems. The course is conducted in cooperation with the Bethlehem Steel Company, and three days per week are spent in the Bethlehem plant for investigation of problems in plant operations. The option is limited to a small group of seniors selected by the department from among those who apply. Summer employment is provided for those students who elect to initiate the program during the summer preceding the senior year.

RESEARCH OPTION

For those students whose interests lie in the fields of theoretical metallurgy or materials science, and who intend to pursue graduate work, a Research Option is offered. In this option, students are required to take Met. 340, Research Techniques (2-3); and Met. 191, Experimental Metallurgy (3). Financial support is awarded to those students who elect to initiate a research program during the summer preceding the senior year. The option is limited to a small group of selected students.

Freshman Year (See page 59)

Sophomore Year (First Semester)

ECO	4	ECONOMICS	3
MATH	23	ANALYTICAL GEOMETRY & CALCULUS III	4
MECH	1	STATICS	3
PHYS	3	HEAT AND ELECTRICITY	4
MET	91	ELEMENTS OF MATERIALS SCIENCE	3
			17

Sophomore Year (Second Semester)

CHE	60	UNIT OPERATIONS	3
MECH	11	MECHANICS OF MATERIALS	3

PHYS	4	ELECTRICITY, LIGHT & ATOMIC PHYSICS	4
MET	10	METALLURGY LABORATORY	2
CE	11	ENGINEERING GRAPHICS	2
GS		REQUIREMENT	3

17

Junior Year (First Semester)

MET	207	ELECTRONIC AND CRYSTAL STRUCTURE	3
MET	210	METALLURGICAL THERMODYNAMICS	3
CHEM	95	PHYSICAL CHEMISTRY	3
MECH	102	DYNAMICS	3
MATH	205	LINEAR METHODS <i>or</i>	3
MATH	231	STATISTICAL INFERENCE	3
GS		REQUIREMENT	3

18

Junior Year (Second Semester)

MET	101	PROFESSIONAL DEVELOPMENT	1
MET	208	PHASE DIAGRAMS & TRANSFORMATIONS	3
MET	218	MECHANICAL BEHAVIOR OF MATERIALS	3
MET	304	EXTRACTIVE METALLURGY I	4
CHEM	195	PHYSICAL CHEMISTRY	3
ME	166	PROCEDURES OF MECHANICAL DESIGN ELECTIVE	2
			3

19

Summer

MET	100	SUMMER EMPLOYMENT	0
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Senior Year (First Semester)

MET	305	EXTRACTIVE METALLURGY II	3
MET	307	STRUCTURE AND BEHAVIOR OF MATERIALS	3
MET	313	MATERIALS FABRICATION APPROVED ELECTIVES	3
GS		REQUIREMENT	6

18

Senior Year (Second Semester)

MET	278	METALLURGICAL REPORTS	3
MET	358	SELECTION OF MATERIALS	3
EE	160	ELECTRICAL CIRCUITS & APPARATUS	3
EE	161	ELECTRICAL PROBLEMS	1
EE	162	DYNAMIC LABORATORY APPROVED ELECTIVE	1
GS		REQUIREMENT	3

17

Research Option

Junior Year (First Semester)

MET	207	ELECTRONIC AND CRYSTAL STRUCTURE	3
MET	210	METALLURGICAL THERMODYNAMICS	3
CHEM	95	PHYSICAL CHEMISTRY	3
MECH	102	DYNAMICS	3
MATH	205	LINEAR METHODS <i>or</i>	3
MATH	231	STATISTICAL INFERENCE	3
GS		REQUIREMENT	3

18

THE COMBINED FIVE-YEAR CURRICULA
ELECTRICAL ENGINEERING AND
ENGINEERING PHYSICS

This curriculum is designed for a student who wants to make an early start on a career in electronics and electronic device research and development. It differs from the four-year programs in Electrical Engineering or Physics in that it provides additional opportunities for study of the fundamental principles of dielectric, magnetic and semiconductor materials along with a study of circuits in modern communications and control systems.

The E.E. degree is conferred on the successful completion of the fourth year, and the E.P. degree at the end of the fifth year.

Freshman Year (See page 59)

Sophomore Year (First Semester)

EE	15	CIRCUIT THEORY I	3
MATH	23	ANALYTIC GEOMETRY & CALCULUS III	4
MECH	1	STATICS	3
MET	91	ELEMENTS OF MATERIALS SCIENCE	3
PHYS	3	HEAT & ELECTRICITY	4

17

Sophomore Year (Second Semester)

EE	16	CIRCUIT THEORY II	4
MATH	205	LINEAR METHODS	3
PHYS	4	ELECTRICITY, LIGHT & ATOMIC PHYSICS	4
PHYS	62	CONTEMPORARY PHYSICS	3
GS		REQUIREMENT	3

17

Junior Year (First Semester)

EE	103	PHYSICAL ELECTRONICS	3
EE	104	LINEAR SYSTEMS ANALYSIS	3
EE	106	MACHINE THEORY	4
MATH	208	COMPLEX VARIABLES	3
GS		REQUIREMENT	3

16

Junior Year (Second Semester)

EE	105	ELECTRONIC CIRCUITS	4
EE	231	ELECTRIC & MAGNETIC FIELDS	3
MECH	102	DYNAMICS	3
MATH	302	METHODS OF APPLIED ANALYSIS	3
GS		REQUIREMENT	3

16

Summer

EE	100	INDUSTRIAL EMPLOYMENT	
Senior Year (First Semester)			
EE	111	PROSEMINAR	1
EE	151	SENIOR LABORATORY	2
EE	245	ELECTROMAGNETIC THEORY	3
PHYS	215	PARTICLES & FIELDS I	3
EE		DEPARTMENTAL ELECTIVES	6
GS		REQUIREMENT	3

18

Senior Year (Second Semester)

EE	152	SENIOR LABORATORY	2
PHYS	213	ELECTROMAGNETISM	3
PHYS	216	PARTICLES & FIELDS II	3
EE		DEPARTMENTAL ELECTIVES	6
GS		REQUIREMENT	3
			<u>17</u>

Fifth Year (First Semester)

PHYS	192	ADVANCED LABORATORY	2
PHYS	340	HEAT, THERMODYNAMICS & PYROMETRY	3
PHYS	362	ATOMIC AND MOLECULAR STRUCTURE	3
MATH	309	THEORY OF PROBABILITY	3
		APPROVED ELECTIVE*	3
		ELECTIVE**	3
			<u>17</u>

Fifth Year (Second Semester)

PHYS	254	OPTICS LABORATORY	2
PHYS	363	PHYSICS OF SOLIDS	3
PHYS	171	PROSEMINAR	1
		APPROVED ELECTIVE*	3
		ELECTIVES**	6
			<u>15</u>

*Two courses selected from Phys. 364, 365, 369; Mech. 302; and Met. 362.

**Students planning graduate study should elect two semesters of German.

INDUSTRIAL ENGINEERING AND BUSINESS ADMINISTRATION

Students with definite objectives in mind which require more concentration in business administration may elect to pursue a five-year program which combines the two curricula of industrial engineering and business administration. This combined curriculum will lead to the degree B.S. in Industrial Engineering at the end of the fourth year and B.S. in Business Administration at the end of the fifth year. The first four years are essentially the standard industrial engineering curriculum. For the fifth year please see page 53 under Business Administration.

Summer

IE	40	MACHINE SHOP PRACTICE	3
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Junior Year (First Semester)

IE	121	ANALYSIS AND DESIGN I	5
IE	221	INDUSTRIAL STATISTICS	4
MECH	102	DYNAMICS	3
MATH	204	LINEAR ANALYSIS	3
PSYCH	1	ELEMENTARY PSYCHOLOGY	3
IE	140	MANUFACTURING PROCESSES LABORATORY	1
			<u>19</u>

Junior Year (Second Semester)

IE	122	ANALYSIS AND DESIGN II	4
IE	222	OPERATIONS ANALYSIS AND DESIGN	4
ACCTG	108	FUNDAMENTALS OF ACCOUNTING	3
ME	168	ELEMENTARY MACHINE DESIGN	4
ECO	333	LABOR PROBLEMS	3
			<u>18</u>

Those students who will major in Accounting in the fifth year will take Acctg. 1 and 2 in the junior year in place of Eco. 333 and Acctg. 108; and will take Eco. 333 in the senior year in place of Mkt. 11; and Acctg. 13 and 14 will be taken in the senior year in place of Fin. 125 and an Approved Technical Elective; and Mkt. 11 and Fin. 125 will be taken in the fifth year.

Summer

IE	100	INDUSTRIAL EMPLOYMENT	0
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Senior Year (First Semester)

EE	160	ELECTRICAL CIRCUITS AND APPARATUS	3
EE	161	ELECTRICAL PROBLEMS	1
EE	162	DYNAMO LABORATORY	1
ME	160	THERMODYNAMICS	3
MKT	11	MARKETING	3
		APPROVED TECHNICAL ELECTIVE	3
ENGL		ELECTIVE	3
			<u>17</u>

Senior Year (Second Semester)

IE	152	INDUSTRIAL ENGINEERING PROJECT	2
CHE	60	UNIT OPERATIONS SURVEY	3
ME	161	ENGINEERING LABORATORY	1
FIN	125	CORPORATION FINANCE	3
		APPROVED TECHNICAL ELECTIVE	6
ENGL		ELECTIVE	3
			<u>18</u>

Those students who will major in Economics, Economic Statistics, or Management in the fifth year, will take Eco. 346 in the senior year in place of Fin. 125, and Fin. 125 will be taken in the fifth year.

THE GRADUATE SCHOOL

Robert Daniel Stout, *Dean*

Graduate study was a part of the original plan of the University and was announced in its first Register in 1866. More definite organization of the work along lines that are now generally accepted dates from 1883. Since that time the degrees of Master of Arts and Master of Science have been offered without interruption. The degree of Doctor of Philosophy was also announced for a time and twice conferred. In the middle nineties this degree was withdrawn and doctoral work was not again offered until 1936, when it was once more authorized by the trustees. In the same year the Graduate School was organized, with a graduate faculty which had full power to enact the necessary legislation governing the work of the school. In 1960 a program of studies leading to the degree of Doctor of Education was first offered.

The rules and regulations of the faculty are developed by a Graduate Committee composed of the President or his representative, the Dean of the Graduate School, and eleven elected members of the faculty.

The Graduate School, in certain areas, offers qualified students opportunity for intensive advanced study and for specialized training in methods of investigation and research, with a view to their development as scholars and independent investigators. The School also aims to serve the needs of teachers and prospective teachers in elementary and secondary schools by providing opportunities for advanced professional training, and by preparing them for administrative positions.

Major work leading to the master's degree may be taken in the following fields: applied mechanics, biology, business administration, chemical engineering, chemistry, civil engineering, economics, education, electrical engineering, English, geology, government, history, industrial engineering, information sciences, international relations, mathematics, materials, mechanical engineering, metallurgy and materials science, philosophy, physics, political science, psychology, and social relations. In the fields of Greek, Latin, German, French, and Spanish, advanced degrees are not offered; but students majoring in other fields may take collateral

work in these fields from the list of courses acceptable for graduate credit ("200" and "300" courses).

Work leading to the doctor's degree is offered in the following fields: applied mechanics, biology, business and industrial economics, chemical engineering, chemistry, civil engineering, education, electrical engineering, English, geology, history, industrial engineering, mathematics, mechanical engineering, metallurgy and materials science, philosophy, physics, and psychology.

ADMISSION TO GRADUATE STANDING

A graduate of an accredited college, university, or technical institution is eligible for consideration for admission to the Graduate School at Lehigh University. Actual admission is subject to enrollment limitations in each department and is, therefore, competitive. An application for admission to the Graduate School may be secured from the Office of Admission. The candidate should file this application as far in advance as possible of the beginning of the semester when he wishes to undertake his graduate work. In addition to the application the candidate should also request that each institution of higher learning which he has attended send directly to the Office of Admission a transcript of his academic record. An *application fee of \$5 will be charged.*

A prospective graduate student is invited to communicate directly with the chairman of the department in which he is interested. If it is convenient for him to visit the University prior to completing his admission or prior to registration, a consultation with the chairman of the department (or his representative) will assist the department in working out a program for the student and will aid the student by giving him a better understanding of the facilities and opportunities for graduate study at the University.

The submission of Graduate Record Examination scores by a student applying for admission is urged. (For information about this examination, write to the Education Testing Service, 20 Nassau St., Princeton, New Jersey.) If a student is applying

for admission to graduate work in education, scores may be submitted for either the Graduate Record Examination or the National Teachers Examination. Candidates for graduate work in business administration may submit scores for the Admissions Test for Graduate Students in Business. In all three instances, test scores may under certain circumstances be required.

Foreign students are required to submit evidence of competence in use of English. Tests such as those administered by the International Institute of Education or the Educational Testing Service are suitable for this purpose.

Admission to graduate standing permits the student to take any course for which he has the necessary qualifications. It does not imply admission to candidacy for a degree. Admission to candidacy for an advanced degree is granted in accordance with the provisions set forth below under "Degrees."

Women are admitted as graduate students on the same terms as men. Except during a summer session, however, they are not ordinarily permitted to attend, either as registered students or as listeners, courses intended only for undergraduates.

A graduate student who is absent from the University for a semester or more must obtain the written approval of the chairman of his major department in order to be readmitted to graduate standing. If the student has not established a major, he must obtain the approval of the Dean of the Graduate School.

Students of Lehigh University who are within a few hours of meeting the requirements for the bachelor's degree may, if given permission by the Graduate Faculty, enroll for a limited amount of work for graduate credit.

RESIDENT GRADUATE STUDENT

A resident graduate student is one whose primary activity is work toward an advanced degree. He must spend at least 20 hours per week on research and/or course work toward the degree, and he may not receive income from any employment requiring services totaling more than 20 hours per week.

A student is recognized as a candidate for the doctoral degree if (a) he has completed at least one

year as a resident graduate student (as defined above) or holds a master's degree or its equivalent, (b) he has maintained a minimum average of 3.0 in his graduate courses, and (c) he has formally notified the dean of the Graduate School through his department his intention to study for the doctoral degree.

This recognition of the student's status as a doctoral candidate is not necessarily an assurance that the student will be able to meet the requirements of the degree.

SPECIAL STUDENT

A student who does not wish or may not qualify for admission to the Graduate School as a graduate student may apply to the Office of Admission for admission as a Special Student. He must hold a baccalaureate degree or have equivalent experience. He may register for courses up to and including the 300-level at the standard graduate tuition rate. Admission depends on approval by both the relevant major department and the Graduate School office. Status as a Special Student does not prejudice in any way a later application for admission as a graduate student.

REGISTRATION

Several days are set aside for graduate registration just prior to the beginning of the semester as indicated in the calendar. However, a student, once admitted, can complete advance registration anytime in January, June, or September as the case may be, by obtaining a registration ticket in the office of the Registrar and arranging in advance for an interview with his advisor. Anyone who can register in advance is urged to do so. Normally students are expected to complete their registration before the close of the third day of instruction. Registration after the tenth day of instruction in a regular semester or the fifth day in a summer session is permitted only when the express consent of the Dean of the Graduate School has been obtained. *A \$10 Late Registration Fee will be charged.*

It should be noted that graduate work itself starts promptly at the beginning of the term, and it is frequently true that graduate courses can be given only if there is a certain minimum demand

for them. Delay in enrolling for a given course may therefore cause the course to be withdrawn.

TUITION AND FEES

The tuition in the Graduate School is \$850 per semester or \$71 per semester hour, whichever amount is lower. The maximum full-time roster of graduate courses is 15 semester hours.

In an effort to help alleviate the existing shortage of fully qualified school teachers in the United States, the University will award educational grants to all qualified elementary and secondary school personnel enrolled in the Graduate School. By virtue of these grants, tuition for teachers either in full-time service or on leave is \$540 a semester or \$45 per semester hour.

A listener's fee of \$35 is charged for each course audited, unless the student is already paying the full tuition fee. (See regulation on page 77.)

Where the major department requires a master's thesis, the student registers for the thesis and pays at the rate of the regular semester hour charge.

A graduate student in residence at the University must register and pay a minimum tuition or dissertation fee of \$600 per semester, except as specified below.

Effective September 1, 1968: To qualify for the doctorate, all students who have not begun graduate work beyond the master's degree or its equivalent before June 1, 1968 must pay tuition fees equivalent to two full academic years beyond the master's degree or its equivalent of 30 credit hours. These fees amount to \$3400. Until these fees are paid, resident doctoral candidates must pay a minimum registration fee of \$600 each semester. Summer registration up to 12 hours is permitted but not required. After the minimum fees have been paid, doctoral candidacy of the resident student can be maintained by a registration fee of \$100 per semester. When appropriate, permission may be requested from the dean of the graduate school to complete the dissertation in absentia at a fee of \$50 per year.

Part-time candidates who have previously met residency requirements should consult the dean of the graduate school about completing the payment of the minimum tuition fee.

Identification cards, entitling the holder to attend

the various campus events, are issued to graduate students at a fee of \$10 for the full academic year, and \$5 for the period from January to June. Students registered for 9 credit hours or more are entitled to an identification card without charge.

TRANSCRIPTS

Each student is entitled to one copy of his record free of charge. This can be an official or unofficial transcript. Unofficial copies are released to the student; official copies are sent directly to the educational institution, company, state board, etc., as the circumstances may require. After the first copy is released a fee of \$1 is assessed for each subsequent copy.

REFUNDS

A graduate student who formally withdraws from the University or who, on the advice of his department chairman and with the approval of the dean, finds it necessary to reduce his roster below twelve hours in any regular semester, may qualify for a tuition refund. The amount of refund is equal to the tuition paid for the course or courses being dropped less 15 per cent of this tuition for each full or fractional week of the semester computed from the date of the beginning of instruction in courses open only to graduate students. There is no refund for semester hours dropped if the remaining roster totals 12 or more hours.

A summer session student who formally withdraws from the University is entitled to receive a refund of his total tuition less \$5 for each credit hour for which he is registered and less a deduction for each day of regular instruction of 4 per cent of the total tuition paid computed from the first day of instruction in the session.

In the event of the death of a student or his involuntary induction into the armed forces, fees will be refunded in proportion to the fraction to the semester remaining at the time of the student's death or induction.

A student who is suspended or expelled from the University is not entitled to any refunds.

FILING OF APPLICATION FOR DEGREE

Candidates for degrees to be conferred in June file with the Registrar, on a form provided for the

purpose, on or before April 15, a written notice of their candidacy; candidates for degrees to be conferred in October file a similar notice on or before September 10. Failure to file such notice by the dates mentioned may bar the candidate from receiving the degree at the ensuing graduation exercises. If a late application can be accepted, the candidate is assessed a \$10 fee to help cover the extra cost of processing.

In addition to the degree requirements set forth below, there may be departmental requirements in the field of the major. These requirements appear in the separate departmental statements in the section, "Description of Courses."

MISCELLANEOUS REGULATIONS

The maximum roster of a full-time graduate student is fifteen semester hours. Graduate students who are employed elsewhere and can give only part of their time to graduate work should restrict the size of their rosters accordingly.

Graduate students who hold University appointments of any kind are permitted to enroll for only a limited amount of graduate work. Full-time employees of the University may not take more than six semester hours of graduate work in any one semester; half-time employees may not take more than ten semester hours.

With the consent of the chairman of his major department and of the chairman of the department concerned, a graduate student may be admitted as a regular listener in one or more courses which course or courses shall be outside his approved program of studies for the degree, provided that the total number of hours in which he is registered and in which he is a listener shall not exceed the limits set forth above. In no case shall a student who has attended a course as a listener be given an examination for credit in that course. A listener's fee is charged for each course audited.

DEGREES

In addition to the general regulations set forth below, more detailed instructions for procedures may be obtained from the Office of the Graduate School.

Students desiring to qualify for graduate degrees in the minimum time should have pursued an

undergraduate major in the subject equivalent to that offered at Lehigh. At the discretion of the chairman of the department, a limited number of credits in closely allied subjects may be accepted in lieu of courses in the undergraduate major. Those with undergraduate deficiencies who are admitted because they are otherwise well qualified will be expected to make up such deficiencies in addition to satisfying the minimum requirement for the degree sought.

MASTER'S DEGREES

The master's degree is granted to properly qualified students who complete satisfactorily at least two full semesters of advanced work. In meeting the requirements for the degree, the student must comply with the following regulations:

1. Each candidate for the master's degree must submit for the approval of the Graduate Committee the program of courses he proposes to take to satisfy the requirements. This program must have the approval of the chairman of the student's major department, and all courses included which are not offered by the student's major department must also be approved by the chairmen of the departments concerned. The program should be submitted as soon as possible after completion of 15 credits toward the degree. Approval of the program by the Graduate Committee signifies that the student has formally been admitted to candidacy for the degree.

2. The *minimum* program for the master's degree must include:

- a. Not less than thirty semester hours of graduate work.
- b. Not less than eighteen hours of "400" level course work (see page 94 for classification of courses).
- c. Not less than eighteen hours in the major field.
- d. Not less than fifteen hours of "400" courses in the major field.

3. The eighteen hours required in the major field are ordinarily taken in one department. Specific exceptions to this rule are mentioned in the departmental statements at the head of course listings. The remaining twelve hours of a *minimum* program,

or any part of them, may also be taken in the major department; or they may be taken in any other field in which courses for graduate credit are offered, as the needs or interests of the student may indicate, subject to the approval of the chairman of the major department. In all cases, the work for the master's degree must be taken under at least two instructors.

4. Graduate students registered in "200" and "300" courses may be assigned additional work at the discretion of the instructor.

5. In order to qualify for the master's degree, candidates will be required (a) to submit a thesis or a report based on a research course of at least 3 credit hours, or (b) to pass a comprehensive examination given by the major department. The department will specify which of these requirements applies, and may specify both. If required, the thesis shall not count for more than six semester hours. The credit to be allowed shall be fixed by the chairman of the major department. One unbound typewritten copy of the thesis, approved by the faculty members under whom the work was done and by the chairman of the major department, shall be placed in the hands of the Dean of the Graduate School with a receipt for \$10.00 to cover the fee for microfilming at least three weeks before the day on which the degree is to be conferred. Information as to the form in which the thesis must be presented may be obtained from the Office of the Graduate School.

6. The master's degree is not granted unless the candidate has earned the grades "A" or "B" in at least eighteen hours of the work of his program. No course in which the grade earned is less than "C" is credited toward the degree. A student who receives more than four grades below "B" in courses numbered "200" or higher becomes ineligible to qualify for the master's degree unless allowed to do so by special petition to the chairman of the major department and to the dean of the graduate school.

7. All work which is to be credited toward a master's degree must be done in actual and regular attendance at Lehigh University.

8. All work on a program for the master's degree must be completed within a six-year period.

When all requirements have been met, the can-

didate is recommended by the faculty to the trustees for the master's degree appropriate to the work pursued.

DOCTOR OF PHILOSOPHY

The degree of Doctor of Philosophy is conferred on candidates who have demonstrated general proficiency and high attainment in a special field of knowledge and capacity to carry on independent investigation in that field as evidenced by the presentation of an acceptable dissertation embodying the results of original research. The requirements for the degrees are more specifically set forth in the following regulations.

1. **TIME REQUIREMENTS.** A candidate ordinarily is expected to devote three or more academic years to graduate study. In no case is the degree awarded to one who has spent less than two full academic years in graduate work. Study for any specified period of time, however, is not in itself regarded as sufficient ground for awarding of the degree.

Graduate work done in residence at other institutions will be accepted in partial fulfillment of the time requirements, provided such work is approved by the Graduate Committee and by the departments concerned.

Work of fragmentary character scattered over a long period of years, or work completed many years before the student becomes a candidate for the degree, is subject to special review by the Graduate Committee. The extent to which such work may be credited towards the fulfillment of the time requirements will be decided by the Committee. All work on a program for the Ph.D. degree must be completed within a ten-year period.

2. **RESIDENCE REQUIREMENTS.** A candidate for the degree must complete at least one full academic year of resident graduate study at Lehigh University.

3. **APPROVAL OF THE DOCTORAL PROGRAM.** Candidates for the doctorate are accepted in a limited number of departments only, and a department may limit the number of candidates accepted in any year. In passing upon a student's program, the Committee will take into consideration the applicant's general education, as well as his special qualifications for work in his chosen field. Each

applicant is notified by the Dean of the Graduate School, in writing, of the action of the Committee upon his application.

The student and his faculty advisor are expected to initiate steps for approval of the student's program in the first semester following completion of 30 hours of graduate credit. The department will determine by examinations or other credentials whether the student is qualified. Application should be submitted to the Graduate Committee not later than one year after completion of the master's degree or its equivalent. Information on the procedure to be followed can be obtained at the Graduate School Office.

The application of a foreign student must be accompanied by a statement from the department in which he intends to specialize, certifying that he has a satisfactory command of English.

At the time of application for program approval a special committee is appointed by the Graduate Committee to direct the work of the candidate.

4. PLAN OF WORK. Preparation for the degree is based on the study of a major subject to which one or two minors may be added. The program of work, to be formulated by the candidate, his special committee, and the chairman of his major department, should be planned to lead to a general mastery of the major field and to a significant grasp of any minor that may be added.

While there is no definite requirement as to the number of courses to be taken, two years devoted to formal courses is customary.

5. LANGUAGE REQUIREMENTS. The candidate must give evidence, through examinations, of a reading knowledge, sufficient for the purposes of his special studies, of at least two foreign languages (in addition to any language which may constitute his major subject). In each case, the required languages are designated by the candidate's major department and approved by the Graduate Committee. In certain fields, the candidate, with permission of the chairman of his major department and approval of the Dean of the Graduate School, may reduce the requirement to one language appropriate to his field.

The qualifying examination in one language must be passed at least twelve (12) months before the candidate applies for his degree.

Language examinations are in charge of a committee consisting of representatives of the language department concerned and of the candidate's major department.

The E.T.S. examinations in German and Russian will be held October 26, 1968 and April 12, 1969. Deadline date for registration is September 20 for the October test, and March 7 for the April test.

Permission to take the language examinations does not imply admission to candidacy for the degree.

6. GENERAL EXAMINATION. The general examinations for the doctorate are designed to test both the student's capacity and his proficiency in his field of study. The examinations are not necessarily confined to the content of courses that have been taken at Lehigh University or elsewhere. They are held not later than seven months prior to the time when the candidate plans to receive the degree. The student's department is in charge of the examination, which may be both written and oral.

Should a candidate fail in any part of the general examinations he may be permitted by the Graduate Faculty to present himself for a second examination not earlier than five months after the first. If the results of the second trial are also unsatisfactory no further examination is set.

7. DISSERTATION. The candidate is required to present a dissertation prepared under the general direction of a professor at Lehigh University. The dissertation shall treat a topic related to the candidate's major subject, embody the results of original research, give evidence of high scholarship, and constitute a contribution to knowledge. It must be approved by the professor under whose direction it was written, by the candidate's special committee, and by the Graduate Committee. A copy bearing the written approval of the professor in charge must be presented to the Dean of the Graduate School for transmission to the student's special committee not later than May 1, if the degree is to be conferred in June; not later than September 1, if the degree is to be conferred in October.

The candidate shall deposit with the Dean of the Graduate School, at least two weeks before the degree is to be conferred: (1) the original typescript of the accepted dissertation, unbound, in standard

form, and suitable for microfilming; (2) the first carbon copy of the accepted dissertation in standard form and binding; (3) three copies of an abstract, not exceeding 600 words, of the dissertation, accompanied by a letter from the dissertation supervisor stating that the abstract is acceptable and suitable for publication; (4) a receipt from the Bursar for the payment of the publication fee of thirty dollars (\$30). The publication fee is used by the University to defray the cost of publishing the dissertation on microfilm (through University Microfilms) and the abstract in *Dissertation Abstracts*. If the candidate wishes to copyright his dissertation, he may do so by paying the copyright fee of fifteen dollars (\$15) to the Bursar at the time the publication fee is paid. Arrangements for the copyright in the author's name will then be made by the University through University Microfilms.

8. FINAL EXAMINATION. After the dissertation has been accepted by his special committee, the candidate will be examined orally by the officers of professorial rank in the departments concerned and such other persons as may be selected by the candidate's special committee.

9. CONFERRING OF DEGREE IN ABSENTIA. The degree of Doctor of Philosophy will not be conferred in absentia unless the candidate is excused by the President of the University.

DOCTOR OF EDUCATION

The degree of Doctor of Education is intended for a limited number of carefully selected students engaged in the fields of administration, counseling, foundations, reading, research, and teaching. Successful professional experience is required for admission to candidacy for this degree.

In general, requirements for the Ed.D. degree parallel those already stated for the Ph.D. degree with the exception of the following: (a) language examinations are not required, (b) a statistics competency examination is required, (c) a residence requirement which may be satisfied by an academic year of full-time study or a semester of full-time study preceded or followed by a summer session in which 12 semester hours of credit are earned. There is enough flexibility in this program to permit certain modifications appropriate to the specific ob-

jectives and background of the doctoral student. For more detailed information, consult the Dean of the School of Education, and see the section on the School of Education on page 86 in this Catalog.

POSTDOCTORAL WORK

Students who have completed the requirements for the doctorate may enroll for postdoctoral individualized study under the guidance of selected members of the faculty. Such a program of study contemplates a broad educational and research development at advanced and mature levels, and provides opportunities to prepare for specific positions. A formal certification of such work as may be accomplished by the student will be made.

RESOURCES FOR GRADUATE STUDY

Since the University began in 1961 to encourage the growth of its Graduate School, resources available for graduate study have greatly increased. Considering the graduate program to be composed of (1) formal course instruction and (2) a research experience, the University has developed means to enable students to fruitfully pursue such work.

Research provides a principal method of training and education at an advanced level by concentrated study on a specific problem under close direction of senior faculty members. Such study in theory and experiment assures that classroom teaching is up-to-date; thus research, classroom, and laboratory instruction complement each other.

Lehigh has numerous special laboratories to facilitate such research in the sciences and engineering. These laboratories are located in Fritz Laboratory, which houses the civil engineering department and the world's largest universal hydraulic testing machine; Whitaker Laboratory, completed in 1965 for the chemical and metallurgical engineering departments; Packard Laboratory, for electrical engineering, mechanical engineering, mechanics, and the Computer Center, the most used laboratory on campus; Williams Hall, for biology, geological sciences, psychology, and the bioelectric research laboratory; the Physics Building; the Chemistry Building, with the Chandler and Ullmann Labora-

tories; and Coxe Laboratory, for metallurgy and the electronic microscopy laboratory.

The University's Linderman Library has holdings of more than 400,000 volumes, and an annual acquisition rate of 12,000. It operates on an electronic circulation system, and is connected by teletype to all libraries which have inter-library loan systems. By 1969 the Mart Memorial Science and Engineering Laboratory will be completed and the Linderman Library will be devoted to the humanities and social science collections, which are increasing steadily.

Under certain programs, Lehigh graduate students have access to facilities at various industries in the area. Also, some of the major libraries of the country are within an hour's drive, and the School of Education has developed a strong rapport with area school systems, for the training of teachers.

The University's policy is to make these resources available to all faculty and students, including undergraduates, but graduate students dominate student usage of the more sophisticated laboratory facilities and library holdings.

One manifestation of the growth of graduate education at Lehigh has been the organization of interdisciplinary centers and interdepartmental projects and co-operation. Recent success with mission-oriented research using an interdisciplinary approach—that is, scientists and engineers working together on a basic problem—promises an interesting kind of graduate education. Lehigh's interdisciplinary centers offer an opportunity to implement this new approach by directing continuous attention to a given group of problems, developing a campus awareness of these problems, stimulating interest in their solution, and, finally, mobilizing the talent across campus required for meaningful research. Besides organizing research, the centers create new courses relative to their research.

There are six interdisciplinary centers, all formed since 1962: Materials Research Center, Marine Science Center, Center for Information Sciences, Center for the Application of Mathematics, Center for Surface and Coatings Research, and Business Economics Center. Their functions are more fully described on the following pages.

Although most graduate students find their interests served by programs available within a single

department, some may elect to work in interdisciplinary areas, which reach into two or more departments. Generally, each graduate student's program can be designed to fulfill his own particular interests, subject to the requirement that the field thus defined has scope and depth appropriate for an advanced degree regardless of whether its boundaries fall within a single department. Faculty tend to regard departmental organization more as an administrative convenience than as a limit to the bounds of their scholarly interests.

CAMPUS EVENTS

The cultural and athletic events of the University are open to graduate students who request identification cards, and recreational facilities are for the use of all.

Lehigh University provides a wide range of social and athletic activities, concerts and dramatic productions, and art and book exhibits for students and their guests, for faculty, neighbors, and alumni.

Normally Lehigh's athletic schedule includes four or five home football games, six or seven wrestling meets at home (Lehigh's most popular sport), nine or ten home basketball games, nine home baseball games, and four home swimming meets.

Students are encouraged to attend the many musical and special events on the Lehigh calendar. Programs of great variety and depth are arranged by the Committee on Performing Arts, the Cleaver Foundation, the Department of Music, and the music organizations of Lehigh. Recent concert series have included the Minneapolis Symphony Orchestra, the Turnau Opera Players, the Bach Aria Group, the Budapest String Quartet, The Robert Shaw Chorale, the Vienna Octet, the New York Pro Musica and such soloists as Marian Anderson, Jerome Hines, and Gerard Souzay.

Among the outstanding speakers brought to the Lehigh campus in recent years, in addition to scholars in many academic disciplines, were the historian Mrs. Catherine Drinker Bowen, Senator Joseph S. Clark, Dr. Arnold J. Toynbee, and Sean O'Faolain.

A noteworthy feature of the special events calendar for any year is the annual Jacob Blaustein Lectures in International Relations which presents

an outstanding public figure speaking on crucial questions of international relations. In the first lecture in 1965, Sir Denis Brogan, well-known British authority on America, discussed "The Present Dilemmas of American Policy in a Changing World." In 1966, General Maxwell D. Taylor dealt considerably with U.S. policy in Vietnam under his subject, "Multi-polarity in World Affairs." In 1967, The Honorable Paul Henri Spaak spoke on "The Atlantic Crisis." The lecture series was established at Lehigh through an endowment gift from the Jacob and Hilda Blaustein Foundation of Baltimore. Mr. Blaustein, Class of 1913, is a pioneer in the petroleum industry and an international statesman of some note.

The Department of Fine Arts arranges a series of monthly exhibits, including works by contemporary American artists and sculptors, as well as industrial, photographic, and student art shows. The University's Permanent Collection of art is displayed in several buildings on the campus.

HOUSING

Most resident graduate students live in rooms or apartments near the campus, although from time to time a limited number of living accommodations is available in the undergraduate Residence Halls on the University campus.

The Graduate School cannot assume responsibility for locating housing. A number of rooms and apartments are available in private residences. Since accommodations are scarce, the student is advised to arrange for housing well in advance of his beginning residence.

Inquiries in regard to accommodations for graduate students, either married or single, can be directed either to the Director of Admission or to the Bureau of Housing Information, Lehigh University.

PARKING REGULATIONS

Graduate students are expected to comply with campus parking regulations. They should register their automobiles, and secure instructions from the Office of the Dean of Students in the Alumni Memorial Building. No fee is charged for this registration.

ACCIDENT AND SICKNESS REIMBURSEMENT INSURANCE

The University requires all resident graduate students to carry the accident and sickness insurance coverage which is available at nominal cost at the Bursar's office, unless the student has approved coverage of his own.

All students are required to carry insurance for both accident and illness either through the University or by other approved policies.

EVENING CLASSES

For the benefit of graduate students who by reason of employment in the fields of teaching or industry, cannot attend classes during the day, a certain number of courses are generally offered in the late afternoon, evening, and on Saturday morning. It cannot be announced in advance which courses these will be, but a student who is interested may receive the necessary information by communicating, before the beginning of each semester, with the chairman of the department in the field in which he is interested. During the year 1967, evening and Saturday classes were held in accounting, business law, chemical engineering, civil engineering, economics, English, finance, government, history, industrial engineering, international relations, marketing, mathematics, mechanical engineering, metallurgy, and psychology. It is anticipated that in the future courses will be offered as the demand warrants.

SUMMER SESSIONS

During the summer the University offers several programs for undergraduate and graduate students: two sessions of five weeks each, several workshops in education, special engineering courses in surveying and machine shop, and two reading and study development laboratory programs — one for high school students and the other for college entrants.

The summer sessions at Lehigh are open to men and women.

FINANCIAL ASSISTANCE TO GRADUATE STUDENTS

Financial support is available to graduate students from a number of sources and in various forms — scholarships, fellowships, traineeships, teaching and research appointments, and loans. The University recognizes the high cost of graduate study, and encourages qualified students to explore all available sources of aid.

Descriptions of Graduate School scholarships and fellowships will be found in Appendix B on page 204.

SCHOLARSHIPS

A scholarship is a grant which covers or helps to defray tuition. Each is awarded on the basis of academic promise and financial need. No services are expected in return.

FELLOWSHIPS AND TRAINEESHIPS

A fellowship or traineeship is a grant to a graduate student which covers his tuition and provides an additional stipend to help meet his living expenses.

The University is fortunate to have received funds from individual donors and corporations which provide for the support of several graduate students on scholarships, fellowships and traineeships. The funds which make these programs possible are listed below. In addition, many government agencies and foundations offer fellowships and other grants which they award either directly to outstanding students for use at institutions of their choice or to institutions for award by them directly to the student. Such funds are described in general below.

Appointment to these fellowships is for a period of two semesters and may be renewed, provided the work of the holder is of such quality as to justify continuation of financial aid. Usually the research work can be used for the thesis or dissertation.

Annual stipends for most fellowships are \$1800 or more, depending upon the qualifications of the applicant. Graduate fellows pay the regular tuition fees. However, the Graduate School, in awarding a fellowship, may award at the same time a Graduate Tuition Grant. This grant provides remission of all

tuition fees during the period for which it is awarded.

TEACHING AND GRADUATE ASSISTANTSHIPS

Several graduate students hold junior academic staff positions as teaching or graduate assistants. They assist the faculty in grading undergraduate quizzes, instructing in the classroom and laboratory, and conducting recitations.

The departments view seriously the benefits of a teaching or graduate assistantship as a preparation for a career in university teaching.

A limited number of teaching assistantships are available in applied mechanics, biology, business administration, chemistry, English, education, geology, government, history, international relations, mathematics, physics, political science, psychology, and in chemical, civil, electrical, industrial, mechanical, and metallurgical engineering.

Half-time assistants devote 15 to 20 hours per week to their duties and receive \$2500 (\$2750 after one year of satisfactory service or to holders of the master's degree) for the academic year plus remission of tuition fees. They may take up to 10 hours of graduate work a semester.

Appointments to assistantships are made upon recommendation of the department chairman. A student who wishes to be considered for such a position should write directly to his departmental chairman. Admission to the Graduate School should still be filed with the Office of Admission.

RESEARCH ASSISTANTSHIPS

Lehigh University cooperates with industrial concerns, technical associations, and government agencies in carrying on basic and applied research. A number of research assistantships are available to qualified graduate students who assist with these research programs.

Many students value the opportunity to participate with senior faculty members in an on-going project. The experience enlivens their course work and often determines one's thesis topic. Often, a research assistant's thesis work parallels his contribution to the project.

Applications for research assistantships should be accompanied by evidence of the candidate's

qualifications for the appointment sought and sent to the Director of the Institute of Research or to the chairman of the department concerned.

Research assistants receive stipends which vary from \$150 to \$550 per month, depending upon the qualifications and academic programs of the appointee and the time assigned to the project. Appointments are generally for one year and normally are continued upon satisfactory academic progress. Part-or full-time employment on research projects is frequently available during the summer and entering students who hold research appointments usually are encouraged to begin their employment in June or July before the commencement of formal graduate study in the fall.

Research assistants holding appointments for half-time or more pay a uniform tuition of \$600 per semester, so long as they are enrolled in course work leading to a degree.

APPLICATIONS

A student may apply for any of the scholarships, fellowships or traineeships awarded or administered by Lehigh University, including those granted by national agencies for presentation by the University, by completing the application form available from the Office of Admission. Each applicant is automatically considered for all awards for which he is eligible. Application must be made on or before February 1. Each application must be supplemented by an official transcript of the candidate's college work, a statement concerning his practical experience, and any other evidence of his qualifications which he may choose to submit.

Scores made by the applicant in the Graduate Record Examination; or, for those in Education, the National Teachers Examination; and for M.B.A. candidates, the Admissions Test for Graduate Students in Business, are desired whenever possible.

Final actions on applications is taken on the recommendation of departments to the Graduate School. Notices of award are mailed in March. In accordance with a resolution of the Council of Graduate Schools in the United States, to which over 180 graduate schools have signified their assent, a student has until April 15 to accept or decline an award.

The holder of a scholarship, fellowship or traineeship may not accept any employment for pay without the written permission of the Dean.

ENDOWMENT OF FELLOWSHIPS

A research fellowship, named in honor of an individual or a corporation, offering opportunities for graduate work and training in research in any designated field of study, may be established in perpetuity through the payment to the Board of Trustees of an appropriate fund.

STUDENT LOAN FUNDS

The University administers a sizeable loan fund program under which financial assistance, long-term and short-term, is available to graduate students. A student may borrow when he has no other support from the University, or to add to his income from a fellowship or assistantship. To be considered, a student must provide complete details of his budget.

Information concerning application for a loan may be obtained from the chairman of the department, the Office of Admission, and the Graduate School Office. Among the loan funds available are the following:

United States Aid Funds Loan Program

Lehigh University is one of more than 600 colleges and universities participating in this national nonprofit loan program for needy and deserving students. Graduate students may borrow as much as \$2,000 per year, but no student may borrow more than \$4,000. Interest of 6% simple and payments of interest and principal begin the fifth month after graduation and may be anticipated. In case of dropouts, payments are due to begin at once. The financial aid officer recommends the loan, after consultation with the student, and the loan is then negotiated at the student's home town bank on the student's own signature.

National Defense Student Loan Fund

In order to extend the benefits of low-interest, educational loans to a larger segment of the student body, Lehigh has joined the National Defense Student Loan Program.

"Special consideration" is mandatory for (1) students with superior academic backgrounds who plan to become elementary or secondary school teachers, and (2) students whose academic backgrounds indicate a superior capacity for or preparation in science, mathematics, engineering, or a foreign language. This does not exclude other students.

ELIGIBILITY. Graduate students are eligible to apply for NDEA loans provided they are full-time graduate students who show themselves capable of "maintaining good standing" and show financial need.

AMOUNT OF LOANS. The maximum loan available is \$1,000 in an academic year and a total of \$5,000.

REPAYMENT. The student's note will be taken for repayment in ten equal installments, beginning one year after the date on which he stops being a full-time student. Interest is charged at the rate of three per cent starting with the first payment. In the case of death or disability, liability for repayment of any balance then due is waived.

TEACHERS. If a graduate becomes a full-time teacher in a public elementary or secondary school, up to one-half of the loan (plus the interest on that portion) will be waived at the rate of ten per cent per annum.

Short-Term Loans

Short-term loans are emergency loans and must be repaid, according to the schedule agreed upon, before the end of classes of the semester for which they are granted. Short-term loans bear interest at the rate of four per cent per year from the date of the note. A minimum interest charge of fifty cents is made for each short-term loan granted.

The maximum amount for which a short-term loan may be granted, whether for tuition or for other purposes, is sixty per cent of the student's total bill to the University for that semester.

Every student incurring indebtedness to the University is required to undertake to pay his debt in full as rapidly as possible. Prompt repayment of loans insures the availability of a continuing fund for other student needs.

THE UNIVERSITY LIBRARIES

Two principles underlie the operation of the Lehigh University Library. The first is the development of sound, balanced collections in support of education and research on the campus. The second is the provision of a reference and information service to assist students and faculty in making maximum use of materials available. A policy of open access to the general collection affords the user the opportunity to browse at leisure or to exploit the literature of his special field.

The Linderman Library incorporates the original library building, a gift of the founder and named in memory of his daughter, Lucy Packer Linderman, and a more modern edifice built in 1929 with contributions from alumni.

General and special collections now number some 460,000 volumes, with annual accessions of about 13,000 volumes. Over 4,000 current periodicals and serials are received, including important newspapers, both foreign and domestic. The Library is a depository for a wide selection of U.S. government documents. Collections are particularly strong in the physical and natural sciences, mathematics, engineering and British Colonial history. The Honeyman Collection of rare books is distinguished for its strength in English and American Literature and the History of Science.

Mart Memorial Library, now under construction, will be used by the Center for the Information Sciences as an operating laboratory for experiments in information transfer. The Mart Library will include 85,000 volumes in the fields of engineering, mathematics, and natural and physical sciences, allowing the present Linderman Library space to increase its holdings in the humanities and social sciences. The Mart Library includes facilities for an all-night study room, a programmed learning room, automated circulation system, computer and teletype consoles, closed-circuit television, and other instrumentation. Located on the northeast corner of New Street and Packer Avenue, the three-story structure is named for two deceased alumni from Kansas: Leon T. Mart '13 and Thomas L. Mart '51.

THE SCHOOL OF EDUCATION

John A. Stoops, *Dean*

The President and the Board of Trustees announced the establishment of the School of Education effective February 1, 1966. The School of Education operates in conjunction with the Graduate School. Its administrative procedures are identical or similar to those of the Graduate School in regard to admission, registration, tuition, fees, transcripts, and other related matters. Degree requirements are also consistent with those established by the Graduate School. The School of Education offers the Master of Arts in Education, the Master of Education, and the Doctor of Education. Details regarding the specific regulations and requirements can be found in that section of this catalog pertaining to the Graduate School (see page 74). Course offerings and other pertinent data may be found under the list beginning on page 118.

The School is interested in the preparation of elementary teachers, secondary teachers, community college teachers, counselors, administrators, reading specialists, curriculum specialists, research specialists, and specialists in the foundations of education. The Intern Teaching Program is specifically designed for qualified persons holding B.A. degrees who wish to enter the field of teaching. The School is particularly interested in established teachers who wish to prepare for leadership responsibility in the School through preparation at the master's and doctorate levels.

Seventy Ed.D. candidates, 611 students engaged in M.A. and M.Ed. programs, and 275 Post-Master's degree students were enrolled in the School of Education in the past academic year.

Whereas graduate study in Education was once undertaken only by those preparing for leadership in the schools, it is now a part of the training required of every qualified teacher. In the face of this mounting trend, Lehigh joined the Lehigh Regional Consortium, strengthened its graduate program, and discontinued professional preparation of undergraduate students.

Accordingly, a fifth-year program is offered to qualified holders of B.A. degrees who wish to

enter teaching. Those admitted to the program have the opportunity to accomplish their professional training and serve as salaried interns in the public schools. At the completion of a full year of full-time study, students have met the requirements to begin teaching. After the completion of one-year of full-time teaching, they will meet the requirements for the Master of Arts (secondary teachers) or the Master of Education (elementary teachers) degree.

For the benefit of in-service teachers many courses are offered in the evenings and on Saturday mornings. Teachers of the Lehigh Valley and surrounding regions are sent special bulletins on the offerings of the School of Education and various departments for the fall, spring, and summer sessions. Each bulletin is scheduled for mailing approximately one month before registration. All teachers are encouraged to participate in the life and work of the University.

The School of Education offers the Master of Arts Degree, major in Education with an academic specialty. Candidates for this Degree must include in their program a minimum of twelve hours of graduate work in an academic field. The balance of the program is in the foundations of education. The academic fields which now cooperate with the School of Education in offering this degree include:

Classical Languages	Mathematics
English	Romance Languages
German	Economics
Government	Social Relations
History	Physical and Natural
International Relations	Sciences

Lehigh's program of training for advanced professional responsibility is planned in three stages. The first is represented in the M.Ed. or M.A.; the second exists in the several specialist programs; and the final stage is the Ed.D.

The Master of Education degree requires, in

addition to broad study of the social foundations of education, specialization in a professional field. Special fields include elementary education, elementary administration, secondary administration, general administration, guidance and counseling, and reading. Although study at the Master's level is intense and specialized, the School recognizes that additional training is needed for professional leadership in most areas. Therefore, programs designed for these specialists are extended to the Post-Master's level.

The Doctorate in Education program at present provides for major work in five areas: (1) administration, (2) reading, (3) educational foundations, (4) counseling, and (5) educational research. Students are screened for admission in the fall and spring of each year and begin doctoral study the following semester. Formal admission to the Ed.D. program usually occurs after the completion of 15-30 hours beyond the master's level. The final written examination is administered when the student and his adviser feel he is prepared. When the student successfully completes the written examination and has his proposal accepted by the Graduate School, he becomes a candidate for the Ed.D.

**EXAMINATION DATES FOR DOCTOR OF
EDUCATION 1968-69 ACADEMIC YEAR**

	Admission Exam	October 4, 1968
Final	Written Exam	November 9, 1968
	Admission Exam	February 7, 1969
Final	Written Exam	March 8, 1969

The School is organized in five divisions. Specific information regarding degree programs can be obtained from the director of the appropriate division.

Division of Educational Administration
John S. Cartwright, Director

Elementary School Principalship, Secondary School Principalship, School Business Managership, Curriculum Administration, School Superintendency.

Division of Counselor Education
John A. Mierzwa, Director

Guidance Counselor, School Psychologist, Counseling Psychologist.

Division of Elementary Education
Alfred J. Castaldi, Director

Elementary Teachers (Interns), and Elementary Master Teachers.

Division of Secondary Education
Natt M. Burbank, Director

Secondary School Teachers (Interns), and Secondary Master Teachers.

Division of Education Specialists
John A. Stoops, Director

Reading, *Charles Versacci*; Community College Teachers, *Charles Guditus*; Foundations, *John Stoops*; and Research, *Merle Tate*.

RESEARCH CENTERS AND ORGANIZATIONS

BUREAU OF EDUCATIONAL SERVICE

The Bureau of Educational Service was organized in 1953 to provide professional assistance to public and private schools and various other educational groups.

Among the purposes of the Bureau are the rendering of professional assistance to educational institutions by a cooperative study of their problems, by fostering research in the field of educational practice, and by helping to make the resources of the University more readily available to communities and agencies in need. In fulfilling these purposes the Bureau obtains the services of specialists from all areas of the academic profession.

Detailed information on assistance with specific problems can be secured from the Director, Bureau of Education Service, School of Education.

BUSINESS ECONOMICS CENTER

The Business Economics Center was established in July, 1965 to (1) apply economic analysis to business problems and to (2) carry out research linking business behavior and policy with economic analysis and investigation. In the first case the goal is to test and make greater use of existing academic economic understanding, and in the second case to develop new ideas which will both be useful in the business world and will contribute to academic advances in developing economic explanations and prediction in the real world.

The Center provides a focal point to which businessmen can turn in seeking solution to economic problems, which will benefit the professional economist by testing principles against applications and which will provide research training for students interested in business economics. The questions of businessmen, government officials and others in the field are invited and arrangements are provided to try to develop answers by organizing research where that appears appropriate and by making use of professional experts who desire to cooperate when that course appears promising. Research fellowships are available to a limited extent to attract students who are desirous of work-

ing on the research problems which arise. Additionally, we have found that many students wish to do research work in the Center for course credit often without financial remuneration because of the intellectual stimulation provided by practical research.

Lehigh University offers an M.S. in Business Economics which students working in the Center usually receive. An increasing number of students who work with the Center are working toward the Ph.D. degree.

The Center works closely with the National Association of Business Economists. The Clearing-house Project of that Association, which concentrates on possibilities of business and academic economists helping each other, is directed at Lehigh University.

CENTER FOR SURFACE AND COATINGS RESEARCH

The purpose of the Center for Surface and Coatings Research, which was established at Lehigh University on February 1, 1966, is to encourage faculty and students from all pertinent disciplines to undertake research relevant to surface and coating phenomena.

The Center expects to fulfill its purpose by providing opportunities for research and education, for the most part at the graduate level. Personnel now engaged in its program include seven faculty members, four research associates, and 25 graduate students specializing in Physical Chemistry, Chemical Engineering, or Mechanics. Participation of other scientific fields is also being developed.

The research program currently emphasizes solid/gas or solid/liquid interactions. The major solid/gas effort is concerned with corrosion, particularly the mechanism whereby structurally important metals corrode, lose strength and fracture under stress. Advanced techniques such as electron spin resonance are being employed to determine physical, chemical and mechanical changes in surface states due to adsorption of elements from the atmospheric environment.

The solid/liquid studies are aimed principally at chemical coatings, most of which are based on colloidal dispersions of pigments in polymeric fluids. Aspects include the mechanism of deaggregation and stabilization, effects of polymer orientation and other adsorbed species on interfacial properties, rheological response under stress, adhesion to and flow into porous substrates, and spectral characteristics of colorant layers.

Other research involves the surface properties of ice nucleants, metal alloys and semi-conductors; and the interfacial behavior of detergents, biodegradable surfactants, protein structures, metal/oil/water systems, non-soap lubricants, and water impurities.

COMPUTING CENTER

More than ten years ago Lehigh created a computing facility to serve the education, research and institutional needs of the University. In 1957, an LGP-30 computer was purchased and a University-wide Computing Laboratory established. By 1962, use of the LGP-30 had demonstrated that a more powerful computer was needed and a GE 225 was acquired. As computer use became widespread across the campus it became obvious that a more broadly based unit was needed. Thus, in July of 1967, the Computing Center was organized as a separate unit along lines similar to the other graduate research centers on campus. Organizationally the manager of the Center reports to the Vice President for Research. A Computing Center Advisory Committee, having both a Users' and a Technical Subcommittee, advises the Vice President for Research on matters relevant to Lehigh's computing environment. The Center serves as the laboratory for departmental courses and research in computer theory, programming, information systems, and information retrieval. Also the Center provides computer service to all departments and centers of the University for the solution of instructional and research problems.

In the summer of 1968, the Center will install a Control Data Corporation 6400 system. This system will consist of 65,536 (60 bits/word) words of storage, ten peripheral and control processors, each with 4096 words (12 bits/word), 167 million

characters of disk storage, 4 magnetic tape units, 1200 cards-per-minute card reader, 250 cards-per-minute card punch, two 1200 lines per minute printers, incremental plotter, remote entry displays and teletypes. The principal programming languages are Fortran IV, Fortran Extended, Cobol, Compress (assembler) and a large library of programs.

Seminars are held and/or sponsored by the Center on varied subjects relating to data processing for faculty, staff and graduate students.

FRITZ ENGINEERING LABORATORY

Founded in 1909, the Fritz Engineering Laboratory serves for the advancement of knowledge and techniques in the fields of structures, structural mechanics, materials, hydraulics and fluid mechanics, structural model analysis, soil mechanics, and sanitation.

The Laboratory is associated primarily with the department of Civil Engineering. In addition, there are cooperative research efforts with other departments of the University and with other institutes and universities. Research projects are sponsored through the Institute of Research by national research councils, industrial corporations and associations, private companies, and by state and federal government agencies.

In 1955 the Laboratory was expanded and modernized to provide excellent facilities for research and instruction. Since then, the additional necessary equipment has been acquired to fill the needs of new research investigations.

Through the Laboratory organization, technical seminars and lectures are presented on current research findings and on new design applications in the various fields of Civil Engineering and related disciplines.

The staff of the Laboratory consists of Lehigh University faculty members, research associates, research assistants, and supporting technical personnel. The Laboratory awards research assistantships and certain fellowships to competent research personnel who are candidates for advanced degrees. Through their work in research programs, men are trained for careers in teaching, in research, and in advanced engineering design.

As a result of the research studies conducted by the staff of the Laboratory, it has been possible to make basic changes to design procedures and specifications in numerous specialty fields. The Laboratory participates in a worldwide exchange of research information, maintains a special library of technical papers appropriate to its fields, and stimulates the publication of papers in technical journals both in this country and abroad.

CENTER FOR THE INFORMATION SCIENCES

The Center for the Information Sciences was established in 1962 as a division of the University Library and is now an independent center. It is designed to fulfill two general objectives. The first is the training of specialists who can analyze and organize information. The second is the investigation of the properties and behavior of recorded information, and the forces governing its flow.

In the last twenty years, technology, science, and the emerging social sciences have not only posed unforeseen demands on libraries, but have generated an entirely new complex of ideas about the processes of communication. The information sciences are a response to these needs and ideas. As science, they cut across such disciplines as psychology, logic, neurophysiology, linguistics, and mathematics. As technology, concerned with the processing of information for optimum accessibility, the information sciences utilize the techniques and concepts of computer technology, librarianship, operations research, and the management sciences.

In 1963, a Division of the Information Sciences was established within the Department of Philosophy, as the instructional section of the Center. A graduate program was initiated in 1964. Research in various aspects of the subject is presently being carried out in cooperation with the Departments of Industrial Engineering, Philosophy, Psychology, Social Relations, and the Computing Center.

MARINE SCIENCE CENTER

The Marine Science Center was established in February 1962 as an interdisciplinary research

organization with the purposes of: providing stimulation to staff and students of several departments; providing interdisciplinary research opportunities; and contributing to the teaching program. In the ocean, physical, chemical, biological and geological processes are so closely interrelated that it is often difficult or impossible to separate them.

Housed in Williams Hall along with the Departments of Biology and Geological Sciences, the facilities of the Marine Science Center comprise about 4,400 square feet, including 4 offices for staff, office space for about 8 graduate students, and 5 laboratories. Major items of laboratory equipment (shared with other departments) include circulating salt water aquaria, RCA electron microscope, Norelco X-ray diffractometer, Beckman D. U. Spectrophotometer, plus other standard items such as are found in good science departments.

Complete facilities for doing research in microbiology and biochemistry include: chemical hoods, walk-in coldroom, refrigerators, fraction collector, ovens, incubators, water baths, tissue grinders, Warburg manometric equipment, lyophilizing equipment, Bausch & Lomb spectrophotometers, fermentors, freezer, shaking machine, 2 refrigerated high speed centrifuges, Heathkit pH meters with recorders, Bronwill cell disintegrator, Mettler analytical and torsion balances, air-vacuum pump, thin-layer chromatographic equipment, paper chromatographic equipment, paper and cellulose acetate zone electrophoresis equipment, high voltage electrophoresis equipment.

Students connected with the Marine Science Center are registered in established University departments—biology, chemistry, geological sciences, and various engineering fields. Research is emphasized at all levels of graduate study. There are many opportunities for beginning graduate students to cooperate with the staff on laboratory and field studies. Advanced students are encouraged to undertake independent and interdisciplinary research problems.

Much of oceanography is learned by doing research in the marine environment. Although Lehigh is an inland university, the staff and students of the Marine Science Center have plenty of opportunities to work at sea through arrangements with other oceanographic institutions. Classes are getting

sea experience through a National Science Foundation supported cooperative arrangement with Duke University (R/V EASTWARD).

Graduate students participating in the program of the Marine Science Center usually receive M.S. or Ph.D. degrees in the traditional discipline of their choice—Biology, Geology, Chemistry, or Engineering. Fellowships and assistantships are available for graduate students who wish to pursue aspects of marine science.

Current research activities of staff and students include: Marine microbiology and biochemistry of proteolytic marine bacteria; Systematics and ecology of deep sea Ectoprocts (Bryozoa); Shallow water nearshore and estuarine sedimentation; Biological effects of thermal pollution; Carbonate mineral geochemistry and diagenesis; Crustacean physiology; Zooplankton dynamics.

MATERIALS RESEARCH CENTER

Dr. Joseph F. Libsch, Director

Dr. Richard M. Spriggs, Associate Director
Advanced Materials Laboratory: Prof. Kraft*, Asst. Prof. Tauber, Feigl.

Mechanical Behavior Laboratory: Asst. Prof. Hertzberg*, Roberts.

Ceramics Laboratory: Prof. Spriggs*, Asst. Prof Runk, Dr. Dutta.

Polymer Laboratory: Assoc. Prof. Manson*, Asst. Prof. Sperling.

Electron Microscopy Laboratory: Assoc. Prof. Wood*.

*Director of Laboratory.

Materials research has played an important role at Lehigh for the past two decades. The Materials Research Center was formally established in February 1962 to fulfill the need for a research and educational facility permitting intellectual stimulation of scientists and engineers dedicated to research in materials. The fundamental objectives of the Materials Research Center are to encourage interaction among the science and engineering disciplines with an interest in materials and to promote interdisciplinary research activity and interdepartmental education opportunities.

To achieve these objectives, the Center:

a. Coordinates and integrates all activities pertaining to materials science and technology at Lehigh University;

- b. Seeks to establish a climate in which faculty members, post-doctoral associates, and graduate assistants develop an awareness of materials;
- c. Arranges for facilities and space required to conduct interdisciplinary research;
- d. Guides the search for new materials by encouraging fundamental research and new approaches to materials problems;
- e. Assists in developing educational opportunities in materials, in particular, interdisciplinary graduate programs devoted to training for research in materials; and
- f. Conducts the Materials Liaison Program with industry and government.

The activities and programs of the Materials Research Center are guided by a Materials Council composed of senior faculty members from all of the engineering departments as well as from the Department of Geological Sciences. The policies and decisions of the Council are implemented by the Director of the Center and his staff.

The present organization of the Materials Research Center, located at the Coxe Laboratory, includes 5 laboratories: Advanced Materials Laboratory, Mechanical Behavior Laboratory, Polymer Laboratory, Physical Ceramics Laboratory, and Electron Microscopy Laboratory. Also there are several associated laboratories physically located within departments that include special laboratories for: Engineering Structure Analysis, Surface Chemistry, Stress Corrosion, Magnetic Materials, Crystal Growing and Zone Processing, Manufacturing Processes, Hydrothermal Synthesis, Solid State Investigations, and Environmental Science Studies.

The Center, from its beginning, has emphasized a coupling approach to materials research, recognizing the mutual intellectual stimulation of scientists and engineers dedicated to a common problem. A logical outgrowth of this approach is the Materials Liaison Program, initiated in 1963. The Program serves as a means for the exchange of knowledge of materials problems between scientists and engineers associated with the Center and their industrial and governmental counterparts, by frequent interaction, achieved by: (1) semi-annual

day seminars; (2) special lectures; (3) consultation on materials problems and research; (4) distribution of reprints and papers; (5) distribution of all M.S. and Ph.D. thesis abstracts on materials research; and (6) monthly seminars with outstanding invited speakers.

Currently, approximately 175 persons, including graduate students and faculty members representing science and engineering departments, are engaged in research pertaining to materials science and engineering. This Center facilitates interdisciplinary programs of study and research that cross the traditional boundaries of science and engineering curricula, providing a fundamental, broad approach to the field of materials science and technology. Graduate students participating in the Center's program usually receive M.S. or Ph.D. degrees in the traditional discipline of their choice, i.e., Chemistry, Physics, Metallurgy and Materials Science, Electrical Engineering, etc.; however, they may pursue course work related to a fundamental understanding of materials in several disciplines and conduct research on a broad materials problem involving several graduate students from different disciplines.

For further information concerning course offerings in Materials, see the description of the B.S. Engineering—M.S. Materials Program and course offerings in Materials on pages 61.

The Center has available several industrial fellowships and provides for a number of fellowships from its own operating funds. In addition, graduate students are awarded various government traineeships and fellowships as well as being offered positions as research assistants. For details of Graduate Scholarships and Fellowships please refer to page 83.

Current interdisciplinary research activities include:

1. Band structure and precipitation phenomena in PbS, PbSe, and PbTe.
2. Characterization of metal oxide films.
3. Control of preferred orientation and its effect on mechanical and physical behavior.
4. Correlation of structure with mechanical and physical behavior.

5. Electron fractography.
6. Environmental crack propagation.
7. Material behavior during fatigue crack propagation.
8. Mode of deformation and fracture in 2-phase metallic and non-metallic materials.
9. Physical metallurgy of sintered carbides.
10. Processing and behavior of ceramic materials.
11. Preparation and properties of materials for solid-state devices.
12. Solidification and segregation phenomena in tool steels.
13. Solidification, structure, and mechanical behavior of unidirectionally solidified eutectic alloys.
14. Structure and properties of diffusion coatings.
15. Structure and properties of sputtered, evaporated, and plated thin films.
16. Superconducting, magnetic, and thermoelectric behavior of unidirectionally solidified eutectic structures.

CENTER FOR THE APPLICATION OF MATHEMATICS

The Center was established in the fall of 1965. The purpose of the Center is to foster interdisciplinary research related to the application of mathematics, to draw on other disciplines for pertinent mathematical problems, and to encourage the development of advanced courses in the application of mathematics.

In addition to the research and the support of teaching already described, the activities of the Center include the sponsorship of a colloquium, of lectures which report current research on the campus, and of expository lectures.

The Center serves in an advisory capacity on interdepartmental graduate programs, both in the design of programs to suit the interests of students and departments and in making recommendations on the award of fellowships and assistantships.

The Center surveys the need for courses in the application of mathematics and is concerned both with the design of new courses and the reorganization of existing courses so that these needs may be better served.

The Center sponsors institutes and conferences. It seeks support through contracts and grants for interdepartmental research related to the application of mathematics.

The Center is concerned with the imaginative use of computing facilities.

INSTITUTE OF RESEARCH

The Lehigh Institute of Research was organized in 1924 to encourage and promote scientific research and scholarly achievement in every division of learning represented in the organization of the University, and in recognition of the need for further and more exact knowledge in science and in the application of science to the affairs of modern life. The Institute was reorganized in 1945 in recognition of the increasing role of government agencies and industry in sponsoring research.

Sponsors of current research activities are as follows:

Abex Corporation
 Air Products and Chemicals, Inc.
 Air Reduction Company, Inc.
 Aluminum Company of America
 American Cancer Society
 American Can Company
 American Cyanamid Company
 American Institute of Steel Construction
 American Iron and Steel Institute
 American Metal Climax, Inc.
 Ashland Oil and Refining Co.
 Atlas Chemical Industries, Inc.
 Bell Telephone Laboratories
 Bethlehem Steel Corporation
 Carpenter Steel Company
 Climax Molybdenum Company
 Louis Calder Foundation
 Column Research Council
 E. I. duPont de Nemours and Company
 Esso Education Foundation
 Esso Research and Engineering Company
 Fuller Company
 General Electric Company
 General Telephone and Electronics Corp.
 Gilbert Associates
 Handy and Harmon Tube Company, Inc.
 Heat Exchange Institute
 Howmet Corporation
 International Business Machines Corporation
 International Nickel Company
 M. W. Kellogg Company
 Kentile, Incorporated
 Lepel High Frequency Laboratories, Inc.
 Louisiana Department of Highways

National Council for Stream Improvement
 National Printing Ink Research Institute
 Newsprint Service Bureau
 Olin Mathieson Charitable Trust
 Paint Research Institute
 Commonwealth of Pennsylvania:
 Department of Highways
 General State Authority
 Department of Public Instruction
 Petroleum Research Fund of the American Chemical Society
 Pressure Vessel Research Council
 Reinforced Concrete Research Council
 Research Council on Riveted and Bolted Structural Joints
 Reynolds Metals Company
 Rohm and Haas Company
 Smith, Kline and French Foundation
 St. Regis Paper Company
 Scaife Foundation
 The Boeing Company
 The Earle Gear and Machine Company
 United Aircraft Corporation
 United States Government:
 Independent Offices:
 Atomic Energy Commission
 National Aeronautics and Space Administration
 National Science Foundation
 Department of Agriculture
 Department of Defense
 Department of the Army
 Army Medical Research and Development Command
 Army Research Office — Durham
 Electronics Material Agency
 Corps of Engineers
 Munitions Command
 Department of the Navy
 Ships Systems Command
 Facilities Engineering Command
 Naval Applied Science Laboratory
 Office of Naval Research
 Department of the Air Force
 Aeronautical Systems Division
 Aerospace Research Laboratories
 Air Force Office of Scientific Research
 Department of Health, Education and Welfare
 Office of Education
 Public Health Service
 National Institutes of Health
 Department of the Interior
 Office of Saline Water
 Federal Water Pollution Control Administration
 Department of Transportation
 Bureau of Public Roads
 U.S. Rubber Company
 United States Steel Corporation
 Welding Research Council
 West Virginia Pulp and Paper Company
 Western Electric Company

DESCRIPTION OF COURSES

DESCRIPTION OF COURSES

Following is a list of undergraduate and graduate courses offered by Lehigh University. For purposes of record, all approved courses are listed. It must be understood, however, that the offerings in any given semester are contingent upon a number of factors, including student needs as determined at the time of pre-registration.

Credit Hours

The number in parentheses following each course title indicates the credit value of the course in terms of semester hours. Three hours of drawing, of work in the laboratory, or of practice in the field are regarded as the equivalent of a recitation or lecture of one hour's duration.

Course Numbering

The course numbering system specifies which courses can be applied to the program of study as the student progresses toward his undergraduate or graduate degree. The numbering series is as follows:

- 0-99 Undergraduate courses, primarily for underclassmen. Not available for graduate credit.
- 100-199 Advanced undergraduate courses. Not open to freshmen except on petition. Not open to sophomores except on petition, unless part of major program or curriculum. Not available for graduate credit.
- 200-299 Courses open to advanced undergraduates and graduates. Not available for graduate credit in the major field.
- 300-399 Courses open to advanced undergraduates and graduates. Available for graduate credit in the major field.
- 400-499 Courses open to graduate students only.

Prerequisites

Academic preparation required for admission to courses is indicated under "Prerequisites" following course descriptions stated in most cases for purposes of convenience in terms of Lehigh courses.

Status required for admission, where numbering does not fully describe this status, is also indicated under "Prerequisites."

A student who does not have the status or the academic preparation set forth as prerequisites must, in order to be admitted to a course, file with the Registrar at the time of registration and on a standard form provided by the Registrar a waiver of prerequisites signed by the instructor teaching or in charge of the course, the head of the teaching department, and the student's curriculum director. Academic work completed elsewhere must be attested in this manner as being substantially equivalent to prerequisites listed, unless the student's records in the Office of the Registrar show that the proper officers have so evaluated this preparation previously.

English 2 shall be prerequisite to all 100—or higher—level courses; exceptions may be made only by petition to the Committee on Standing of Students.

ACCOUNTING

Professors

ROBERT HUGH MILLS, PH.D., *Chairman*
ALFRED PAUL KOCH, M.S.
CARL LELAND MOORE, M.A.
WENDELL PIGGOTT TRUMBULL, PH.D.

Assistant Professors

FRANCIS MARIO BRAODY, JR., M.B.A.
RALPH M. KRAUS, M. LITT.
FENG-SHYANG LUH, PH.D.

Instructor

ROBERT L. STONE, M.A.

51. Essentials of Accounting (3)

The organization, measurement and interpretation of economic information. Introduction to accounting theory, concepts and principles, the accounting cycle, and information processing. Exposure to controversial issues concerning income determination and valuation. Prerequisite: Sophomore standing. First and second semesters. Staff

52. Essentials of Accounting (3)

Financial statement analysis for managerial and external use. The use of economic information for managerial planning and control. Introduction to job order, process, and standard cost accounting, variable costing, and volume-mix-price-cost relationships. Prerequisite: Acctg. 51 or 108. First and second semesters. Staff

108. Fundamentals of Accounting (3)

A one-semester survey of accounting principles and practices, including an introduction to industrial cost systems designed primarily for those students planning to take only one accounting course. Other students should take the Acctg. 51, 52 sequence. First and second semesters.

111. Business Data Processing (3)

An introduction to electronic data processing emphasizing general principles applicable to business data. The course includes (1) familiarization with a basic computer language, (2) uses of computers in processing information for the needs of business enterprises, and (3) the elements of integrated systems of financial information for business purposes. Not open to students who have had a previous course in computers. First and second semesters. Mr. Luh

213. Intermediate Accounting (3)

Intensive study of theory, generally accepted accounting principles, and problems concerned with presenting fairly the operating results and financial position of business entities; preparation, analysis, and interpretation of financial statements. Prerequisite: Acctg. 52. First semester.

214. Intermediate Accounting (3)

A continuation of Acctg. 213. Prerequisite: Acctg. 52. Second semester.

For Advanced Undergraduates and Graduates

304. Governmental and Institutional Accounting (3)

Application of accounting principles and procedures to problems of budgets, appropriation, and funds in governmental units, educational institutions and hospitals. Prerequisite: Acctg. 52 or 108.

305. Financial Statements and Reports (3)

Study of the features of accounting data essential to the interpretation and evaluation of business operations and financial position. Analysis of financial statements and reports from point of view of management, investors, creditors, and others. Not available to accounting majors. Prerequisite: Acctg. 52 or 108. Second semester. Mr. Trumbull

307. Federal Tax Accounting (3)

Survey of the Federal law and regulations for determining the income tax liability of individuals, partnerships, trusts, and corporations. Prerequisite: Acctg. 52 or 108. First semester. Mr. Koch

308. Tax Planning and Research (3)

Advanced course in Federal tax laws, regulations, and interpretations. Concerned with advance planning, timing of business transactions, and research on the rulings of the U. S. Treasury Department and the decisions of various Federal courts. Prerequisite: Acctg. 307. Second semester. Mr. Koch

315. Advanced Accounting (3)

Problems dealing with business combinations, partnerships, fiduciary accounts, insolvent concerns, national income accounts, etc. Prerequisite: Acctg. 213 or 214. Second semester.

320. Auditing (3)

Survey of auditing theory, objectives, and practices relating largely to the responsibilities of independent professional accountants; ethics of the profession, generally accepted auditing standards, internal control, examination of various systems including EDP, statistical methods, report writing, etc. Prerequisite: Intermediate Accounting. First semester. Mr. Brady

324. Cost Accounting (3)

Principles and practices of industrial cost accounting, including cost planning and budgeting, cost controls, job-lot and standard and process systems, variance analysis, performance reports, costs in management decisions. Prerequisite: Acctg. 52 or 108. First and second semesters.

325. Controllership (3)

Analysis of the controllership function and of the controller's department as that phase of management responsible for the optimum use of accounting information, accounting facilities and techniques of financial control in a business enterprise. Prerequisite: Acctg. 324. Second semester. Mr. Moore

371. Readings (3)

Readings and research in various fields of accounting; de-

BIOLOGY

signed for superior student who has a special interest in some topic or topics not covered by the regularly rostered courses. Written term paper or papers required. Prerequisite: Preparation in accounting acceptable to the supervising professor and the department chairman. First or second semester. Staff

372. Readings (3)

Continuation of Accounting 371. First or second semester. Staff

For Graduates

The specialized accounting courses at the 300-level are frequently offered in graduate sections in addition to the 400-level courses. These graduate offerings permit MBA students to take a limited concentration of 9-12 hours in accounting. If they have taken 12 to 15 hours in accounting as undergraduates, their total professional preparation of 21-27 hours represents a sound basis for a career in public, industrial or governmental accounting. Undergraduates may wish to plan ahead for a full five-year program including the master's degree for professional accounting preparation. (Note that Acctg. 422, Managerial Accounting, is for non-accounting major MBA students and not open for credit to masters' candidates who majored in accounting as undergraduates or who are carrying an accounting field of specialization at the graduate level.) For further information about CPA requirements in different states or for the selection of accounting electives, see the Chairman, Accounting Department.

422. Managerial Accounting (3)

Survey course for non-accounting majors (related course for accounting majors is Acctg.); uses of accounting data for managerial planning and control; including cost control; capital expenditure planning; product pricing decisions; operations research applications. Prerequisite: Accounting 51 and 52 or equivalent. First semester. Mr. Moore

431. Accounting Theory and Thought (3)

A critical and historical examination of modern accounting concepts. Concerned with measuring enterprise income and capital and related economic data, in both simplified and realistic circumstances, and with communicating and interpreting such data effectively to interested parties. Prerequisite: 15 hours of accounting. First semester.

442. Professional Accounting Seminar (3)

Survey of technical and professional accounting problems at the advanced level. Intensive review of CPA examination material and of management services performed by accountants. Prerequisite: 15 hours of accounting. Second semester.

Mr. Mills

Professors

SAUL BENJAMIN HARBER, PH.D. *Chairman*
RICHARD GRIFFITH MALSBERGER, PH.D.
BASIL WALDO PARKER, PH.D.
FRANCIS JOHN TREMBLEY, PH.D.

Associate Professors

SIDNEY SAMUEL HERMAN, PH.D.
BRADFORD BRECKENRIDGE OWEN, PH.D.

Adjunct Professors

EDWARD JOHN BENZ, M.D.
EUGENE M. LANDIS, M.D., PH.D.

Assistant Professor

HAYDEN NELSON PRITCHARD, PH.D.

Teaching Assistants

LAURENCE MICHAEL BRICKMAN, RICHARD ALBERT DOERING, PETER N. KLOSE.

Research Assistants

JEANNE EVELYN ARGOT, BRUCE CHARLES COULL, ABRAHAM BAGOT EASTWOOD III, CHARLES I. GIBSON, GARY ALAN MARSHALL, FREDERICK CARLTON MONSON

Students may not take for credit both Biol. 21, Principles of Biology (3) and Biol. 13 Human Biology (3). Under special circumstances, a student may petition for an exception to this policy.

13. Human Biology (3)

A lecture course in biological principles as illustrated by man. Man in relation to his environment, the organ systems of man, population biology, parasitism, elements of human inheritance, and human evolution. First and second semesters.

21. Principles of Biology (3)

Introduction to biology by study of selected principles. Topics covered include cell structure and function, plant and animal structure and function, diversity and evolution of organisms. Three lectures per week. First and second semesters.

22. Introduction to Biology Laboratory (1)

Laboratory observations and experiments to illustrate how biological information is acquired. Designed primarily as a laboratory to accompany Biology 21. Prerequisite: Biology 21 previously or concurrently. First and second semester. One 3-hour laboratory per week.

28. Genetics (3)

A study of the basic laws governing inheritance in plants and animals, chromosome behaviour, nature of genes. The relation of environmental modifications, hybrid variation, and mutations to the mechanics of evolution. Prerequisite: One semester of biology. Second semester.

34. Comparative Vertebrate Anatomy (4)

A course in vertebrate zoology with emphasis on the study of homologous body structures in the various vertebrate classes and their relationship to the functional demands of habit and

environment in each class. Detailed dissections of representative vertebrates are made in the laboratory. Two lectures and two laboratory periods each week. Prerequisite: Biol. 21 and 22, or equivalent; sophomore standing. Second semester.

35. Microbiology (3)

A basic course for students majoring in biology. A study of the physiology, biochemistry, and morphology, including staining methods, of representative heterotrophic micro-organisms. Recitations, lectures, and laboratory work. Prerequisite: A laboratory course in biology. Second semester.

For Advanced Undergraduates and Graduates

221. Undergraduate Research (3)

Laboratory work, field work, or both depending upon the interest and competence of the student. Prerequisites: Junior standing and consent of the Chairman of the department. First semester.

Staff

231. Natural History and Ecology (3)

A concentrated course in recognition of species of plants and animals and study of their interrelationships in natural and altered environments. Lectures and seminars in use of keys and preservation of collections. Primarily designed for secondary school teachers in life sciences. Prerequisites: Graduate standing or consent of instructor. Summer Session.

Mr. Trembley

232. Natural History and Ecology Workshop (3)

Field and laboratory work in Natural History and Ecology. Must be taken concurrently with Biol. 231. Summer Session.

Mr. Trembley

233. Modern Biology for Teachers (3)

Lectures, demonstrations, and readings in frontier areas of biology. For secondary school teachers in biology and general science. Not available for undergraduate credit. First semester.

234. Modern Biology for Teachers (3)

Continuation of Biology 233. Second semester.

261. Special Topics in Biology (1-3)

Research, conferences, and reports on selected topics not covered in the general undergraduate offerings. May be taken more than once for credit. First semester.

262. Special Topics in Biology (1-3)

Continuation of Biology 261. Second semester.

272. Senior Seminar (3)

Seminar, for biology majors only, on recent advances in biology. Introduction to research literature on selected topics. One 3-hour seminar per week. Second semester.

303. Advanced Invertebrate Zoology (3)

A detailed survey of representative invertebrates. Anatomical and histological examination of selected types. Concepts of evolution and speciation. One lecture and two laboratories per week. Prerequisite: Two semesters of biology, one with laboratory. Second semester.

Mr. Herman

306. Ecology (3)

The basic principles of ecological interrelationships; training in use of analytical keys and reference collections for the identification of plants and animals; field trips for the study of interrelationships of living organisms. Two lectures and one laboratory period or field trip per week. Prerequisite: Two semesters of Biology, one with laboratory. Second semester.

Mr. Trembley

313. General Histology (3)

The techniques of preservation and preparation of animal and plant tissues for microscopical study; comparative studies of fresh and preserved tissues. One lecture and two laboratory periods per week. Prerequisite. Biol. 21 and 22 or equivalent, Biol. 34 or equivalent recommended. First semester.

Mr. Owen

314. Vertebrate Embryology (3)

A study of reproduction from germ cell formation through establishment of the principal organ systems of the vertebrate body. Various mechanical and physiological problems confronting the growing embryo are considered, and direct observation of whole mounts, sections, and living material are made in the laboratory. Two lectures and one laboratory period each week. Prerequisite: Biol. 34 or equivalent. Second semester.

Mr. Owen

320. Physiology (3)

Lectures and laboratory work covering the principles underlying the operation of life processes. The subject matter is not limited to any one group of organisms, but is derived from living things in general. Prerequisite. Two semesters of biology, one with laboratory; Chem. 52, or consent of the chairman of the department. Two lectures and one laboratory period per week. First semester.

Mr. Barber

334. Growth and Development in Plants (3)

A comparative study of life cycles and embryo growth and development in the plant kingdom, including the algae, bryophytes and tracheophytes. Emphasis is placed on morphology, physiology, and the role of macromolecular substances during growth and differentiation. Prerequisites: Two semesters of biology with laboratory. First semester. Two lectures, one laboratory.

Mr. Pritchard

336. Evolution of Land Plants (3)

A comparative study of the ontogenetic and phylogenetic development of plants as they invaded the terrestrial environment. The algae are studied briefly, but stress is placed on the bryophytes and tracheophytes (land plants). The life cycles of representative plants are examined in detail. Two lectures and a laboratory. Prerequisite: Biology 21 or its equivalent. First semester.

Mr. Pritchard

353. Virology (3)

A lecture course on Rickettsiales, Virales, and bacterial viruses including taxonomy, physical and chemical properties, immunological characteristics, and evolution. Prerequisite: A course in microbiology or bacteriology. First semester.

Mr. Malsberger

361. Sanitary Microbiology (3)

Laboratory, field work, and reports on the microbiology of water supplies, waste disposal, and food processing. Prereq-

uisite: One semester each of microbiology and analytical chemistry. First or second semester as required.

Messrs. Parker, Malsberger

For Graduates

The Biology Department accepts a limited number of students who are interested in graduate study towards the Ph.D. degree. Candidates for M.S. degrees are also accepted but emphasis is on the former degree. Currently the department averages twenty to twenty-five full-time graduate students in residence each year.

The training program initially emphasizes breadth in biology followed by concentration in a special field of interest. Because of the small size of the department staff and the restricted number of graduate students, staff and students work together very closely, especially during the years of student specialization.

The first two or two and one-half years are devoted primarily to course work but some of these are special research and readings courses that may serve as starting points for thesis research. Staff members normally direct student research programs only in areas encompassed by their own research interests. These are: comparative physiology of nerve and muscle, capillary circulation, virology, biological oceanography, histochemistry, aquatic biology, including fisheries biology and biological aspects of water pollution. Interdisciplinary programs in biological aspects of marine sciences may also be arranged in cooperation with the Marine Sciences Center.

Special department requirements for the M.S. degree include one year of graduate biochemistry, one semester of graduate statistics and at least one semester of research, as well as passing an M.S. qualifying examination. Requirements for the Ph.D. degree are determined by the student's special committee and are tailored to fit his special needs and interests, but also include passing a special examination as well as a defense of the Ph.D. theses.

The prerequisite for graduate work in biology is undergraduate training in biology, chemistry, physics and mathematics approximately equivalent to that taken by biology majors at Lehigh University. Minor deficiencies in these areas may be completed during the first year of graduate study, usually, however, without graduate credit. Candidates for admission to graduate study in biology should take the Graduate Record (G.R.E.) Advanced Test in Biology as well as the G.R.E. Verbal and Mathematical Aptitude tests. Failure to include results of these examinations with application for admission can seriously delay or prevent action on the application.

Current departmental projects of special interest are as follows:

Neurophysiological mechanisms in animal behavior; Viral diseases of fresh-water fishes; Biological surveys of lakes; Thermal and Industrial Pollution of the Delaware River; Geochemistry of the Plankton of the Bermuda Platform; Periphyton and water quality; Cytochemistry of lymphocystis tumor cells; and Capillary permeability, porosity and dye cinematography.

402. Comparative Animal Physiology (3)

Lectures and seminars on selected areas in the comparative physiology of animals. Introduction to the current literature of subjects studied. These include mechanisms of

osmotic control, temperature effects, nerve and muscle physiology and others. Prerequisite: Two years of college biology or consent of instructor. Second semester.

Mr. Barber

405. Special Topics in Biology (1-3)

Research, conferences, and reports on selected topics not covered in the general graduate offerings. May be taken more than once for credit.

Staff

406. Biological Seminar (1)

An advanced seminar in current developments including departmental research. Required for candidates for graduate degrees. Second semester.

Staff

407. Biological Research (3)

Investigations in any phase of the biological sciences according to the student's preparation and interests. First semester.

Staff

408. Biological Research (3)

Continuation of Biol. 407. Second semester.

Staff

409. Advanced Morphology (3)

A laboratory course in special phases of morphology, such as comparative osteology, comparative morphology, or embryology of the vertebrates, etc., to meet the individual interest of the student.

Mr. Owen

410. Topics in Modern Biology (3)

A seminar in genetics, evolution, and current developments in biological sciences. Required of all candidates for advanced degrees in the department. First semester.

Staff

411. General Cytology (3)

Conferences, assigned readings, and laboratory work on the structural features of the cell in relation to cellular function and on modern methods of preparing living and fixed tissues for cytological study. Included are special studies of the cytology of microorganisms. Prerequisite: Biol. 313 or its equivalent. First semester.

Mr. Owen

412. Field Zoology (3)

Methods of biological survey work; animal censuses; collection, preparation, and care of zoological specimens; use of keys; study of the interrelationships existing between the groups of local animals, especially the vertebrates, and of their habitat preferences. Lectures, laboratory work, and field trips.

Mr. Trembley

413. Problems in Field Zoology (3)

Concentrated work in the life history study of one or more local species. To be taken concurrently with or following Biol. 412 depending upon the previous experience and interest of each student.

Mr. Trembley

414. Advanced Ecology (3)

Conferences and field work with emphasis in such areas as aquatic ecology, limnology, and fisheries biology. Whenever possible this will include participation in research problems conducted by the Water Resources Council of the Lehigh Institute of Research. Prerequisite: Consent of the instructor. First and second semesters.

Mr. Trembley

415. Cytochemistry (3)

A study of morphological and biochemical events during

CHEMICAL ENGINEERING

cell growth and differentiation including lectures, labs. and student reports on current literature. Special emphasis is placed on developmental patterns and laboratory procedures of the cytochemist. Prerequisite: Consent of the instructor. First semester.

Mr. Pritchard

416. Immunology (3)

Consideration of antigen-antibody systems from theoretical and practical aspects. Lectures and reports on the structure and origins of antigens and antibodies and the mechanisms of agglutination, precipitation, complement fixation, anaphylaxis etc. Laboratory work on preparation, standardization, and assay of antigens and antibodies. Prerequisite: Biol. 353, Chem. 371 or equivalent. First semester.

Mr. Malsberger

417. Marine Ecology (3)

An advanced course in the ecology of the marine environment. Study of the physical and chemical factors, organisms and their interrelations. Ecological theory pertaining to population dynamics and energy flow. Two lectures and one laboratory period per week. Prerequisite: Consent of chairman of department. First semester.

Mr. Herman

418. Biological Oceanography (3)

Surveys of marine plant and animal plankton, nekton and benthos. Composition of various groups, productivity, interrelationships of plants and animals and the role of microorganisms in the sea. Three lectures per week. Prerequisite: Consent of chairman of department. First semester.

Mr. Herman

432. Laboratory Methods in Virology (3)

Basic methods used in the isolation, identification, and handling of viruses. Practical exercises in the preservation of viruses, chick embryo techniques, tissue culture, staining methods, immunological techniques, and microscopy are included. Prerequisite: Biol. 353. Second semester. Mr. Benz

462. Advanced Microbiology (3)

A detailed consideration of algae, fungi, protozoa, and microorganisms other than the Eubacteriales of concern to the microbiologist or sanitarian. Two lectures and one laboratory period or field trip per week. First semester.

Mr. Parker

480. Marine Science Seminar (1)

An advanced interdisciplinary seminar on various problems of marine sciences, with visiting speakers and student presentations. May be substituted for Biol. 406. Second semester.

Staff

BUSINESS ADMINISTRATION

The College of Business and Economics offers four degrees at the master's level, the M.B.A., the M.S. in Management Science, and the M.S. in Business Economics and Master of Arts in Economics. On a more advanced level the College offers a Ph.D. in Business and Industrial Economics, described on page 54.

Professors

LEONARD ANDREW WENZEL, PH.D., *Chairman*
ALAN SHIVERS FOUST, PH.D., *McCann Professor*
CURTIS WILLIAM CLUMP, PH.D.

Associate Professors

ROBERT WILLIAM COUGHLIN, PH.D.
WILLIAM L. LUYBEN, PH.D.
WILLIAM EDWARD SCHIESSE, PH.D.
FRED P. STEIN, PH.D.

Assistant Professors

GARY WAYNE POEHLIN, PH.D.
LESLIE H. SPERLING, PH.D.

Instructor

SIDNEY KLEINBERG, M.S.

Lecturer

JACOB MYER GEIST, PH.D.

Teaching Assistants

MAHMOUD F. ABD-EL-BARY, FRANK W. KOKO, JR., HOWARD BARKER LANGE, JR., ASIT KUMAR RAY, JAMIL-U REHMAN, ASHOK K. TAORI

Research Assistants

CARL ANDERSON, JOSEPH O. BRYDEN, ESTEBAN CHORNET, ANDREW W. DE GRAFF, GOUTAM R. HATTIANGADI, AGUSTIN B. JUMAWAN, JR., KENNETH JURIS, HOWARD B. LANGE, JR., IWAO MATSUI, RONALD MYERS, JOSEPH R. POLEK, DOUGLAS N. RODGERS, GAIL R. STEINER, RICARDO N. TAN, RAMESH C. TRIVEDI

51. Chemical Engineering Computation (4)

Basic technical principles and laws of conservation as applied to chemical processing operations. Mathematical description of steady state and time-variant systems. Digital and analog computation as applicable in these areas. One lecture, two recitations, and one calculation session per week.

52. Transport Phenomena (4)

The principles of transport of energy, momentum, and mass and the analogies between them. Transport coefficients and their evaluation. Applications in variable-property fields within a phase. Three recitations and one laboratory per week. Second Semester.

60. Unit Operations Survey (3)

The theory of heat, mass, and momentum transport. Laminar and turbulent flow of real fluids. Heat transfer by conduction, convection, and radiation. Application to a wide range of operations in the chemical and metallurgical process industries.

100. Summer Employment (0)

During the summer (preferably following the junior year) candidates for the degree of B.S. in Chemical Engineering are required to obtain industrial experience through employment for at least eight weeks in a plant or laboratory or engineering office and submit a report thereon.

165. Unit Operations I (4)

A laboratory-related study of the implications of transport phenomena and conservation principles as applied to chemical processing equipment. Two recitations, two laboratory periods per week. Prerequisite: Ch.E. 52. Fall Semester.

Mr. Clump

166. Unit Operations II (4)

A continuation of Ch.E. 165. One recitation, three laboratory sessions per week. Spring Semester.

174. Chemical Plant Design (3)

A study of the technical and economic aspects of the design, location, and operation of chemical plants. Prerequisite: Ch.E. 166. Second semester.

181. Chemical Engineering Laboratory I (3)

Laboratory experiences in the fields of unit operations, reaction kinetics, process control and dynamics, and thermodynamics. A research project leading to a final report will be a part of this course. Six hours in the laboratory per week. Prerequisite: Ch.E. 166. First Semester.

182. Chemical Engineering Laboratory II (3)

A continuation of Ch.E. 181. Six hours in the laboratory per week. Second semester.

For Advanced Undergraduates and Graduates

200. Chemical Engineering Thermodynamics (3)

Energy relations and their application to chemical engineering. Consideration of flow and non-flow processes, evaluation of the effect of temperature and pressure on thermodynamic properties of ideal and actual fluids; prediction of the heat effects accompanying phase changes and chemical reactions, application to industrial processes. Prerequisites: Ch.E. 51, Chem. 91 or equivalents. First semester.

301. Process Design (3)

Intensive study of selected or proposed chemical processes with emphasis on optimum order of steps, flow diagrams, energy balances and recycle ratios and their effect on the balance sheet of the operation. Approximation methods of obtaining data. Prerequisite: Ch.E. 200. Second semester.

Messrs. Foust, Poehlein

302. Chemical Engineering Kinetics (3)

The application of chemical kinetics to the design and operation of reactors. Interrelations of kinetics, thermodynamics and unit operations in steady or unsteady states. Prerequisites: Ch.E. 164, 200 or equivalent, previously or concurrently. Second semester.

Mr. Stein

315. Transport Processes (3)

A combined study of the fundamentals of momentum transport, energy transport and mass transport and the analogies between them. Evaluation of transport coefficients for single and multicomponent systems. Analysis of transport phenomena through the equations of continuity, motion and energy. First semester.

Messrs. Clump, Schiesser

320. Waste Water Control (3)

The physical processes of importance in the design of in-

dustrial waste water treatment facilities. Topics will include sedimentation and filtration processes as well as advanced methods such as adsorption, ion exchange, osmosis, foaming, freezing, and hydrate formation.

Mr. Clump

386. Engineering Process Control (3)

Concepts of feedback control. Transfer function representation of linear systems. Closed loop transfer functions and the response of closed loop feedback control to deterministic signals. Mathematical models for discrete and distributed systems. Introduction to cascade, feed-forward and computer control. Analysis of complex systems by digital simulation. Prerequisite: Senior standing in a curriculum of the Engineering College, or consent of the instructor. First semester.

390. Nuclear Reactor Engineering (4)

A consideration of the engineering problems in nuclear reactor design and operation. Topics include instrumentation and control, reactor fuels and materials, thermal aspects, radiation protection and shielding, fuel processing, and reactor design. Three lectures, one laboratory period. Prerequisite: Senior standing. Second semester.

Messrs. Clump, Coughlin

392. (Chem. 392) Polymer Science (3)

Introduction to concepts of polymer science. Kinetics and mechanism of polymerization, synthesis and processing of polymers, characterization, relationship of molecular conformation, structure and morphology to physical and mechanical properties. Lectures and laboratory. Prerequisite: Chem. 95 or equivalent. Messrs. Manson, Poehlein

For Graduates

The Department of Chemical Engineering at Lehigh University is a department of moderate size active in research and teaching emphasizing the theory of chemical processing operations. The teaching staff consists of nine senior faculty men plus four locally employed engineers who serve as lecturers. The undergraduate enrollment has been stable over the past several years at a figure that produces about forty B.S. degrees each year. The graduate enrollment has grown markedly so that there are now thirty-five full-time graduate students enrolled in the Department plus approximately an equal number of locally employed engineers who enroll for one or two graduate courses. Our graduate students have come from many educational institutions. Some of these are: M.I.T., R.P.I., Delaware, Rochester, Purdue, Drexel, Carnegie Inst. of Tech., Newark College of Engineering, U.C.L.A., Case, Penn State, Virginia, Maryland, N.Y.U., and Tufts. Last year the Department awarded thirteen M.S. degrees, and six Ph.D degrees.

Offerings of the Department include courses in thermodynamics, reaction kinetics, transport processes, heat transfer, mass transfer, momentum transfer, process dynamics, and applied mathematics. In addition, more specialized courses in catalysis, cryogenic engineering, and polymer processing are offered on a rotating basis. The individual graduate student builds his program out of these courses plus additional work in mathematics, chemistry, mechanical engineering, physics, and industrial engineering as his interests and goals dictate. The net result is a training extending the breadth and depth of under-

standing of the fundamentals of Chemical Engineering. There is very little additional material in specific applications or industries. These are chosen by the student according to his own interests, but usually are consistent with this basic Departmental philosophy.

The research facilities of the Department are continuously being expanded and are adequate to support the research interests of the staff and graduate students. In addition to the research equipment directly available in the Department, graduate students often find the GE-225 computer operated by the University's Computer Center a valuable research tool. Currently, research is going on in the following fields:

Thermodynamic Properties of Multicomponent Systems —

Joule-Thomson coefficients of gas mixtures

Latent heat of vaporization at high pressure

Phase equilibria

Specific heats and heats of solutions of liquid mixtures

PVT measurement

Measurement of the effect of pressure on heat capacity

Adsorption equilibria from gas mixtures on various substrates

Fluid Dynamics —

Retention studies in process equipment

Eddy diffusivity measurements

Process dynamics and response in flow systems

Turbulence in annular flow

Rheology of heavily-doped suspensions

Viscoelastic properties of suspensions

Dynamics of film-splitting

Flow of non-Newtonian fluids

Heat and Mass Transfer —

Two-phase heat and momentum characteristics

Ice formation on cold surfaces

Pulsed extraction column performance

Mass transfer through dialysis membranes

Reaction Kinetics —

Reaction rates in shock wave fronts

Kinetics of thermal decomposition of explosives

Reduction of metal oxides in plasmas

Ion exchange catalysis

Mechanism of explosion initiation

Catalysis in ortho-para hydrogen conversion

Influence of microstructure on gas adsorption and catalysis

Process Dynamics and Control —

Distributed parameter representation of engineering systems

Effect of long control lines on response of pneumatic control systems

Frequency response of process systems

Digital simulation of chemical process systems

Optimization of absorber operation

Feed-forward control of distillation columns

Polymer Characteristics —

Polymer crystallization mechanism

Compressibility of polymer melts

Characteristics of heterogeneous polymer systems

Diffusion in swollen polymers

Interfacial polymerization mechanisms

The Department has just occupied the new Metallurgical

and Chemical Engineering Laboratory. In this building some 40,000 ft. of high quality space is available for the research, teaching, and office needs of the Department. The building is completely air conditioned, and includes specially designed facilities for analog computation, research, calibration standards, process dynamics study, reaction kinetics and thermodynamics research, nuclear engineering, high pressure research, and a wide range of general research space.

In addition to activities that are traditionally chemical engineering, the Department cooperates with several other campus groups to offer interdisciplinary programs. At present these include a program in Chemical Metallurgy carried on in cooperation with the Department of Metallurgy and Materials Science, a program in polymers science through cooperation with the Polymers Research Laboratory of the Materials Research Center, a program in water resources through cooperation with the Departments of Civil Engineering and Biology, and research in interfacial phenomena through the Center for Surface and Coatings Research. More complete descriptions are available on all of these programs.

Of these, the most completely formulated is the Chemical Metallurgy Program. Though Ph.D. programs are available this is basically an M.S. program. Graduates from this program should be uniquely prepared to contribute to the metal refining industry. The program includes industrial exposure as well as a carefully selected sequence of courses and research topic. Study in this program is underwritten by several industrial concerns. Students having an interest in this area should write for a descriptive brochure.

A cooperative M.S. program has been initiated for those specially interested in careers in design. An individually tailored course sequence is coupled with a design project which replaces the more conventional M.S. research project. In order to assure complete support of the design work, and a professional evaluation of it, this project is done within the process design group of one of several nearby design engineering companies. The student is supported by the host company.

Arrangements have been made with Air Products and Chemicals Inc., and with Bethlehem Steel Company to allow a graduate student in Chemical Engineering to support himself by part-time employment in their research or engineering departments. Both of these installations are within easy driving distance of the Lehigh campus, and in both places the student would receive experience in the most advanced work being done in the industry. Typically, a student would work 20 hours per week and would receive pay equivalent to that of a teaching assistant. This would allow him to enroll for about 10 hours of graduate course work per semester, and to progress toward the M.S. degree at a rate equivalent to that of a teaching or research assistant. Under this arrangement, the student pays his own tuition which he accumulates from his industrial wage.

There are available within the Department several opportunities for financial support for the graduate student. See page 83 for details.

Opportunities for financial support during graduate studies are varied, depending upon individual interests and needs. However, they are limited in number, and cannot be offered to more than a few of the qualified applicants. The

time required for an M.S. degree can vary from twelve months to two years depending upon the type of support and the preparation, diligence, and ability of the student. A Ph.D. degree is obtainable in a minimum of 36 months, but more normally requires 4 years.

400. Chemical Engineering Thermodynamics I (3)

Applications of thermodynamics in Chemical Engineering. Topics include prediction of physical and chemical equilibria, heat effects accompanying solution, flow of compressible fluids, refrigeration including solution cycles, vaporization and condensation processes. Prerequisite: An introductory course in thermodynamics. First semester.

Messrs. Wenzel, Stein

401. Chemical Engineering Thermodynamics II (3)

A detailed study of the uses of thermodynamics in predicting phase equilibria in solid, liquid, and gaseous systems. The phase rule; solution theories; uses of equations of state. Theoretical basis and development of equations of state. Applications to azeotropic and extractive distillation, multicomponent separations, liquid extraction. Second semester, alternate years.

Mr. Wenzel

410. Chemical Engineering Kinetics (3)

The application of chemical kinetics to the engineering design and operation of reactors. Non-isothermal and adiabatic reactions. Homogeneous and heterogeneous catalysis. Residence time distribution in reactors. Prerequisite: Ch.E. 302. Second semester, alternate years.

Mr. Stein

413. Heterogeneous Catalysis (3)

Surface area, pore structure and pore-size distribution of catalysts. Influence of pore-diffusion on catalytic reactions and the design of catalytic reactors. Chemical adsorption and physical adsorption. Chemistry, energetics and kinetics of adsorption, desorption, and surface reaction. Electronic structure and catalysis; atomic orbital and bondstructure models. Mechanisms of catalytic reaction of industrial importance. Selection and classification of catalysts.

Mr. Coughlin

421. Heat Transfer (3)

Analysis of steady and unsteady state transfer. Radiation, vaporization, and condensation. Heat transfer in high velocity flow and in rarified gases. Applications. Second semester.

Messrs. Foust, Clump

425. Momentum Transfer (3)

The fundamentals of momentum transfer in chemical engineering systems. Applications of the equations of motion. Boundary layer theories. Modern theories of turbulence. Applications in high velocity flow, flow through porous media, flow of non-Newtonian fluids, two phase flow, equipment residence times. Second semester, alternate years.

Mr. Poehlein

430. Mass Transfer (3)

Equilibrium stage and continuous contact mass transfer operations with emphasis upon distillation, absorption, and extraction. Binary and multicomponent separations.

Mr. Clump

435. Simultaneous Heat and Mass Transfer (3)

Unit Operations involving simultaneous heat and mass transfer. Emphasis on drying, humidification, dehumidification, and condensation in the presence of non-condensable gases. First semester, alternate years. Mr. Clump

440. Process Design (3)

Synthesis of flow sheets for various processes, investigation of contributions to overall economy of various alternatives. Evaluation of profitability of alternatives. Second semester, alternate years.

Mr. Foust

441. System Dynamics and Control (3)

Survey of dynamic models for heat exchangers, reactors, distillation columns and other processing units. Principles of dynamic testing using periodic, transient and random signals. Feedforward, adaptive and computer control.

Messrs. Luyben, Schiesser

442. System Design (3)

The state space formulation of dynamic systems. Concepts of observability and controllability. The discrete and continuous formulations of the maximum principle. Dynamic programming. Optimization by systematic search. Alternate years.

Messrs. Luyben, Schiesser

450. Special Topics (3-12)

An intensive study of some field of chemical engineering not covered in the more general courses. Credit above 3 hours is granted only when different material is covered.

451. Problems in Research (1)

Study and discussion of optimal planning of experiments and analysis of experimental data. Discussion of more common and more difficult techniques in the execution of chemical engineering research.

455. Seminar (1-3)

Critical discussion of recent advances in chemical engineering. Credit above 1 hour is granted only when different material is covered.

461. Chemical Engineering Calculations I (3)

Application of ordinary and partial differential equations to the solution of chemical engineering problems with emphasis on chemical reactions and transport processes as they occur in industrial chemical processing. Applications of solution in series, separation of variables, and integral transforms. Prerequisite: Math. 322. First semester.

Messrs. Coughlin, Luyben, Schiesser

462. Chemical Engineering Calculations II (3)

A continuation of Ch.E. 461 with emphasis on applications involving numerical methods. Second semester, alternate years.

Messrs. Schiesser, Coughlin, Luyben

470. Cryogenic Engineering (3)

Liquefaction and separation of gases, physical and chemical principles. Low temperature thermometry. Insulation. Properties of fluids and of structural materials. The behavior of helium. Ultra-low temperature phenomena and theories. First semester, alternate years.

Messrs. Stein, Wenzel

CHEMISTRY

471. Low Temperature Processes (3)

The problems and design of plants operating in the cryogenic temperature range: Refrigeration demands. Distillation and heat exchange at low temperatures. Analysis of processes for thermodynamic and operating efficiency. Problems of safety, non-steady state behavior, and control. Second semester, alternate years.

Mr. Wenzel

480. Research (3-4)

Investigation of a problem in chemical engineering. First semester.

481. Research (3-4)

Continuation of Ch.E. 480. Second semester.

492. (Chem. 492) Polymer Science (3)

Selected topics including reaction kinetics, thermodynamics and kinetics of crystallization, new analytical techniques, molecular weight distribution, morphology and processing, non-Newtonian flow behavior, second-order transition phenomena, novel polymer structures. Prerequisite: Ch.E. 392 or Chem. 392 or equivalent.

Messrs. Manson, Poehlein

Professors

EDWARD DELBERT AMSTUTZ, PH.D., *Chairman*
JOSEPH ROBERT MERKEL, PH.D.
ROBERT STEACY SPRAGUE, PH.D.
THOMAS EDWIN YOUNG, PH.D.

Associate Professors

ALFRED JAMES DIEFENDERFER, PH.D.
VELMER BERNEL FISH, PH.D.
DORESWAMY R. IYENGAR, PH.D.
CHARLES STEPHEN KRAHANZEL, PH.D.
ROLAND WILLIAM LOVEJOY, PH.D.
JOHN ALEXANDER MANSON, PH.D.
WILLIAM EDWARD OHNESORGE, PH.D.
JAMES EDWARD STURM, PH.D.

Assistant Professors

NED D. HEINDEL, PH.D.
FORTUNATO JOSEPH MICALE, PH.D.
THOMAS RUSSELL ORTOLANO, PH.D.
DANIEL ZEROKA, PH.D.

Instructor

DONALD JOSEPH ROMANIK, B.S.

Teaching and Graduate Assistants

WALTER BRYANT, TIN HO CHIU, JAMES W. DAVIS, CATHERINE T. FERRY, DAVID FINK, WILLIAM FINES, HORACE GROFF, DANA M. GYURICSEK, COLEMAN R. HAMEL, STANLEY IOBST, THOMAS JENSEN, EDWARD LAREAU, WILLIAM L. LETTINGER, L. JOSEPH MALE, GREGORY MCNAMEIN, JAMES MOLNAR, PAUL ROBERT REED, JR., TIBOR SIPOS, WILLIAM SUNDAY

Research Assistants

EVELYN Y. Y. HUI, ELSIE L. KELLERMAN, JOHN E. MENEAR, ALAN J. SOLOMON

1. Chemical Principles I (3)

An introduction to the important principles of chemistry. Topics include atomic structure and bonding, stoichiometry, kinetic molecular theory, states of matter, solutions, and an introduction to chemical equilibrium. Math. 21 previously or concurrently. Two lectures, or recitation. First and Second semester.

Staff

II. Chemical Principles I Lab (1)

A laboratory course to be taken concurrently with Chemistry 1. Emphasis is on quantitative methods. One three-hour laboratory period per week. First semester.

Staff

3. Chemical Principles II (3)

A continuation of Chemistry 1. Topics include further work in chemical equilibrium, and introductions to thermodynamics, kinetics, and electrochemistry. Selected descriptive chemistry of certain metallic and non-metallic elements. Prerequisite: Chemistry 1. Two lectures, one recitation. First and Second semesters.

Staff

13. Chemical Principles II Lab (1)

A laboratory course to be taken concurrently with Chemistry 3. Emphasis is on quantitative physico-chemical experiments. Prerequisite: Chemistry 1. One three hour laboratory period per week.

Staff

39. Analytical Chemistry (3)

The fundamentals, theory, and practice, of analytical chemistry for all students except chemistry majors. Selected topics in the areas of classical and instrumental analysis are discussed. Fundamental techniques are presented in the laboratory or by demonstration. Two lectures, one laboratory period. Prerequisite: Chem. 3. First semester.

Messrs. Fish, Diefenderfer

51. Organic Chemistry (3)

Systematic survey of the typical compounds of carbon, their classification and general relations; study of synthetic reactions. Prerequisite: Chem. 3 or Chem. 2. First semester.

Mr. Amstutz

52. Organic Chemistry (3)

Continuation of Chem. 51. Prerequisite: Chem. 51. Second semester.

Mr. Amstutz

53. Organic Chemistry Laboratory (2)

Preparation of pure organic compounds. Prerequisite: Chem. 3 or Chem. 2. First semester.

Messrs. Amstutz, Young, Heindel

54. Organic Chemistry Laboratory (2)

Continuation of Chem. 53 with particular emphasis upon aromatic compounds and qualitative organic analysis. Prerequisite: Chem. 53. Second semester.

Messrs. Amstutz, Young, Heindel

55. Organic Chemistry Laboratory (2)

A course in the preparation of pure organic compounds and the techniques of organic chemistry. Designed especially for chemical engineers. Prerequisites: Chem. 51 and Chem. 52 concurrently. Messrs. Young, Amstutz, Heindel

91. Physical Chemistry (3)

An introduction to physical chemistry which integrates the molecular and macroscopic viewpoints. The particulate structure of matter: nuclear and atomic structure, kinetic theory, elements of quantum chemistry. Prerequisites: Chem. 3 preferably, or Chem. 2. Second semester.

Messrs. Sturm, Lovejoy, Zeroka

95. Physical Chemistry (3)

An introduction to physical chemistry primarily for students not majoring in chemistry. Classical thermodynamics; chemical kinetics; the kinetic theory of gases; applications of principles to problems of engineering interest. Prerequisite: Chem. 3 or Chem. 2; Math 23, previously or concurrently. First semester.

Mr. Manson, Sturm

100. Professional Training (0)

During the summer following the sophomore or junior year candidates for the degree of B.S. or B.A. in Chemistry are expected to obtain professional experience through employment in a laboratory or plant and to submit a report thereon.

190. Physical Chemistry (3)

A continuation of Chem. 91. Development of first, second, and third laws of thermodynamics with application to solids, liquids, and gases; solutions; chemical equilibria.

Elements of statistical mechanics and statistical thermodynamics. Properties of the solid state.

Messrs. Lovejoy, Sturm, Zeroka

192. Physical Chemistry Laboratory (1)

This course, together with Chem. 193, provides a coordinated sequence of laboratory studies which illustrate the physico-chemical principles presented in Chem. 91. Emphasis is placed on both the quantitative interpretation of the data and the experimental method. Prerequisite: Chem. 91. First semester.

Physical Chemistry Staff

193. Physical Chemistry Laboratory (1)

Physical chemical measurements. Prerequisite: Chem. 91, previously or concurrently. Second semester.

Physical Chemistry Staff

195. Physical Chemistry (3)

A continuation of Chem. 95 which integrates the molecular and macroscopic viewpoints. Nuclear, atomic and molecular structure; statistical thermodynamics; the solid state; topics in surface chemistry. Prerequisite: Chem. 95. Second semester.

Mr. Manson

232. Analytical Chemistry (3)

Theory and practice of chemical analysis. Principles of quantitative separations and determinations; theory and application of selected optical and electrical instruments in analytical chemistry: interpretation of numerical data, design of experiments, solute distribution in separation methods. Prerequisite: Chem. 51, 91. Second semester.

Messrs. Fish, Diefenderfer, Ohnesorge

234. Analytical Chemistry Laboratory (2)

Laboratory course: experiments coordinated with and illustrating methods and principles discussed in Chem. 232. Second semester.

Messrs. Fish, Diefenderfer, Ohnesorge

302. Principles of Inorganic Chemistry (3)

Application of the theories of atomic and molecular structure and of chemical bonding to the periodic relationships and selected descriptive chemistry of the non-transition elements. Introduction to transition metal complex ions and coordination compounds and to the theories of bonding in these substances. Prerequisite: Chem. 91 previously or concurrently. First semester.

Mr. Kraihanzel

303. Nuclear and Radiochemistry (3)

A broad survey of nuclear science with particular emphasis on aspects of importance to chemistry and biology. Elementary nuclear theory; production, separation and identification of radioactive and stable isotopes; use of isotopes in the study of chemical and biological systems; radiological safety; nuclear engineering. Two lectures and one lecture-laboratory. First semester.

Mr. Sturm

306. Inorganic Laboratory (2)

A laboratory course illustrating a variety of techniques for the preparation and purification of inorganic compounds. Hours equivalent to two laboratory periods per week will be arranged by the instructor. Prerequisite: Chem. 302, previously or concurrently. Messrs. Kraihanzel, Ortolano

308. Coordination Chemistry (3)

The thermodynamics of metal ion complex formation in solution. Kinetics and mechanisms of transition metal complex reactions. Isomerism in complex compounds. Introduction to organo-metallic chemistry. Prerequisite: Chem. 302 or its equivalent. Second semester.

Mr. Krahanzel

310. Instrumentation Principles I (3)

A study of electrical, electronic and optical principles in modern instrumentation for measurement and control. Principles and applications of vacuum tubes, transistors and phototubes with associated circuitry applied to modern instrumentation. Transducer application to fields of electrical, optical and mechanical measurement. Two lectures and one three hour laboratory. First semester.

Mr. Diefenderfer

311. Instrumentation Principles II (3)

A continuation of Chem. 310 with emphasis upon mechanical principles, including kinematic design and mechanical computation. Development of the total instrumental concept integrating all facets of the problem. Two lectures and one three hour laboratory. Prerequisites: Chem. 310 or equivalent. Second semester.

Mr. Diefenderfer

352. Organic Chemistry, Heterocyclic Compounds (3)

The chemistry of thiophene, pyrrole, furan, pyridine and their derivatives, considered from the viewpoint of recent theories of organic structure and reaction mechanisms. Prerequisite: Chem. 358.

Mr. Young

356. Quantitative Organic Analysis (1)

The practice of the common analytical procedures involving the quantitative estimation of carbon, hydrogen, halogen, nitrogen and sulfur; the iodine number method; the hydroxyl value; the acid value and the saponification number. One laboratory period per week. Prerequisites: Three hours of analytical chemistry; a course in organic chemistry. Second semester.

Mr. Fish

358. Advanced Organic Chemistry (3)

The study of modern theories of reaction mechanisms and their application to the problems of organic chemistry. Prerequisite: One year of organic chemistry. First semester.

Mr. Heindel

368. Advanced Organic Laboratory (2 or 3)

The synthesis and study of organic compounds illustrating the important techniques and special pieces of apparatus commonly used in organic chemical research. Prerequisite: One year of organic chemistry and laboratory. First or second semester.

Messrs. Young, Heindel

371. Elements of Biochemistry (3)

A general study of carbohydrates, proteins, lipids, nucleic acids and other biological substances and their importance in life processes. Protein and enzyme chemistry are emphasized. Prerequisite: One year of organic chemistry. First semester.

Mr. Merkel

372. Advanced Biochemistry (3)

Dynamic aspects of biochemistry: Enzyme reactions including energetics, kinetics, and mechanisms; Metabolism

of carbohydrates, lipids, proteins, and nucleic acids; Photosynthesis, electron transport mechanism, coupled reactions, phosphorylations, and the synthesis of biological macromolecules. Prerequisite: Chem. 371. Mr. Merkel

375. Research Chemistry Laboratory (3) (Optional)

Advanced study or an investigation involving intensive work in laboratory and library. Topics in active research include adsorption, analytical processes, drying oils, heterocyclic organic compounds, hydration of inorganic salts, kinetics of combustion, natural and synthetic resins, pigments, surface chemistry and X-ray technique. Prerequisite: Consent of chairman of department. Second semester.

Staff

377. Biochemistry Laboratory (1-3)

Laboratory studies of the properties of chemicals of biological origin and the influence of chemical and physical factors on these properties. Laboratory techniques used for the isolation and identification of biochemicals. Prerequisite: Chem. 371, previously or concurrently. First semester.

378. Biochemical Preparations (1-3)

A laboratory course involving the preparation or isolation, purification and identification of chemicals of biological origin. Prerequisite: Chem. 377 and 372, previously or concurrently. Second semester.

Mr. Merkel

381. Radiation and Structure (4)

A study of the method and theory of the development of chemical information from radiation-matter interactions; macroscopic optics, scattering phenomena, quantal phenomena. Applications to problems of analytical, inorganic, organic and physical chemical interest. Three one-hour lectures and one three-hour laboratory. Prerequisites: Chem. 190 and 232. First semester.

Messrs. Diefenderfer, Zeroka

382. Structure, Electrochemistry and Kinetics (4)

A unified study of matter in the process of change. Elements of irreversible thermodynamics; steady-state electro-chemistry; chemical kinetics, phenomenology and interpretation; non-steady-state electrochemistry; electrokinetic phenomena. Correlation with chemical structure. Prerequisite: Chem. 381. Second semester.

Messrs. Diefenderfer, Sturm

392. (Ch.E. 392) Polymer Science (3)

Introduction to concepts of polymer science. Kinetics and mechanism of polymerization, synthesis and processing of polymers, characterization, relationship of molecular conformation, structure and morphology to physical and mechanical properties. Lectures and laboratory. Prerequisite: Chem. 95 or equivalent. Messrs. Manson, Poehlein

397. Colloid and Surface Chemistry (3)

Introduction to concepts of colloid and surface chemistry. Classification of colloidal systems; determination of surface and interfacial tensions; spreading of films on liquids; types of emulsions; foams and aerosols; nature of the solid/gas and solid/liquid interface; causes of colloidal stability and determination of particle size; rheology of disperse systems. Prerequisite: Chem. 95 or equivalent. Mr. Micale

For Graduates

The Department of Chemistry offers graduate work leading to both the M.S. and the Ph.D. degrees (the M.S. is not a prerequisite for the Ph.D.); facilities are available for post-doctoral research. 70 M.S. and Ph.D. candidates were enrolled in the Department in the 1967-68 academic year.

A student may specialize in biochemistry, analytical, inorganic, organic, or physical chemistry. The department has numerous laboratory facilities and considerable scientific equipment for chemical research as well as a capable faculty which works closely with students in the classroom and in the research laboratory.

The University Library contains approximately a half-million volumes and currently subscribes to some 6000 serials and periodicals. There are particularly strong collections available for research in the physical and natural sciences.

The Graduate program in chemistry at Lehigh has a two-fold purpose. It affords a student the opportunity to acquire a modern advanced knowledge of chemistry within the framework of formal graduate courses and permits the development of techniques required of competent research through independent scientific investigation. The graduate program for the Ph.D. degree in Chemistry consists of approximately one-third formal course work and two-thirds independent research and study. A student entering upon graduate study with a teaching assistantship will spend an average of three or four years of full time residency beyond the bachelor's degree to complete all the requirements for the Ph.D. degree.

During his first year of graduate work a student normally takes basic graduate courses from the fields of analytical, biological, inorganic, organic, and physical chemistry and becomes acquainted with the research interest of the various faculty members. From these contacts the student is able to assess critically his own research interests, and thus choose a research director. Having selected a research director, a research problem is mutually agreed upon; a thesis committee is appointed to serve in an advisory capacity.

It is assumed that an entering graduate student in chemistry will have satisfied the requirements for the bachelor's degree that meets the minimum standards recommended by the American Chemical Society Committee on Professional Training. Thus, in addition to the usual chemistry courses, a student's undergraduate curriculum should include at least one year of physics, mathematics through the calculus, and at least one year of a foreign language, preferably German. If a student shows a deficiency in one or more of these undergraduate areas, these can be rectified during the first year of graduate work and do not affect a student's eligibility for an appointment to an assistantship. Teaching and Research Assistantships, as well as fellowships, are available to graduate students in chemistry. The assistantships are regarded as half-time appointments, permitting a student to enroll for up to ten credit hours of course work per semester. Students on teaching appointments normally have an average of 10 hours per week of instructional duties in undergraduate recitation classes or laboratories. The University does not charge tuition or other fees of students on teaching appointments.

Current research projects of interest include the following:

Analytical Chemistry — Electron-reduction and oxidation mechanisms of organic compounds; atomic absorption spectrometry of refractory forming metals; Hammett correlations with electrochemical reduction potentials; formation constants, bonding properties, and structure of complexes formed by biindolyl compounds; polarographic studies of substituted hydrazines. Luminescence of metal chelates; voltammetry in non-aqueous solvents. X-ray fluorescence methods of analysis.

Biochemistry — Synthesis, isolation, and characterization of proteolytic enzymes of marine bacteria; determination of the amino acid specificity of bacterial proteases; mechanism of action of proteolytic enzymes. Nucleases of marine bacteria. Isolation and characterization of antimicrobial substances. Physiology and biochemistry of marine bacteria and other microorganisms. Riboflavin — light reactions.

Inorganic Chemistry — Synthesis and characterization of amide complexes of transition metals; silicon organometallic compounds, and aryl and alkyl transition metal compounds; substitution and rearrangement reactions involving metal carbonyls. The electronic structures of transition metal complexes as a function of ligand strength and of actual-vs-effective symmetry and coordination number; environmental effects on unsaturated complexes; vapor phase and single crystal electronic absorption spectroscopy of complexes.

Organic Chemistry — Synthesis of medicinal agents; correlation of molecular structure and pharmacological behavior; chemical models for biochemical reactions. Sulfur bonding in novel heteroaromatic sulfur compounds; kinetics and mechanisms of reactions of organosulfur compounds; molecular orbital correlations of electronic spectra, redox potentials, and ionization potentials of heteroaromatic systems; equilibria and formation thermodynamics of heterocyclic charge transfer complexes, kinetics of chromic acid oxidations; photo-catalyzed reductions, oxidations, and enolizations; synthesis of new heterocyclic systems.

Physical Chemistry — Vacuum ultraviolet photochemistry; radiation chemistry; flash photochemistry and kinetic spectroscopy. Surface chemistry of pigments, metals, semiconductors, and plastics; heterogeneous nucleation phenomena; catalysis; heats of wetting; stability of colloidal dispersions; polymer adsorption. Molecular structure and bonding properties of inorganic, organic, and organometallic compounds from vibration-rotation spectra using infrared and Raman spectroscopy; molecular motion in the crystalline state. Molecular structure, conformation, and properties of polymers in solution and in the solid state. Application of quantum mechanics and statistical mechanics to problems of chemical interest. Heterogeneous catalysis; adsorption and chemisorption kinetics.

The Chemistry Department has offices, laboratories, a library, and other research facilities throughout the four floors of Chandler Laboratories; biological chemistry is located in nearby Williams Hall which also houses the Biology Department. The specialized equipment available in the department for graduate research includes: mass spectrometer, x-ray diffraction spectrometer, single-beam grating infrared spectrometer, Raman spectrograph, nu-

clear magnetic resonance spectrometer, electron spin resonance, emission spectrographs, atomic absorption spectrometer, spectrofluorometer, phosphorescence spectrometer, light scattering photometer, differential refractometer, flash photolysis apparatus, densitometers, preparative and analytical gas chromatographs, ellipsometer, double-beam infrared and ultra-violet-visible recording spectrometers, counting equipment for radioactivity measurements, Wenking potentiostat, recording-multipurpose polarographs, and chronopotentiometers high speedcentrifuges, automatic fraction collectors, freeze dryers, high voltage electrophoreses apparatus, electron microscope, laboratory fermentor, walk-in cold room, cell disintegrator, Warburg respirometer, zone and disc electrophoresis apparatus, paper and column chromatography equipment, freeze-dryer, autoclave.

In addition to the facilities of the chemistry department, there are several research centers located on the campus that are maintained by the University: Center for Information Sciences, Marine Science Center, Materials Research Center, Center for the Application of Mathematics, Center for Surface and Coating Research, The Computing Laboratory on campus is equipped with a CDC 6400 computing and information processing facility.

400. Inorganic Chemistry Research (1-4)

Investigation of a problem in inorganic chemistry.

Messrs. Krahanzel, Ortolano, Sprague

401. Inorganic Chemistry Research (1-4)

Continuation of Chem. 400. Second semester.

Messrs. Krahanzel, Ortolano, Sprague

402. Advanced Inorganic Chemistry (3)

Theories of bonding. Group theoretical principles will be utilized in studies of molecular orbital and ligand field theories of bonding. Prerequisite: Chem. 302 or equivalent. Second semester.

Mr. Ortolano

403. Advanced Topics in Inorganic Chemistry (3)

Subjects of contemporary interest in inorganic chemistry, including quantitative treatment of acid-base chemistry in non-aqueous solvents, mechanisms of inorganic reactions, chemistry of organo-metallic compounds and metal carbonyls, and chemistry of metal chelates. This course may be repeated when a different topic is offered. Prerequisite: Chem. 302 or its equivalent and consent of instructor. First or second semester.

Messrs. Sprague, Ortolano, Krahanzel

429. Seminar in Inorganic Chemistry (1-6)

Reports and discussions of recent developments in inorganic chemistry.

Messrs. Krahanzel, Ortolano, Sprague

430. Analytical Research (1-4)

Investigation of problems in analytical chemistry. First semester.

Messrs. Diefenderfer, Fish, Ohnesorge

431. Analytical Research (1-4)

Continuation of Chem. 430. Second semester.

Messrs. Diefenderfer, Fish, Ohnesorge

432. Advanced Analytical Chemistry (3)

Theory of precipitation analysis; physico-chemical methods; micro-analysis; chromatography; organic-analytical reagents; accuracy and precision in analysis. Prerequisite: Six hours of analytical chemistry. First semester.

Messrs. Fish, Ohnesorge

433. Advanced Topics in Physico-Analytical Chemistry (3)

Consideration of physico-chemical analytical techniques. Special topics in electro-chemical, statistical and optical methods such as electrode kinetics, diffusion phenomena, electronic emission spectroscopy.

Messrs. Diefenderfer, Fish, Ohnesorge

436. Advanced Methods of Analytical Chemistry (3)

An examination of the theory and application of certain selected topics of modern instrumental analysis. The application of these techniques to the solution of chemical problems. Three lectures per week. Prerequisite: Six hours of analytical chemistry. Second semester.

Messrs. Fish, Diefenderfer, Ohnesorge

439. Seminar in Physical Chemistry (1-6)

Reports and discussions of recent developments in physical chemistry.

Physical Chemistry Staff

440. Elements of Theoretical Chemistry II (3)

Applications of chemical thermodynamics to gases, various types of equilibria, and chemical reactions with emphasis on real systems. Elementary statistical thermodynamics. Kinetic processes; rate laws and mechanisms; kinetic theory and transition state interpretations. Prerequisite: Chem. 442 or consent of department chairman. Second semester.

Messrs. Lovejoy, Sturm

441. Chemical Kinetics (3)

A study of kinetic processes. Phenomenological chemical kinetics; order, mechanism effect of external variables on rate. Theories of the rate constant. Relation between thermodynamics and kinetics. Applications to selected systems such as unimolecular decompositions, adsorption and catalysis. Prerequisite: One year of physical chemistry. First semester.

Mr. Sturm

442. Elements of Theoretical Chemistry I (3)

An introduction to fundamental chemical physics. Quantum chemistry of simple systems; theories of chemical bonding; approximation methods. Molecular structure and spectroscopy. Principles of chemical thermodynamics including first, second and third law considerations; properties of state functions. Prerequisite: One year of physical chemistry. First semester.

Messrs. Lovejoy, Sturm

449. Seminar in Analytical Chemistry (1-6)

Reports and discussions of recent developments in analytical chemistry.

Messrs. Fish, Diefenderfer, Ohnesorge

450. Theoretical Organic Chemistry (3)

An advanced study of topics in theoretical and mechanistic organic chemistry: solvolyses, rearrangements, multi-center

reactions, carbenes, photochemistry and the application of nuclear magnetic resonance to organic chemical problems.
Messrs. Young, Heindel

451. Theoretical Organic Chemistry (3)

The chemistry of benzenoid aromatic compounds, quinones and non-benzenoid aromatic substances, including modern theories of structure, electrophilic, nucleophilic and homolytic aromatic substitution and the less familiar addition reactions of aromatic systems. Prerequisite: Chem. 358.
Mr. Young

458. Topics in Organic Chemistry (3)

An intensive study of limited areas in organic chemistry.
Messrs. Young, Heindel

459. Seminar in Organic Chemistry (1-6)

Reports and discussions of recent important developments in theoretical and applied organic chemistry.
Messrs. Young, Heindel

460. Organic Chemistry Research (1-4)

Investigation of a problem in organic chemistry. First semester.
Messrs. Amstutz, Young, Heindel

461. Organic Chemistry Research (1-4)

Continuation of Chem. 460. Second semester.
Messrs. Amstutz, Young, Heindel

466. Advanced Organic Preparations (2 or 3)

A laboratory course of instruction in advanced techniques of the preparation of organic compounds. First or second semester.
Messrs. Young, Heindel

471. Natural Products (3)

A survey of the chemistry of steroids, terpenes, alkaloids and antibiotics with emphasis on instrumental methods of analysis and structure proof, recent synthetic and bio-synthetic pathways.
Mr. Heindel

473. Seminar in Biochemistry (1-4)

Reports and discussions of current developments in the field of biochemistry.
Mr. Merkel

474. Biochemistry Research (1-4)

Investigation of a problem in biochemistry.

475. Biochemistry Research (1-4)

Continuation of Chem. 474.

476. Microbial Biochemistry (3)

Composition, nutrition and metabolism of micro-organisms; with emphasis on microbial enzyme reactions and products of microbial metabolism. Prerequisites: Chem. 372. and Biol. 35 or their equivalents.

477. Topics in Biochemistry (3)

Intensive study of selected areas of biochemistry, such as mechanisms of enzyme action, new developments in the chemistry of lipids, nucleic acids, carbohydrates and proteins. Prerequisite: Consent of the chairman of the Department.
Mr. Merkel

478. Advanced Biochemical Preparations (1-3)

An advanced laboratory course in the preparation, isolation, purification and identification of biochemically produced materials. Emphasis is placed on materials and procedures of current interest in biochemistry. Prerequisites: Consent of the chairman of department.

490. Physical Chemistry Research (1-4)

Investigation of a problem in physical chemistry. First semester.
Physical Chemistry Staff

491. Physical Chemistry Research (1-4)

Continuation of Chem. 490. Second semester.
Physical Chemistry Staff

492. (Ch.E. 492) Polymer Science (3)

Selected topics including reaction kinetics, thermodynamics and kinetics of crystallization, new analytical techniques, molecular weight distribution, morphology and processing, non-Newtonian flow behavior, second-order transition phenomena, novel polymer structures. Prerequisite: Chem. 392 or equivalent.
Messrs. Manson, Poehlein

494. Quantum Chemistry (3)

Principles and applications of quantum mechanics to chemical problems. Applications to chemical bonding, molecular structure, reactivity and spectroscopy. Prerequisite: Chem. 442 or consent of chairman of Department.
Messrs. Lovejoy, Zeroka

495. Statistical Thermodynamics (3)

Principles and applications of statistical mechanics to chemical problems. A study of the techniques for evaluating the properties of matter in bulk from the properties of molecules and their interactions.
Mr. Zeroka

497. Surface Chemistry (3)

Applications of colloid chemistry; special topics in surface chemistry. Lectures and seminar. Prerequisite: Chem. 397 and Chem. 441.
Mr. Zettlemoyer

498. Advanced Physical Chemistry Seminar (3)

An advanced study of some field of physical chemistry. Rotation-vibration spectroscopy; theory of solutions; photochemistry and radiation chemistry; irreversible thermodynamics or other topics of current interest.
Physical Chemistry Staff

CIVIL ENGINEERING

Professors

DAVID ALAN VANHORN, PH.D., *Chairman*
LYNN SIMPSON BEEDE, PH.D., *Director, Fritz Lab*
GEORGE CLARENCE DRISCOLL, JR., PH.D.
WILLIAM JOSEPH ENEY, M.S., *Joseph T. Stuart Professor*
ALEXIS OSTAPENKO, PH.D.

Associate Professors

GEORGE ANSON DINSMORE, M.S.
JOHN WILLIAM FISHER, PH.D.
WALTER H. GRAF, PH.D.
TI HUANG, PH.D.
JOHN ORTH LIEBIG, JR., M.S.
LE-WU LU, PH.D.
LAMBERT TALL, PH.D.

Assistant Professors

JOHN RODGER ADAMS, PH.D.
ARTHUR WILLIAM BRUNE, PH.D.
WAI-FAH CHEN, PH.D.
JOHN HARTLEY DANIELS, M. S.
HSAI-YANG FANG, PH.D.
TERENCE JOHN HIRST, PH.D.
EDWARD K. LEVY, S.M.
ROGER GEORGE SLUTTER, M.S.
BUNG-TSENG YEN, PH.D.

Postdoctoral Research Associates

GORAN A. ALPSTEN, PH.D.
CELAL NIZAMETTIN KOSTEM, PH.D.

Instructors

JOSEPH A. CORRADO, M.S.
ROBERT PAUL KERFOOT, M.S.
STEPHEN CHIHCHI KO, B.S.
RONALD BENNETT MADISON, M.S.
CHING-KUO YU, M.S.

Teaching and Graduate Assistants

FELIX BARDA, CHARLES E. BREWER, GEORGE E. GLAHN, ANGEL LAPUS LAZARO III, EDWARD T. MANNING, JR., JOHN FORREST MUNN, CHARLES RAYMOND SCAWTHORN

Research Assistants

ZIYA AKTAS, JAMES OLIVER ARMACOST III, LAUREN DUNCAN CARPENTER, CHINGMIIN CHERN, SURESH KALYANJI DESAI, JAMES RICHARD DIMITRI, SHU-JIN FANG, KARL HEINZ FRANK, DONALD CHARLES FREDERICKSON, THOMAS EUGENE GALLAGHER, MAX W. GIGER, MANFRED A. HIRT, JOSEPH JUIN-SHYONG HUANG, SAMPATH N. S. IYENGAR, SUNG-WOO KIM, YOSHIO KISHIMA, PETER K. KRUGMANN, JAMES HONYIN LEE, LEE-CHONG LIM, CHENG-SHUNG LIN, DAVID EDWARD LUFT, SHOSUKE MORINO, DARYOUSH MOTARJEMI, COLIN O'CONNOR, MINORU OHTA, PAUL J. PATTERSON, JOHN WILMER PETERS, ULISE CAMILO RIVERA, ANOUSHIRAVAN ROKHSAR, DONALD ROY RUTLEDGE, SAKDA SANTATHADAPORN, WOLFGANG SCHUELLER, EUGENE LOWRY SHENINGER, LEO H. M. VAN ZUILEN, ANTON W. WEGMULLER, NORIAKI YOSHIDA

10. Problem Computation Laboratory (1)

Preparation of problems for computer programming with emphasis on problems in civil engineering; technique of programming for computers. First semester.

11. Engineering Graphics (2)

Use of drawing instruments; freehand lettering and shape description; theory of orthographic projection, revolution, and pictorial representation; theoretical problems in space relationships between points, lines, and planes; surfaces as loci. Emphasis on visualization and geometric logic. First and second semesters.

12. Applied Engineering Graphics (2)

Drawings for civil engineering projects; graphical solutions and representation of data. Prerequisite: C.E. 11. Second semester.

40. Principles of Surveying (3)

Study of theory of errors and measurements; applications to field procedures in the use of the tape, level, transit, selection of instruments, office procedures in computations; relation of errors to precision, accuracy, preparation of survey specifications. Astronomical observations, leveling, traversing, stadia and elements of photogrammetry. Prerequisite: C.E. 11. Second semester.

41. Engineering Surveys (3)

Applications of surveying to route location, topography, highways, construction, and boundaries. Daily recitation and field work for a three-week period. Prerequisite: C.E. 40. Summer session.

43. Advanced Surveying (3)

Adjustment of instruments; investigation of systematic and observational errors; elements of least squares with application to surveying; adjustment of level nets and triangulation; celestial observation; precise leveling; photogrammetry. Office work, with some field exercises. Prerequisite: C.E. 40. Second semester.

100. Industrial Employment (0)

During the summer following the junior year, students are required to spend at least eight weeks in approved office or shop work or on engineering construction. A written report on the shop work or project, outlining the experience obtained, is due on return from summer vacation.

102. Civil Engineering Proseminar (1)

A study of current civil engineering projects and developments with written reports. At weekly meetings these reports are presented orally in abstract. Prerequisite: Senior standing. First semester.

103. Special Problems (1-6)

Supervised individual research problems with report. Prerequisite: Consent of instructor. First and second semesters.

104. Readings in Civil Engineering (1-3)

Study of selected technical papers, with abstracts and reports. Prerequisite: Consent of instructor. First and second semesters.

106. Structural Design (3)

Elementary theory and design of structures in steel, wood, and concrete. An abridged course in stress analysis and design for students other than civil engineers. Prerequisite: Mech. 11. Second semester.

112. Advanced Mechanics of Materials (3)

Further topics in column and beam theory, including unsymmetrical bending, combined stresses, conjugate beam methods; curved beams, impact loading, buckling. Prerequisite: Mech. 11. First or second semester.

121. Mechanics of Fluids (3)

The behavior of real fluids and the more important physical laws; potential flow, boundary layer, lift, drag, and waves, with practical applications to flow through pipes, open channels, turbines, and pumps. Dimensional analysis and similitude. Prerequisite: Mech. 102 previously or concurrently. First and second semesters.

123. Fluid Mechanics Laboratory (1)

Introduction to laboratory techniques, calibration principles, and fluid measurements. Closed conduit flow of water, oil, and air; open channel flow of water, wind tunnel studies; hydraulic machinery testing. Prerequisite: C.E. 121 concurrently. First and second semesters.

126. Water Resources Engineering (3)

Water Resources Planning. The hydrologic cycle. Frequency, probability and duration analysis of precipitation and stream flow. Hydrographs and stream flow routing. Pressure conduit flow in pipe networks. Gradually-varied flow in open channels. Pump systems. Spillways and stilling basins. Coastal engineering. Prerequisite: C.E. 121. Second semester.

145. Transportation Engineering I (3)

Principles of the design, construction, and maintenance of transportation facilities with emphasis on highways and airports in the areas of geometric, drainage, and pavement design. Properties and performance of materials used. Field trips and design problems. Prerequisites: C.E. 41; C.E. 239. First semester.

146. Transportation Engineering II (3)

Principles of planning for major forms of transportation facilities. Development, operation, coordination, and regulation of highway, rail, air, water, and pipeline transportation. Traffic studies, location analysis, and economic consideration. Mass transportation of freight and passengers. Studies of large transportation terminals. Prerequisite: C.E. 145. Second semester.

150. Structural Analysis I (3)

Analysis of statically determinate frames and trusses; influence lines; deflections; statically indeterminate structures by method of deflections. Digital computer applications. Prerequisite: Mech. 11, C.E. 12. First semester.

151. Structural Theory (3)

Introductory course in the theory of structural steel design, including bolted, riveted and welded connections, pins, tension members, columns, and beams. Prerequisites: C.E. 150. First semester.

153. Reinforced Concrete Theory (3)

Analysis and design of reinforced concrete structural elements including beams, slabs and compression members by both the ultimate strength and working-stress methods. Analysis and design of footings and retaining walls. Introduction to prestressed concrete. Prerequisite: C.E. 154. First semester.

154. Structural Analysis II (3)

Elastic analysis of statically indeterminate beams, frames, and trusses by methods of energy, moment distribution, and slope deflection; influence lines; introduction to plastic analysis. Prerequisite: C.E. 150. Second semester.

155. Structural Design (3)

Design of structures utilizing various structural materials. Prerequisites: C.E. 151, 153. Second semester.

156. Plastic Design in Steel (3)

Application of theory of plastic analysis to structural design. The behavior of steel structures beyond the elastic limit and up to formation of a failure mechanism. Plastic analysis and design of beams, columns, connections and rigid frames. Prerequisite: C.E. 151, 154. First or second semester.

157. Concrete Laboratory (1)

Principles of the behavior of plain and reinforced concrete. Design and preparation of concrete mixtures, and tests of aggregates, control cylinders, and reinforced concrete beams. Prerequisite: C.E. 153 previously or concurrently. First semester.

162. Sanitary Engineering (3)

A systematic study of water and waste-water treatment employing the concept of unit-operations. Laboratory work includes field studies, examination of water and waste-water samples, batch and pilot plant experiments. Prerequisites: Chem. 3, C.E. 121. Second semester.

For Advanced Undergraduates and Graduates

201. Foundation Engineering (3)

Application of soil engineering to foundation design. Site investigations and engineering tests to evaluate subsoil conditions. Procedures for choosing and proportioning foundation elements to meet specific structural requirements. The design and construction of temporary and permanent retaining structures. Prerequisites: C.E. 239; C.E. 153 previously or concurrently; or consent of department chairman. First semester.

Mr. Fang

239. Soil Mechanics (3)

Fundamental physical and mechanical properties affecting soil action in engineering projects: identification; classification; hydromechanical, deformation, shear and compaction properties. Applications of theories and principles in engineering practice. Prerequisite: Mech. 11; or consent of department chairman. Second semester.

Messrs. Fang, Hirst

309. Analytical Methods in Structural Engineering (3)

Matrix, numerical, and approximate methods applicable to various problems in structural mechanics. Special

methods including iteration and finite differences. Introduction to theory of elasticity with application to engineering problems. Energy principles in structural analysis. Prerequisite: Math. 205 or equivalent. First semester.

Messrs. Ostapenko, Lu

312. Ground Water Hydrology (3)

Theory of ground water flow. Analysis of well production test data; ground water budgets; artificial recharge. Analog models. Prerequisite: Consent of Instructor.

Messrs. Brune, J. Adams

320. Hydraulic Engineering Structures (3)

Preparation and protection of foundations. Design of earth, gravity, arch, and buttressed dams. Wave forces. Design of seawalls, bulkheads and breakwaters. Prerequisites: C.E. 121 previously or concurrently; or consent of department chairman. First or second semester.

Mr. Brune

321. Hydraulic Machinery (3)

Theory of hydraulic turbines and centrifugal pumps. Operating characteristics and performance testing of pumps and turbines. Problems in pump and turbine systems. Prerequisite: C.E. 322 or consent of department chairman. Second semester.

Mr. Adams

322. Hydromechanics (3)

Fundamental equations of fluid flow. Stress on viscous flow with introductions to turbulence, boundary layers, and turbulent shear flow. Hydraulic applications. Prerequisites: Math. 205, C.E. 121. First or second semester.

Messrs. Graf, Adams

323. Hydromechanics Laboratory (1)

Study of instrumentation and equipment used in hydromechanics research. Individual design and direction of measurement programs. Prerequisite: C.E. 322 previously or concurrently.

Staff

351. Structural Design: Timber (3)

Analysis and design of timber columns, beams, tension members, trusses, connections, mechanical fasteners; study of allowable stresses, fire resistance, and preservation of timber structures; project and timber tests with reports. Prerequisite: A course in structural design and theory. Second semester.

Messrs. Liebig, Eney

352. Dynamics of Structures (3)

Analysis and design of structures subjected to time-dependent loads. Behavior of lumped-mass and distributed-mass systems. Exact and approximate analyses of linear and non-linear systems. Applications to earthquake design, blast-resistant structures, wind effects, bridge vibration. Prerequisite: Consent of Instructor.

Messrs. Van Horn, Yen, Huang

360. Sanitation (3)

Study of those environmental factors having an influence upon public health, including food and milk sanitation; garbage and refuse collection and disposal; insect and rodent control; lighting, heating, and ventilation; plumbing, industrial hygiene, school sanitation; and swimming pools, but excluding water works and sewerage. Prerequisite: C.E. 162 previously or concurrently. First semester.

395. Civil Engineering Planning (3)

Planning of civil engineering projects; selection of site; situation survey and data analysis; consideration of utilities; transportation; parking; architectural and structural features of structures; sub-surface exploration; air and water pollution control; landscaping; economic studies; estimates of costs; general plans and reports. Prerequisite: Consent of chairman of department. Second semester.

Messrs. Daniels, Eney

For Graduates

Graduate studies in Civil Engineering permit the student to build upon the broad background of undergraduate training in order to prepare for professional practice at an advanced level, for research and development, or for teaching. The selection of graduate courses and research opportunities offered in the department permits the development of study programs either encompassing a wide range of interests or pursuing a special area of civil engineering in depth. The Department offers advanced work in structural engineering, soil and foundation engineering, hydraulic engineering, water resources, and water pollution, leading to the M.S. and Ph.D. degrees. A master's degree can also be earned in sanitary engineering. Twenty-six Ph.D. and 46 M.S. candidates were enrolled in the Department in the 1967-68 academic year.

A master's degree program will normally consist of a number of courses in a major area plus at least one course in each of two minor areas. The major area and at least one of the minor areas must be taken in Civil Engineering.

Each candidate for a master's degree is expected to take at least one research course (C.E. 402, 404, 406, 407, 422, or 440), but a minimum of 24 hours of his program should consist of courses outside this group. Research Assistants and Fellows normally will prepare a thesis.

The following subjects, in addition to the C.E. courses listed below, may be considered a part of the major field in C.E.: Mech. 402, Advanced Analytical Mechanics; Mech. 404, Advanced Vibration Analysis; Mech. 409, 410, Theory of Elasticity; Mech. 412, Theory of Plasticity; Mech. 415, Structural Mechanics & Elastic Stability; Mech. 416, Theory of Plates & Shells; Mech. 421, Hydrodynamics; Mech. 422, Advanced Mechanics of Compressible Fluids; M.E. 342, Mechanical Vibration Analysis; M.E. 441, Stress Analysis in Design; M.E. 442, 443, Analytical Methods of Engineering. Subject to approval, courses from other departments may be included in the major.

The Ph.D. degree program will include (1) courses in the major field, and possibly in minor fields, (2) a reading knowledge of one foreign language, and (3) a dissertation.

Holders of master's degrees planning to become candidates for a Ph.D. must take a qualifying examination at the first opportunity following one semester in residence. The qualifying examination is given once each year between the fall and spring semesters. After qualification, the program of work is formulated by the candidate, his special committee, and the department chairman. The program will include courses in the major field and possibly in minor fields, one foreign language, and a dissertation.

The laboratories of the Department are located in the

Fritz Engineering Laboratory of Civil Engineering. Established in 1909 by the generosity of the late John Fritz and improved through additions to apparatus and equipment, the laboratory offers complete facilities for research and instruction in steel structures, hydraulics, soil mechanics, concrete structures, structural model analysis, and sanitary engineering.

Structural testing equipment includes dynamic testing machines and a 5,000,000 pound universal hydraulic testing machine, and other special loading apparatus. Hydraulic testing equipment includes a dredge pump test facility, the largest in this country, plus installations for testing models of spillways, open channels and beach facilities.

400. Experimental Methods of Structural Research (3)
Mechanical properties of structural materials and different procedures of evaluating these properties; experimental methods of stress analysis; statistical analysis of experimental data. Second semester. **Mr. Yen**

401. Experimental Methods of Structural Analysis (3)
Analysis of structures using various experimental techniques; use of mechanical devices in investigation of special problems, such as temperature deformations, foundation displacements, and integral action of structures; moire fringe method; theory of similitude and its application to model design; principles of structural analogies. First or second semester. **Messrs. Eney, Lu**

402. Structural Model Analysis (2-5)
Individual structural research problems, with report. Prerequisite: C.E. 401. First and second semester. **Messrs. Eney, Lu**

404. Structural Research (2-5)
Individual research problems with reports. First and second semester. May be repeated for credit. **Staff**

405. Advanced Design of Steel Structures (3)
Analysis and design of welded structures and their components; residual stresses; brittle fracture; fatigue strength. Structural fasteners. Study of current research and related design practices. First semester of alternate years. (Offered Fall 1967). **Mr. Tall**

406. Special Problems in Civil Engineering (3)
An intensive study, with report, of some special field of civil engineering. May be repeated for credit. First and second semesters. **Staff**

407. Thesis (1-6) Staff

410. Pretressed Concrete (3)
Analysis and design of prestressed concrete structures. Elastic and plastic properties of concrete. First semester. **Messrs. Van Horn, Haung**

411. Selected Topics in Concrete Structures (3)
Analysis and design of prestressed, folded plate, and thin shell structures. Principles and applications of ultimate strength, limit design, and yield line theories. Second semester. **Messrs. Van Horn, Haung**

420. Open Channel Flow (3)

Gradually varied flow in natural and artificial channels. Transitions for subcritical and supercritical flow. Flood routing or sediment transportation. Prerequisite: C.E. 322 or consent of department chairman. Second semester, alternate years.

Messrs. Graf, Adams

421. Hydraulic Laboratory Practice (1-5)

Study of theory and method of hydraulic experimentation, simultaneously with laboratory work. Prerequisite: C.E. 322 or consent of department chairman. First or second semester.

Mr. Brunc

422. Hydraulic Research (2-5)

Individual research problems with reports. First and second semesters. **Staff**

423. Advanced Hydromechanics (3)

Solution of potential flow problems by conformal mapping, singularities, relaxation, and graphical methods. Emphasis on application to problems in hydraulic machines, free surface flow, porous media, and water waves. Prerequisite: C.E. 322 or consent of department chairman. Second semester, alternate years. **Messrs. Graf, Adams**

440. Soils Research (2-5)

Individual research problems relating to soil engineering, with report. Prerequisite: A course in soil mechanics. First or second semester. **Staff**

443. Advanced Soil Engineering I (3)

The origin, composition, and physico-chemical properties of soils and their influence on the engineering properties and behavior of soils; transmission of water in saturated and unsaturated soils; theory of compaction; frost action; application of hydro-mechanics to soil engineering problems. Prerequisite: C.E. 239 or equivalent. First semester.

Messrs. Fang, Hirst

444. Advanced Soil Engineering II (3)

Fundamental and advanced theories of soil mechanics applicable to earth structures and foundation design; stresses in wedges and in layered systems for ideal elastic, plastic and viscoelastic soils, theory of consolidation, vibrations and other dynamic forces. Prerequisite: C.E. 443. Second semester.

Messrs. Fang, Hirst

445. Advanced Foundation Engineering (3)

Current theory and practice relating to the design of foundations for buildings and other rigid structures. Stress distribution due to loads on shallow and deep foundations; soil compression and rupture theories; analysis and limitations of settlement; structural design of foundations; construction problems; and site investigations. Prerequisite: Consent of instructor. First semester.

Mr. Fang

446. Earth Structure (3)

Current theory and practice relating to the design of large embankments, earth dams, and backfills. Slope analysis theories; theory of pavement design; loads on conduits and structures in embankments; evaluation of base courses; soil compaction; selection of material; and constructions. Prerequisite: Consent of instructor. Second semester.

Mr. Fang

CLASSICAL LANGUAGES

450. Advanced Structural Theory I (3)

Deflections due to various causes. General force and deformation methods of analysis of statically indeterminate structures using matrix algebra. Specialized methods: column analogy, moment distribution, etc. Prerequisite: C.E. 154 or equivalent. First semester.

Messrs. Fisher, Ostapenko

451. Advanced Structural Theory II (3)

Selected topics in structural theory: influence lines, multi-story building frames, space structures, suspension bridges (elastic and deformation methods), arches, relaxation, etc. Prerequisite: C.E. 450. Second semester.

Messrs. Fisher, Ostapenko

453. Structural Members and Frames (3)

General torsion of thin-walled open, closed, and combined open and closed cross-sections; general instability of thin-walled members; inelastic instability; special problems in stability. Desirable preparation: C.E. 309 and Mech. 415. Second semester.

Mr. Ostapenko

454. Plate and Shell Structures (3)

Analysis and design of plates loaded transversely and in their plane. Shear lag; influence surfaces. Buckling and post-buckling behavior of elastic and inelastic plates. Membrane and bending analysis of cylindrical, rotational and hyperbolic-paraboloidal shells. Exact and approximate engineering methods. Design considerations. Prerequisite: Consent of Instructor.

Mr. Ostapenko

456. Graduate Seminar (1-3)

Study of current topics in the field of civil engineering. First or second semester.

Staff

458. Plastic Analysis and Design (3)

Theory of plasticity and its applications to structural design. The behavior of steel structures beyond the elastic limit and up to collapse. Study of component parts of frames; methods of predicting strength and deformation in the plastic range. Studies of industrial type frames. Current research. Comparison of conventional design methods with plastic design techniques. First semester.

Messrs. Lu, Chen

459. Advanced Topics in Plastic Theory (3)

Advanced problems in plastic analysis and design: minimum weight design, composite design, deflections, shake-down, and arch analysis. Fundamentals of the mathematical theory of plasticity; the general theorems of limit analysis and their applications to beams under combined loading, space frames, plates and shells. Current developments. Prerequisite: C.E. 458. Second semester of alternate years (Offered Spring 1968).

Mr. Lu

460. Water Supply and Sewage (3)

Theory and design of facilities for the supply and distribution of water and for collection of waste water. First semester of alternate years.

461. Treatment of Water and Waste Water (3)

Theory and design of treatment facilities for water, sewage, and industrial waste; advanced topics of current practices, with reports. Second semester of alternate years.

Professors

JOSEPH ABELE MAURER, PH.D., *Chairman*
DOUGLAS DAVID FEAVER, PH.D.

Assistant Professor

EDNA SOPHIA DEANGELI, PH.D.

Instructor

JOHN VINCENT CODY, M.A.

Greek

1. Elementary Greek (3)

For all students who desire to obtain a knowledge of the fundamentals of the Greek language. Early in the semester there will be reading in stories and legends in easy Greek. First semester.

2. Elementary Greek (3)

Continued work in Greek vocabulary, forms, and syntax. Selected readings in Greek prose. Prerequisite: Gk. 1. Second semester.

3. Intermediate Greek (3)

Xenophon: *Anabasis*, and other works. Grammar review. Prerequisites: Gk. 1. and 2, or one year of entrance Greek. First semester.

4. Intermediate Greek (3)

Plato: *Euthyphro*, *Apology*, and *Crito*, or other dialogues. Prerequisite: Gk. 3. Second semester.

11. Greek Drama (3)

Representative plays of Sophocles, Euripides, and Aristophanes. Literary study of the drama. Prerequisite: Gk. 4. First semester.

12. Greek Drama (3)

Continuation of Gk. 11. Prerequisite: Gk. 4. Second semester.

13. Greek Historians (3)

Selections from Herodotus, Thucydides, or Xenophon. A study of Greek historiography. Prerequisite: Gk. 4. First semester.

16. Greek Epic (3)

Selections from the *Iliad*. A study of the epic as genre. Prerequisite: Gk. 4. Second semester.

21. Ancient History (3)

The development of civilization from palaeolithic times to the world empire of Alexander the Great. The social, economic, religious, philosophic, artistic, and literary development of the ancient world; the origin of political institutions. First semester.

50. Greek Literature in English Translation (3)

The development of the major departments of Greek literature; required readings in English translations, with special attention to the epic, drama, and lyric poetry. No knowledge of the Greek language is required. First or second semester.

For Advanced Undergraduates and Graduates

202. Greek Archaeology (3)

Aims and methods. A chronological presentation of prehistoric civilizations including the neolithic, Minoan, Helladic, and Mycenaean periods. A study of extant ancient monuments, buildings, and city plans of important sites of the classical and Hellenistic periods. Lectures, collateral readings, and reports. First semester. Mr. Feaver

311. Homer (3)

Rapid reading of considerable portions of the *Iliad* or the *Odyssey*. Homeric language, syntax, and metre. Prerequisites: Gk. 4 and consent of chairman of department. First semester.

316. Plato (3)

The Republic, and other dialogues. Lectures on classical philosophy. Prerequisites: Gk. 4 and consent of chairman of department. Second semester.

Latin

22. Ancient History (3)

Continuation of Gk. 21. The Hellenistic Age. Rome from its origin to 395 A.D. Second semester.

51. Latin Literature in English Translation (3)

A study of Latin literature by means of the best English translations. The lives of the most important authors are studied and their works read according to the major departments of literature — history, comedy, epic, lyric, etc. Emphasis is placed on the chronological development of the literature and historical background necessary to the interpretation of the author's works. Lectures and readings with special reports. No knowledge of the Latin language is required. First or second semester.

61. Elementary Latin (3)

For all students who desire to obtain a knowledge of the fundamentals of the Latin language. Special emphasis on English derivations and the principles of grammar. First semester.

62. Caesar (3)

Selections from Caesar: *The Gallic War*. Prose composition and syntax. Prerequisite: Lat. 61 or 2 entrance units. Second semester.

63. Nepos and Cicero (3)

Nepos: *de Viris illustribus*; Cicero's orations and either *de Senectute* or *de Amicitia*. Prerequisite: Lat. 62 or 3 entrance units. First semester.

65. Vergil (3)

Vergil: *Aeneid*, selections from the entire work; study of the aesthetic, political, and philosophical values of Vergil's poetry. Prerequisite: Lat. 63 or at least 3 entrance units. Second semester.

166. Horace (3)

Selected Odes. Lectures on the history and development of lyric poetry; constant practice in reading the more important metres; memorization of stanzas and passages. Prerequisite: Lat 65 or at least 4 entrance units. First semester.

167. Roman Prose Writers (3)

Selections from Cicero, Tacitus, and Seneca. Prerequisite: Lat. 65 or at least 4 entrance units. Second semester.

168. Latin Drama (3)

Readings of selected plays of Plautus, Terence, and Seneca. Prerequisite: Lat. 65 or at least 4 entrance units. First semester.

169. Satire (3)

Selected satires of Horace and Juvenal. Lectures on the history of Roman satire and its influence on modern literature; study of social conditions under the empire. Prerequisite: Lat. 65 or at least 4 entrance units. Second semester.

For Advanced Undergraduates and Graduates

203. Archaeology of Italy (3)

Neolithic, Terramara, Villanovan, and Etruscan cultures. Rome the city: its buildings, monuments, and streets, its destruction and rediscovery through excavation; origin and growth of the city; the three periods, empire, republic, and kingdom; methods of identifying and dating monuments. A survey of Pompeii, Herculaneum, and Ostia. Lectures, readings, and reports. First or second semester, Mr. Feaver

211. Readings (3)

Intensive reading in one author or in a selected genre. Prerequisites: Six hours of courses at the "100" level and consent of chairman of department. First semester.

Mr. Maurer

212. Readings (3)

Intensive reading in one author or in a selected genre. Prerequisites: Six hours of courses at the "100" level and consent of chairman of department. Second semester.

Mr. Maurer

301. The Roman Republic (3)

The final century of the Roman Republic (133-44 B.C.) studied through a close examination of the original sources in translation. The course gives a broad comprehension of the historical background to the Latin authors of the Roman Republic normally read in secondary school. First semester.

302. The Roman Empire (3)

A continuation of Latin 301. The principate of Augustus and the first century of the Roman Empire (44 B.C.-70 A.D.). The course gives a broad comprehension of the historical background to the Latin authors of the Augustan and Silver Age normally read in secondary school. Second semester.

303. The Roman Epic (3)

The epic in Latin literature with lectures on the Greek models; early Latin translations of Greek epics; later minor writers of epic. Passages from Lucretius, Vergil, and Ovid; a study of the *Aeneid* in its entirety. Prerequisites: Six hours of courses at the "100" level and consent of chairman of department. First or second semester.

ECONOMICS

304. Latin Historical Grammar (3)

The development of Latin syntax with survey of early Latin. Syntactical analysis of Caesar, Cicero, and Vergil. The development of classical prosody and metrics with emphasis on changes in the hexameter from Catullus and Lucretius to Vergil. The course is designed primarily for teachers of Latin in secondary schools and for majors in Classical Languages planning to teach. Prerequisites: Six hours of courses at the "100" level and consent of chairman of department. First or second semester.

Professors

FINN BJORN JENSEN, PH.D., *Chairman*

NICHOLAS W. BALABKINS, PH.D.

ELMER CLARK BRATT, PH.D.

GERALD GARB, PH.D.

ELI SCHWARTZ, PH.D.

L. REED TRIPP, PH.D., *Magee Professor*

Associate Professors

ALVIN COHEN, PH.D.

JAMES B. HOBBS, D.B.A.

WARREN AIKEN PILLSBURY, PH.D.

EDWARD ROSENBAUM, PH.D.

JOHN E. WALKER, PH.D.

Assistant Professors

JAY RICHARD ARONSON, PH.D.

FRANK A. DUNN, M.A.

RICHARD ALLYN GONCE, M.B.A.

CHING SHENG SHEN, PH.D.

ANDREW R. WEINTRAUB, PH.D.

Adjunct Professor

S. HERBERT UNTERBERGER, PH.D.

Instructors

ROBERT V. CORKHILL

JACOB DE ROOY, A.M.

ANDREW C. GROSS, M.B.A.

JON TERENCE INNES, B.S.

JOHN DANIEL KEEFE, M.A.

JOHN T. PETRAKIS, M.A.

FRANCIS X. SPLANE, M.A.

Teaching Assistants

RICHARD SAMUEL COWAN, JR., DAVID JOHN DEANGELO, WILLIAM LORNE MCINTOSH, KENT RONALD NILSSON, DAVID D. ROPER, THOMAS MARIA SEBASTIAN

Research Assistants

CHARLES E. GRIFFITHS, EDWARD R. KLEIN, MICHAEL F. MOHR

3. Economics (3)

A general course in the principles of economics, covering the organization of production, problems of concentration and efficiency, principles of value and price, income distribution and labor problems. First and second semester.

4. Economics (3)

A continuation of Eco. 3 in which the work deals with the basic institutions of economic life, money and banking, the general price level, national income, income determination, business cycles, monetary policy, and public finance. Prerequisite: Eco. 3. First and second semester.

11. Introduction to Political-Economic Thought (3)

An evaluative study of key problems in political economy and in the organization of economic power and function. Involved are thoughtful and parallel reading of contemporary and classical writers and effective essays and research papers. First semester.

12. Introduction to Political-Economic Thought (3)

Continuation of Eco. 11. Second semester.

45. Statistical Method (3)

An introduction to quantitative method: descriptive statistics, elementary probability and sampling, estimation and testing of population parameters, simple correlation and regression. Prerequisite: A course in college-level mathematics.

129. Money and Banking (3)

A general course dealing with the nature and functions of money and commercial banking, monetary and banking development in the United States, the value of money, foreign exchange, and monetary, credit and fiscal policies. Prerequisite: Fin. 129. Second semester. Mr. Petrakis

130. Money and Banking (3)

A course dealing with specific monetary and banking problems with suggested actions to resolve these problems. Prerequisite: Eco. 129. Second semester. Mr. Petrakis

For Advanced Undergraduates and Graduates

*All of the following courses in economics
have as a prerequisite a one-year
course in the principles of economics*

206. Intermediate Micro-Economic Theory (3)

Determination of prices in terms of the equilibrium of the business enterprise and consumer choices in markets of varying degrees of competition; determination of wages, rent, interest, and profits. First and second semesters.

Messrs. Cohen, Pillsbury, Walker, Weintraub

303. Economic Development (3)

The principal determinants of economic development; economic development in advanced and underdeveloped countries. First or second semester. Mr. Cohen

305. The Economic Development of Latin America (3)

Forces at work in the changing economics in Latin America; in addition to the economic variables, social and political factors are considered and related to technological change and the development process. Second semester.

Mr. Cohen

307. History of Economic Thought (3)

Traces development of economic doctrines. Discusses views of mercantilists, classical economists, socialists, and

neo-classical economists on value, distribution, money, and national economic policy. Relates economies to social issues of a period. Mr. Goncze

308. History of Economic Thought (3)
Continuation of Eco. 307. Mr. Goncze

309. Comparative Economic Systems (3)
A comprehensive examination of the philosophical, economic, and political tenets of American Capitalism, Soviet Socialism, and Nazi Fascism. Analysis of economic planning under various socio-economic systems; study of comparable economic growth of the U.S. and the Soviet Union. First semester. Mr. Balabkins

310. Economic Evolution (3)
A study of the causes and effects of changes in the economic organization of Western society. Oriented by the examination of special problems. Second semester.

311. Economics Resource Use (3)
Problems of the economic use and development of human and natural resources, with particular reference to the future and to relationships within and between regions. Prerequisite: Eco. 306 or consent of chairman of department. First semester. Staff

316. Intermediate Macro-economic Theory (3)
Introduction to the theory of income, employment, and growth. Provides tools of analysis necessary for dealing with aggregate economic problems. Second semester.

332. Monetary-Fiscal Policy (3)
A course devoted to the study of monetary, credit, and fiscal policies of governments and central banks with particular reference to the policies of the United States Treasury and the Federal Reserve System. Current problems will receive special emphasis. Prerequisite: A course in money and banking. First semester.

Messrs. Aronson, Jensen, Schwartz

335. Manpower Economics (3)
The structure of the labor force; the theory of wages and employment; the economics of legal and social aspects of the labor market. First and second semester.

Mr. Weintraub

336. Business and Government (3)
A general survey of the economic aspects of the relation of government and business in the United States, with considerable emphasis on problems of public utility rate making, finance, public ownership and operation, and related issues. Second semester.

Mr. Pillsbury

337. Transportation and Spatial Economics (3)
The principles of transportation in theory and practice are integrated with traditional and spatial economics. Transport models and location theories are reviewed for varying conditions of spatial separation of economic activity. Transportation policies are analyzed and evaluated in terms of their efficiency in the allocation of resources for the firm and the economy at the local, regional and national levels. Prerequisite: Economics 306 or consent of the Instructor. First semester.

Mr. Pillsbury

338. Labor Market Institutions (3)

The development of the social and legal status of trade unions; the process of collective bargaining; the evolution of modern social welfare programs. First and second semester.

Messrs. Gross, Rosenbaum

339. International Economics (3)

The theory of international trade; the theory of tariffs; United States Commercial policies; the impact of growth and development on the world economy. First semester.

Mr. Jensen

340. International Economics (3)

The balance of payments and the theory of disturbances and adjustment in the international economy; international monetary policies. Second semester.

Mr. Jensen

343. European Economic Integration (3)

Analysis of the problems of economic integration with special emphasis on the development of economic cooperation and integration in Western Europe. The methods and the problems of economic planning in the Common Market. United States trade and investments and European economic integration. First or second semester.

Mr. Jensen

346. Business Cycles and Forecasting (3)

A study of economic conditions, involving short-term fluctuations, growth, forecasting and stabilization proposals. Prerequisite: A course in statistics. First and second semesters.

Mr. Bratt and Staff

347. National Income Analysis (3)

Analysis of income and product aggregates for the point of view of development and structural breakdown, emphasizing sector accounts, savings and investments; and integrated with broad macroeconomic theory. Prerequisite: Eco. 346. First semester.

Messrs. Bratt, Shen

348. Advanced Business Cycles (3)

Recent business cycle theories; the evolution of the theories and the problems of economic change which the theories attempt to explain. Prerequisite: Eco. 346. Second semester.

Mr. Bratt

352. Advanced Statistical Method (3)

A further course in quantitative method: sampling design, probability distributions including the analysis of variance, and multiple correlation and their application to common situations. Prerequisite: Eco. 45 or equivalent. First semester.

Mr. Shen

353. Public Finance: Federal (3)

A course dealing with government expenditures and revenues, the economics of taxation, and government administration. First semester.

Messrs. Aronson, Jensen, Schwartz

354. Public Finance: State and Local (3)

The major issues regarding revenues, expenditures, deficit and budgeting policy will be examined in the light of fiscal principles and economic effects. Particular attention will be given to current practices in Pennsylvania and contiguous states. Prerequisite: Fin. 351. Second semester.

Mr. Aronson

371. Readings in Economics (3)

Readings in various fields of economics, designed for the student who has a special interest in some field of economics not covered by the regularly rostered courses. Prerequisite: Preparation in economics acceptable to the department chairman. First semester.

Staff

372. Readings in Economics (3)

Continuation of Eco. 371. Second semester.

Staff

For Graduates**404. Developmental Theory and Problems (3)**

The evolution of growth doctrines and the analysis of such developmental problems as: structural versus monetary reform, ideological controversy of the appropriate economic system, balanced investment programs as opposed to unbalanced plans, the nature and changes in the aggregate production function, and dependence upon domestic as opposed to foreign source of savings. Prerequisite: Eco. 303. Second semester.

Mr. Cohen

425. Public Finance (3)

Major issues in taxation of income consumption, and capital; principles of government debt management; budgeting and fiscal planning for economic stability and growth.

Mr. Schwartz

431. Managerial Economics (3)

Problems of business enterprise: price and output determination analysis of cost and demand functions in markets of various types and under various conditions of general business. Emphasis will be on the application of economic theory to business practice. Prerequisite: Economics 206 or consent of the instructor. First and second semesters.

Messrs. Hobbs, Walker

432. Micro-Economics (3)

A survey of methods of decision making at the micro-economic level utilizing concepts developed in price theory and econometrics. Prerequisite: Eco. 206 or equivalent.

Messrs. Garb, Pillsbury, Walker, Weintraub

435. Micro-Economic Analysis (3)

Topics in resource allocation and price determination. Theories of choice of consumers, firms, and resource owners under monopoly, monopsony, competition, and alternative market forms. Prerequisites: Eco. 432 or equivalent and consent of instructor.

Mr. Garb

436. Macro-Economics (3)

Theory of employment, income, and growth. Role of money in theory of output. Policies for economic stability and growth. Prerequisite: Consent of the instructor.

Messrs. Innes, Shen

437. Labor Economics (3)

The economic environment of labor and industrial relations with some emphasis on current research involving theoretical and empirical analyses of labor markets. Prerequisite: Eco. 335 or Eco. 338 or equivalent. First semester.

Mr. Unterberger

438. Labor-Management Administration (3)

A study of the administration of the relationship between management and the labor force both where that relationship is governed by a formal agreement and where it is not. The concepts underlying the substantive provisions of labor agreements are analyzed. The problem of agreement making and the methods for peace keeping are subjected to critical appraisal. Prerequisite: Eco. 335 or 338 or equivalent. Second semester.

Mr. Unterberger

440. Regional Science-Metropolitan Analysis (3)

A study of the methodology of regional science with emphasis on metropolitan area analysis. A survey of the applications of this methodology to the economic problems of regions and metropolitan areas. Second semester.

Mr. Pillsbury

441. Foreign Trade Management (3)

Current problems of foreign operations: including channels of export in foreign markets, management of exports at home and abroad, export and import financing, foreign investments, policies of government and international agencies as they affect foreign operations. Second semester.

Mr. Jensen

444. Banking and Monetary Policy (3)

Description and analysis of the U. S. monetary and banking structure. The supply and demand for funds. Financial markets. Central bank controls; monetary theory and policy. Prerequisite: A course in Money and Banking. First and second semesters.

Messrs. Aronson, Jensen, Schwartz

447. Systems of National Accounts (3)

A study of American National Accounts, relating the theoretical analysis to actual and potential measurements; also relation to National Accounts of other countries. Coverage includes national income, input-output, flow of funds, national balance sheet and other systems of aggregation. First semester.

453. Time Series Econometrics (3)

Statistical measurement of economic change and its economic significance. Second semester.

Mr. Shen

454. Forecasting (3)

A study of the methods of business forecasting and its relation to planning with emphasis on the prediction of growth and short-term movements. Prerequisite: Eco. 346 or equivalent. Second semester.

Mr. Bratt

455. Econometric Methods (3)

The development of economic models. The statistical estimation of economic parameters, and the testing of hypotheses suggested by economic theory. The development of production, cost, demand, and consumption functions; aggregate cyclical and growth models. Prerequisites: Background in statistics and calculus. Second semester.

Mr. Shen

EDUCATION

456. Mathematical Economics (3)

Designed to provide an understanding of the way in which various mathematical techniques are applied in the formulation and development of economic concepts and theories. The course may draw on theories of the consumer and of the firm, the analysis of economic fluctuations and growth, general equilibrium theory, and other areas of economics where mathematical techniques have been found to be useful. Prerequisite: Math. 205; or the consent of the instructor. Second semester.

Mr. Garb

461. Methodology in Theory and Research

Foundations of theory construction and empirical research in economics and related subject matter. Theory, hypothesis formation and empirical study in the business firm, organizations, industrial relations, and micro-macro research.

Mr. Garb

471. Special Topics (3)

An extended study of an approved topic in the field of economics.

Staff

472. Special Topics (3)

Selected topics not covered in scheduled courses in the Department. May be repeated for credit with the consent of the Chairman of the Department. Second semester. Staff

475. Business Economics Seminar (3)

Independent research for M.S. in Business Economics candidates. Second semester.

Mr. Bratt

490. Thesis in Economics (6)

Subjects for these may be selected by consultation with major adviser and approval of chairman of department and M.A. committee. First and second semester.

Staff

Professors

JOHN A. STOOPS, ED.D., *Dean*
NATT BRYANT BURBANK, M.A.
JOHN S. CARTWRIGHT, M.A.
ANDREW J. EDMISTON, PH.D.
MERLE W. TATE, ED.D.

Associate Professors

LLOYD WILLIAM ASHBY, ED.D.
CLIFFORD A. BURKET, ED.D.
ALFRED JOSEPH CASTALDI, ED.D.
JOHN ANTHONY MIERZWA, ED.D.
ESTOY REDDIN, ED.D.
NORMAN HAROLD SAM, ED.D.

Assistant Professors

CHARLES W. GUDITUS, ED.D.
ETHEL MAY MCCORMICK, M.ED.
PAUL VAN REED MILLER, PH.D.
WILLIAM BUTLER STAFFORD, ED.D.
BLOSSOM WEISS TEPPER, ED.D.
CHARLES JOSEPH VERSACCI, ED.D.
ELVIN GALEN WARFEL, ED.D.

Adjunct Professors

NANCY LARRICK, ED.D.
RICHARD C. RICHARDSON, PH.D.

Instructors

RAYMOND BELL, M.ED.
THOMAS FLECK, JR., M.ED.
DARLENE MARILYN JOHNSON, M.ED.
JUDITH KEMMERER, M.ED.
HARRY MARTIN OVERLINE, M.ED.
DAVID ALEXANDER PROVEN, M.A.
ALICE DUFFY RINEHART, M.A.

Lecturers

JOSEPH S. BUTTERWECK, PH.D.
HENRY DAUM, ED.D.
GEORGE DOURIS, M.F.A.
ROY H. DUNGAN, ED.D.
MARGARET C. GRANDOVIC, M.ED.
JOHN WYCLIFFE KHOURI, ED.D.
ROBERT LEWIS LEIGHT, ED.D.
JAMES E. NANCARROW, D.ED.
WILLIAM WALLACE OSWALT, ED.D.
HENRY WILLIAM RAY, ED.D.
STEPHEN ALAN SCHAFER, M.H.L.
MARGARET MELCHIOR SEYLAR, M.A.

Teaching Assistants

M. PATRICIA BARE, MARY LOUISE MACINNIS, TED FRANKLIN RABOLD

Graduate Assistants

PAUL A. DELIO, FREDERICK GILMARTIN, CHARLES R. HOLLENBACH, SIDNEY H. SEGAL, M. LOUISE STABLER, DONALD B. VEIX, EDMOND ARTHUR WATTERS III.

For Advanced Undergraduates and Graduates

(For further information see the
School of Education, page 86.)

391-392. Workshop (3, 5, or 6)

Cooperative study of current educational problems. Designed to provide elementary and secondary school teachers an opportunity to work at their own teaching levels and in their own fields. Students will be limited to six credits during a summer session but may register for more than one workshop provided there is no duplication in subject matter. First or second semester.

Messrs. Sam, Stoops and Staff

393. Instructional Media (3)

Study of principles underlying the use of graphic and sound projection in teaching. Utilization of commercial, student, and teacher made materials. Applications of new instructional media such as television, teaching machines, and computer assisted instruction to classroom teaching. First semester.

For Graduates**400. Psychological Foundations of Education (3)**

Study and practice of methods involved in making a psychological analysis of pupils or classroom situations particularly in relation to school problems. First semester.

Mrs. Tepper, Mr. Stafford

401. Sociological Foundation of Education (3)

An analysis of the school as a social institution. This includes a consideration of man's cultural heritage and the function of education in preserving and improving it; group behavior relating to school problems; the integration of education with the life and institutions of the community and society; the social role of the teacher; social change and the school. First or second semester.

Mr. Mierzwa, Mrs. Rinehart

402. Anthropological Foundations of Education (3)

Emerging uses of anthropological analysis in the study of the educative process in our own society and in other societies. Particular emphasis is placed upon relevance of a particular cultural or sub-cultural value pattern to the structure of educational institutions. First semester.

403. Teaching in the Two Year College (3)

Major theories of teaching, learning, and measurement are studied with particular reference to the problems of instruction in the two year college. The characteristics of students in two year colleges are examined. Participants undertake research in the field. First or second semester.

Mr. Guditus

406. Historical Foundations of Education (3)

The developments of primary, secondary, and higher education; the aims, curricula, methods, and systems of education from early times to the present, in relation to the social conditions and processes. First semester.

Mr. Burkett

407. Philosophical Foundations of Education (3)

Comparative philosophical analysis of the aims of education in the social order; the nature, needs, and adjustments of modern industrial society; the conflicting demands upon education by a changing civilization as represented by modern social points of views; the implications of contemporary education philosophy for social progress. First and second semester.

Mr. Stoops

408. Comparative Education (3)

A survey of educational practices abroad including all programs from nursery to graduate education. Major emphasis is placed upon systems of articulation, social foundations, legal foundations, and structure in government. The nature and purposes of the schools are considered with particular reference to cultural patterns. Focus is also placed upon major problems and trends. Second semester.

Mr. Warfel

409. The Two-Year College (3)

Historical and philosophical analysis of the two-year college as an institutional mode in American higher education. The unique nature of the two-year college is considered in relation to its service functions and the values in American higher education. Participants undertake research in the field. First or second semester.

Mr. Guditus

410. Structure and Syntax of the Academic Disciplines (3)

Professors from other departments of the University are presented in discussions coordinated by the School of Education. The patterns which organize and identify the academic disciplines are emphasized. Study is given the nature and significance of the conceptual structures which guide inquiry or research in certain major fields of scholarship. Implications for planning of curricula and preparations of teaching materials are considered.

Mr. Stoops and Staff

411. Personality and Adjustment (3)

The theory of individual and social adjustments and the individual and cultural factors in learning of motives and adjustments with particular reference to the educative processes and the work of educational institutions. Relationships to the typical varieties of adjustive behavior and determinants of personality are shown. Mental life, conduct, personal, and social adjustment are analysed with regard to changing conceptions of self and the interplay of emotion and intellect. Fall semester; alternate years. Prerequisite: Permission of instructor.

Messrs. Edmiston, Miller

412. Individual Assessment and Interviewing (3)

A study of the appraisal process and the data used to understand and predict educational, vocational, and social behavior. Surveys of advanced methods and instruments in appraisal including comparison of diagnostic approaches, interpretation of research, preparation of written reports, and application in practice are included. Spring semester; alternate years. Prerequisite: Permission of instructor.

Mrs. Grandovic, Messrs. Mierzwa, Millon

413. Theories of Psychological Counseling (3)

A historical analysis and synthesis of concepts drawn from Jung, Rank, Freud, Adler, and neo-analysts with particular reference to the educative process and the work of educational institutions. The research and current trends in counseling on educational, social, and vocational problems are studied. Precepts and practices in mental health screening are examined. Fall semester; alternate years. Prerequisite: Permission of instructor. Messrs. Millon, Edmiston

414. Child Development (3)

A study of physical, intellectual, emotional, and social aspects of child development as they relate to the elementary schools. Second semester. Mr. Castaldi

416. Classroom Didactics (3-6)

Initial preparation of interns for classroom teaching. Secondary interns are trained in special methods of subject fields and the reading problems of secondary students. Elementary interns study the place of subjects in the elementary school. Open to interns only. Second semester. Messrs. Burbank and Castaldi

422. Education of Exceptional Children (3)

Methods of instruction and provision of materials for children who differ markedly from the normal, i.e., gifted, subnormal and maladjusted; the problems of the teacher in a system that makes little provision for the exceptional child. Actual case studies of pupils are required. First or second semester. Mrs. Grandovic

423. Diagnostic and Remedial Teaching (3)

The role of the classroom teacher as a diagnostician of corrective learning difficulties. Emphasis is placed on the nature and methods of educational diagnosis and the specifics of diagnostic teaching important to daily classroom instruction at all levels. Opportunities are offered for experiences in diagnosis and program prescription. First and second semester. Mr. Oswalt

424. Linguistics in Education (3)

Emphasis on the nature of language, phonetic applications, and the relationships of linguistics to instruction in the language arts. Second semester. Miss Reddin

425. The Diagnosis and Adjustment of Reading Difficulties (3)

A survey of problems in diagnosing and adjusting reading difficulties. The psychology of reading as related to learning difficulties; the measurement and diagnosis of reading difficulties; the development of informal tests for identifying reading difficulties; materials for corrective and/or remedial instruction. Second semester. Messrs. Versacci, Overline

426. Independent Study and Research (3-9)

Individual or small group study in the field of specialization. Approved and supervised by the major advisor. Not more than three (3) credits may be earned in a semester. First and second semester. Mr. Tate and Staff

427. Observation of Teaching (3)

Study, directed observation of, and initial practice in the various phases of teaching in a campus laboratory-demon-

stration school or in elementary and secondary schools in the area. First or second semester.

Messrs. Burbank, Guditus, Warfel

428. Intern Teaching (6)

Intensive practice in the application of the principles of teaching. Each intern is appointed to a full-time teaching position for one semester. Supervision is provided both by the employing school district or community college and by the University. Prerequisite: Ed. 427. First and second semester.

Messrs. Burbank, Guditus, Warfel

429. Intern Teaching Seminar (3)

Critical Analysis and discussion of classroom instructional practices. Discussion and illustration will be based on the experiences of participants as they engage in intern teaching. Education 428 required concurrently. First and second semester.

431. Developmental Reading (3)

Introductory course spanning the elementary and secondary levels. Emphasis on the history of reading instruction, basic premises in reading, the sequence of language development, directed reading activities and reading in content areas. First and second semester.

434. Mathematics in Elementary Education (3)

Mr. Sam

435. Social Studies in Elementary Education (3)

Mr. Warfel

436. Science in Elementary Education (3)

Mr. Castaldi

437. Language Arts in Elementary Education (3)

Mr. Sam

438. Fine Arts in Elementary Education (3)

Mrs. Rutkoff, Mr. Douris

443. Elementary School Administration (3)

The major problems of organization and administration of elementary schools; types of organization, pupil promotion, time allotment, service agencies, and plant and equipment. Required for a principal's certificate. First semester.

Miss McCormick

444. The Elementary School Curriculum (3)

Problems of curriculum development in the first six grades; subject matter placement, program-making for difficult types of schools, regular vs. special subjects, articulation, and similar problems. Second semester.

Mesdames McCormick, Reddin

449. Children's Literature in Reading Instruction

A consideration of the role of literature in the instructional program of the elementary schools. Emphasis is given the use of trade books for individual instruction in reading.

Miss Lerrick

453. Secondary School Administration (3)

The major problems of organization and administration of secondary schools; program of studies, teaching staff, pupil personnel, plant and equipment, and community

relationships. Required for a principal's certificate. First semester.
Messrs. Ashby, Nancarrow

454. The Secondary School Curriculum (3)

Methods of study of curriculum problems, selection of subject matter in various fields, principles of program construction, and similar problems. First semester.

Messrs. Ashby, Cartwright

455. Statistics I (3)

Reduction and description of data. Characteristics of the frequency distribution. Types of distributions. Simple correlation and regression. Score transformations. Statistical inference: tests of hypotheses and estimation of parameters. Uses of the normal, *t*, and chi-square sampling distributions. First or second semester.

Miss Reddin, Messrs. Tate and Miller

456. Statistics II (3)

Review of descriptive statistics. Movements of the frequency distribution. Errors of inference and their control. Power of a statistical test. Extended applications of the binomial, normal, *t*, and chi-square sampling distributions. The *F* distribution. Simple analysis of variance and covariance. Special methods of correlation. Multiple linear correlation and regression through the four-variable case. Prerequisite: Statistics I. First semester.

Messrs. Tate and Miller

457. Statistics III (3)

Selected topics including complex designs in analysis of variance and covariance, multiple correlation and regression factor analysis, and nonparametric methods. Emphasis on experimental design. Prerequisite: Statistics II and consent of instructor. Second semester.

Mr. Tate

458. Statistics IV (1)

Theory and practice of handling mass data in research studies. Use of data-processing equipment in school systems. Prerequisite: Statistics II. First or second semester.

Mr. Tate

460. Group Processes and Group Guidance (3)

Analysis of group dynamics as related to attitude and behavior change. Procedures and resources for promoting individual and group development. Emphasis on group processes as related to guidance and counseling. Second semester.

Mr. Mierzwa

463. Public School Administration (3)

A systematic treatment of the problems of administration, local, state and national. The newer developments which are modifying educational administration; state authorization and organization, the board of education, the superintendent of schools, personnel management, business administration, financial support, and public relations. Second semester.

Mr. Cartwright

464. Foundations of Curriculum Construction (3)

Principles of curriculum construction which underlie the reorganization of the program of studies for elementary and secondary schools; origin and background of the curriculum; methods of organization; curriculum planning and development; and pertinent applications. K-12 First or second semester.

Miss McCormick

465. Administration of Higher Education (3)

Analysis of legal foundations, administrative controls, and operational patterns of the various types of higher institutions with special emphasis on the two-year college. Coverage of traditions which establish duties, responsibilities, and rights of faculty, administration, and board of control in American colleges and universities. Second semester.

Mr. Richardson

466. Supervision of Instruction (3)

Analysis of the principles underlying the organization and supervision of instruction; application to specific teaching situations. No lines will be drawn between the elementary and the secondary school. First or second semester.

Mr. Cartwright

467. Extra-Class Activities (3)

A cooperative study in the philosophy and psychology supporting activity programs; their organization and administration. Emphasis will be given to the teacher's part in the program, e.g., clubs, student councils, homeroom and class organization, assemblies, publications, finance. First semester.

Mr. Keim or Staff

470. Practicum in Analysis of Reading Difficulties

An investigation of research as it relates to analysis of reading difficulties; practice in administration of test materials and the analysis of reading difficulties. First or second semester.

Mr. Versacci

471. Evaluation in Education (3)

Primarily for classroom teachers. Construction and evaluation of the teacher-made test. Selection of published tests and interpretation of individual and group results. Reliability and validity, school marks, emphasis on evaluation of student achievement. Second semester.

Messrs. Burkett and Castaldi

472. Educational Tests and Measurements (3)

Primarily for specialists in measurements and research. Theory of measurement as applied to various kinds of tests and scales. Item analysis; pre-testing, scaling and equating; errors of measurement; reliability and validity; prediction; factor analysis in test development. Prerequisite: Educ. 455 or permission of the instructor. First or second semester.

Mr. Miller

473. Advanced Personnel Seminar

An overview of industrial labor relations as a background for a more detailed study of the movement toward the organization of public employees, with special reference to implications for public school administrators; current developments: the meaning and scope of negotiations, the development of grievance procedures, negotiation agreements, and the negotiation process. Prerequisites: Public School Administration, Educ. 463, Personnel Seminar, Educ. 478.

474. Seminars in School Building (3)

Messrs. Burbank, Cartwright

475. Seminar in Business Management (3)

Mr. Cartwright

476. Seminar in School Finance (3)
Messrs. Abbott, Cartwright

477. Seminar in School-Community Relations (3)
Messrs. Burbank, Cartwright

478. Seminar in School Personnel Problems (3)
Messrs. Burbank, Cartwright

479. Seminar in School Law (3)
Messrs. Abbott, Cartwright

480. Elementary School Guidance (3)
Study of child development as related to guidance in elementary schools. Emphasis on assessment and counseling. Analysis of the roles of counselors, teachers, parents, and other specialists and their influence upon the child in the elementary school. Second semester. Prerequisite: Education 482 and permission of the instructor. Mr. Stafford

482. Philosophy and Principles of Guidance (3)
Introduction to the guidance of children and youth in elementary and secondary school and to the guidance of adults in school, business, and industry. Theoretical foundations, principles and ethics of guidance are considered together with implications for school and extra-school experience. Guidance functions such as identification, appraisal, placement, orientation, motivation, support, curriculum design, and resource development are surveyed. Organizations of school personnel programs are analyzed. First or second semester. Mrs. Tepper, Mr. Stafford

483. Counseling (3)
An intensive examination of theories and techniques of counseling. Critical study of the counseling process through lectures, case histories, and demonstrations. Case studies by students are required. First or second semester.
Mr. Mierzwa

484. Career Development (3)
Study of the process of selecting and pursuing educational and vocational goals with an emphasis upon decision making. Career development is examined as a facet of general human development. Evaluating and using occupational, educational, and related information. First or second semester.
Messrs. Mierzwa, Stafford

485. Elementary School Principal's Clinic (3-6)
Mr. Sam

486. Secondary School Principal's Clinic (3-6)
Mr. Ashby

487. School Psychologist's Clinic (3-12)
Mr. Mierzwa

488. School Superintendent's Clinic (3-6)
Messrs. Burbank, Cartwright

489. Reading Specialists Clinic (3-12)
Mr. Versacci

491-492. Advanced Seminars in Education (3)
Mr. Stoops and Staff

493. Research (3)
Basic principles of research and techniques of gathering and analyzing data. Students will review relevant research reports and prepare a research proposal on an educational problem. Recommended to be taken before approval for candidacy. First and second semester.
Miss Reddin, Mr. Tate

494. Field Work (3-6)
Identification of significant problem(s) in an educational environment, review of the literature, and development of appropriate research plans. No more than 3 credits may be earned in a semester. First and second semester. Mr. Miller

496. Seminar in Research Methods (3-6)
For specialists in measurements and research. Research designs and application to various kinds of educational problems; data collection and analysis. Seminar will include criticism and evaluation of student proposals. First or second semester.
Mr. Miller and Staff

498. Internship (3-9)
Designed to give advanced students an opportunity to obtain practical experience in selected school systems. Conference hours for students and staff members will be devoted to discussion of work and problems encountered in the schools. Students will be sectioned as follows: Section A, elementary school principals; Section B, secondary school principals; Section C, guidance counselors; Section D, superintendent of schools; Section E, reading specialists; and Section F, specialists in measurements and research. First or second semester. Mr. Stoops and Staff

ELECTRICAL ENGINEERING

Professors

JOHN J. KARAKASH, M.S., *Chairman and Distinguished Professor*

WALTER EMIL DAHLKE, PH.D.

ARTHUR IRVING LARKY, PH.D.

ALFRED KRISS SUSSKIND, S.M., (chairman, as of June 1, 1968)

Associate Professors

NIKOLAI EBERHARDT, PH.D.

DANIEL LEENOV, PH.D.

LESLIE GUY MCCRACKEN, JR., PH.D.

Assistant Professors

WILLIAM A. BARRETT, PH.D.

WILLIAM FOWLER HOLLABAUGH, PH.D.

CARL SANFORD HOLZINGER, PH.D.

JOHN GEORGE ONDRIA, PH.D.

Adjunct Professor

LAVEEN KANAL, PH.D.

Instructor

PABLO H. R. NASHI, M. SC.

BEEGAMUDRE RAKOSH-DAS, A.I.I.SC.

DONALD LEE TALHELM, M.S.

Lecturers

EDWARD FRANKLIN REIS, M.S.

JOHN EDWARD ROTH, M.S.

Teaching Assistants

WILBERT CHARLTON ADAMS, JR., HENRICK ARTHUR SCHUTZ.

Graduate Assistants

JOHN A. BERSETH, J. PAUL DETHOMAS, HANS R. GNRELICH, SAMARES KAR, KARL KERCHMAR.

14. Circuit Theory (3)

Energy relations and voltage-current characteristics of idealized electrical circuit elements. Singularity functions. Response of linear circuits. Formulation of network equations. Network theorems and applications. Sinusoidal forcing functions. Prerequisite: Phys. 4, Math. 205, previously or concurrently. Not offered after Fall, 1968.

15. Circuit Theory I (3)

Classical circuit analysis: energy and volt-current relations for idealized circuit elements; singularity functions; response of linear circuits; formulation of network equations; network theorems. Introduction to digital computer programming: compiler language programming; assembly language programming; computer organization. Analog computer programming. Includes one three-hour problem session/laboratory. Prerequisite: Phys. 3, Math. 23 previously or concurrently. First semester.

16. Circuit Theory II (4)

Continuation and completion of EE 15. Includes one 3-hour laboratory. Prerequisite: EE 15. Second semester.

100. Summer Work

During the vacation following the junior year, each stu-

dent is expected to spend at least eight weeks getting experience in some industrial organization. A written report on the experience gained therein, is due on or before February 1.

101. Analog and Digital Computation (2)

Concepts of analog and digital computation. Introduction to compiler language programming, assembly language programming, computer organization, analog computer programming. Solution of electrical problems by analog and digital techniques. Includes one three-hour problem session. Prerequisite: E.E. 104 concurrently. Not offered after Fall, 1968.

103. Physical Electronics (3)

Physical phenomena basic to vacuum, gaseous, and solid-state electronic devices. Kinetic theory of gases; atomic structure; electron emission. Electronic conduction through solids, vacua, and gases. Prerequisite: Phys. 4.

104. Linear Systems Analysis (3)

Fourier series, Fourier integral, and Laplace transforms. Transform analysis methods applied to linear systems, especially electric networks. Complex frequency domain analysis. Prerequisite: E.E. 16 First semester.

105. Electronic Circuits (4)

Transistor and vacuum tube amplifiers. Linear and piecewise linear circuit models. Frequency response, feedback, and oscillation. Includes one three-hour laboratory. Prerequisite: E.E. 14.

106. Machine Theory (4)

Principles of magnetic fields and forces. Analysis of power conversion apparatus, including transformers, magnetic amplifiers, direct current machines, induction motors and synchronous machines. Includes one three-hour laboratory. Prerequisites: E.E. 16; E.E. 104, concurrently. First semester.

111. Electrical Engineering Proseminar (1)

A weekly seminar to acquaint students with developments in research and industry which are outside the scope of the undergraduate courses. Students are required to present oral and written reports on topics relevant to all phases of electrical engineering. Prerequisite: Senior Standing.

151. Senior Laboratory (2)

Senior projects. Two three-hour sessions. Prerequisites: E.E. 105 and 106. First semester.

152. Senior Laboratory (2)

Senior projects. Two three-hour sessions. Prerequisites: E.E. 105 and 106. Second semester.

160. Electrical Circuits and Apparatus (3)

Theory and applications of electrical circuits, machines. Electronic devices and circuits. Prerequisites: Math. 23, Phys. 4. First or second semester.

161. Electrical Problems (1)

A three-hour problem period to accompany E.E. 160. Prerequisite: E.E. 160 concurrently. First or second semester.

162. Electrical Laboratory (1)

Experiments on circuits, machines, and electronic devices. Prerequisite: E.E. 160 concurrently. First or second semester.

For Advanced Undergraduates and Graduates

201. Introduction to Digital Systems (3)*

Number representation and coding. Serial and parallel arithmetic operations; memory devices and their characteristics; input-output devices; instruction decoding; digital differential analyzers; logical implementation of the above.

205. Pulse and Digital Circuitry (3)*

Wave shaping and pulse generation. Models of electron tubes, semiconductor devices and circuits. Timing and switching circuits. Feedback, negative resistance, and non-linear circuits.

212. Control Systems (3)

Introduction to feedback control systems. Transfer functions. Trial and error synthesis of time invariant linear controls. Root loci and frequency-response methods. Servomechanism transducers. Non-linear controls. Prerequisite: E.E. 104. Second semester.

231. Electric and Magnetic Fields (3)

Electrostatics and magnetostatics. Three-dimensional field solutions of elementary geometries. Two-dimensional solutions and conformal mapping. Free-hand field plotting and numerical techniques.

233. Power System Analysis I (3)

Determination of transmission line constants; transmission line equations. General circuit constants. Regulation efficiency. Symmetrical components. System faults. Sequence impedances of transmission lines, transformer banks; metering. Prerequisite: E.E. 106. First semester.

234. Power System Analysis II (3)

Steady state and transient power limits of transmission systems; electro-mechanical characteristics of electrical machines and networks. Prerequisite: E.E. 233. Second semester.

241. Logic and Switching Theory (3)*

Switching algebra; n-variable theorems and related active, semi-conductor and magnetic embodiments. Combinational logic; minimization methods using algebra, tables, hypercubes, maps. Symmetric functions, decompositions, and sequential networks. Linear binary machines. Prerequisites E.E. 101, 104, and 105. First semester.

244. Communication Networks (3)*

Introductory theory of two-terminal and four-terminal network synthesis. Matrix representation of networks. Filter theory. Prerequisites: E.E. 104 and 105. Second semester.

245. Electromagnetic Theory (3)

Maxwell's equations; Poynting's theorem; transmission; reflection, and refraction of waves. Transmission lines; rectangular and cylindrical waveguides.

304. Semiconductor Electronics (3)*

Introduction to solid state physics and quantum statistics; band theory; conduction mechanism in solids. Intrinsic and extrinsic semiconductors; junctions. Theory of diodes and transistors. Equivalent circuits.

306. Solid State Magnetic and Dielectric Devices (3)*

Origin of magnetic and dielectric properties. Electrostrictive and magnetostriuctive systems. Nonlinear magnetic and dielectric materials. Magnetic and dielectric amplifiers. Digital techniques employing square loop materials. Magnetic recording. Magnetic and dielectric measurements. Ferrites at microwave frequencies.

342. Communication Theory (3)*

Transmission theory for unilateral, active, multi-port networks using Fourier series and integrals. Modulations, the analog and digital coding of information. The demodulation process with noise present. System performance measures. Second semester.

346. Microwave Circuits and Techniques (3)

Impedance transformation along waveguides. Matching techniques. Resonance cavities as circuit elements. Scattering and transfer matrices. Periodic structures. Selected microwave devices. Basic techniques of microwave measurements. Second semester.

350. Special Topics (3)

Selected topics in the field of electrical engineering not included in other courses.

361. Physics of Materials (3)

Consideration of the principles of quantum mechanics, statistical thermodynamics. Intended to provide a basic understanding of the principles underlying the study of structure and properties of materials. Prerequisites: Met. 91, Math. 221, or 205.

*Departmental Electives

For Graduates

Members of the department are particularly interested in advanced work in the following areas: electron and solid-state devices, microwaves, information and control systems, and digital systems.

A student who wishes to qualify for an advanced degree with a major in electrical engineering should have as preparation for his graduate work background equivalent to that required for the B.S. in E.E. at Lehigh University. Research training or thesis credit equivalent to six semester hours is required by the department for the master's degree. Subject to approval by the departmental advisor, graduate degree programs may include as part of the "major," courses chosen from offerings of other departments. This is necessary in those cases where courses in physics and mathematics provide a foundation for advanced work.

The laboratories of the Department are located in the James Ward Packard Laboratory of Electrical and Mechanical Engineering. Facilities for experimental work in electronics and communication include low-, medium-, high-, and microwave-frequency components; special research facilities are available for the study of semi-conduc-

tor networks and digital functions. A laboratory with ultra-high vacuum equipment is available for the study of semiconductor surfaces and the preparation of special devices. Students interested in problems related to power systems have at their disposal a 6-generator, a.c., network analyzer.

401. Digital Systems (3)

Principles of machine organization; macro- and micro-programming. Modern concepts and practices in logical design.

404. Solid State Device Theory (3)

Transport theory, conductivity; recombination. Large signal theory of p-n junction devices; analysis of switching, Ebers-Moll and charge control models. First semester.

Messrs. Dahlke, Leenov

406. The Physics of Magnetism (3)

Origins of magnetism. Depolarizing tensors, gyromagnetic effects, spin-orbit coupling, Lande g factor, magnetostatic, magnetoelastic, magnetocrystalline, and exchange energies; static and dynamic magnetization processes, resonance studies. Wave propagation in ferrites. Second semester.

Mr. Holzinger

409. Advanced Electromagnetic Theory (3)

Maxwell's equations in the scope of modern physics. Radiation from antennas, in the earth's atmosphere, in anisotropic and gyrotropic media and in a plasma. Selected boundary and eigen value problem. First semester.

Mr. Eberhardt

410. Electronics of Microwave Tubes (3)

Optics of electron beams. Ballistic theory of transit time tubes. Space charge waves. Interaction of space charge waves with slow electromagnetic waves. Thermal noise in electron streams with basic introduction to mathematical treatment of random noise. Latest devices using free electrons. Offered in alternate years.

Mr. Eberhardt

411. Information Theory I (3)

Topological spaces; metric spaces; measure; probability theory. Information measure, self- and mutual; maximization and inequalities; channels, transmission criteria, and control of redundancy including feedback and fading. First semester.

Mr. McCracken

412. Information Theory II (3)

Continuous channels without memory, coordinate transformation and noise whitening, Gaussian channels. Band limited signals, sampling, normed linear multi-dimensional spaces, character recognition with criteria. Transitional entropy, cylinder sets, shift translations, sequential processes, networks, and automata.

Mr. McCracken

413. Active Networks (3)

Synthesis of active networks to proscribed frequency characteristics, stability and realizability criteria, parameter drift effects. (Offered alternate years.)

Mr. Larky

425. Power System Analysis (3-6)

Steady state and transient analysis of power systems. Traveling waves; free and forced oscillations; reflections; transition points; multi-conductor systems; multi-velocity

waves. Attenuation and distortion; lighting surges; switching surges; arcing grounds; protective devices. Surges in transformer and machine windings.

426. Power System Stability and Protection (3-6)

Power flow and power limits of systems having synchronous and asynchronous machines. Stability criteria, and other related topics. Principles of system protection.

431. Topics in Switching Theory (3)

Emphasis on structural concepts appropriate for exploiting electrical devices and networks more powerful than conventional gates. Major topics included: logical completeness, threshold logic, multivalued logic, synthesis with assumed network forms, algebraic machine structure theory and its application to synthesis, error diagnosis in switching circuits, fault masking in switching circuits.

432. Finite and Infinite State Machines (3)

Emphasis on behavioral aspects of digital machine models. Major topics included: descriptions of sequential behavior, Gedanken experiments, information losslessness, iterative systems, introduction to Turing machines and computability.

441. Automatic Control Systems I (3)

Logical synthesis of continuous and discrete, linear and non-linear, time-invariant control systems using Wiener methods. Generalized harmonic analysis; probability functions, averaging, stationary processes, correlation, spectra, and Campbell's theorems. Error minimization and functional minimization using Lagrangian multipliers. Error integral equation formulation, reduction to factorization solutions, and compensation network realizations. Control of bandwidth, saturation, dead-zone, sampling, and quantization in system design. First semester. (Offered alternate years.)

Mr. McCracken

442. Automatic Control Systems II (3)

Fourier integral treatment of linear, multipole, time-invariant systems. Double Fourier integral analysis of time-varying systems. Vectors, matrices, and linear transformations; eigenvalues, eigenvectors, and canonical forms; calculus of matrices and linear differential equations. Autonomous systems analysis; stability, phase-planes. Poincare index, Lyapunov functions. Discrete systems analysis; stability, responses, Nyquist sampling; adaptive switching for terminal control, minimum-time and maximum range. Second semester. (Offered alternate years.)

Mr. McCracken

443. Network Theory (3)

Properties of driving-point and transfer functions; synthesis; realizability and positive-real functions. First semester.

Mr. Larky

444. Microwave Devices (3)

Devices using paramagnetic resonance: isolators, circulators, digital phase shifters, modulators, limiters. Cavity and traveling wave maser. Optical masers. Cavity and traveling wave parametric amplifiers. Tunnel diode amplifiers. Application of perturbation theory to microwave devices. Offered in alternate years.

Mr. Eberhardt

ENGLISH

450. Special Topics (3)

Selected topics in the field of electrical engineering not covered in other courses.

452. Advanced Solid State Device Theory I (3)

Electron-phonon scattering; hot electrons; Gunn effect. Avalanche breakdown; Read diode. Second semester. Messrs. Dahlke, Leenov

453. Advanced Solid State Device Theory II (3)

Theory of tunneling with applications to metal-insulator-metal and metal-insulator-semiconductor structures. Surface properties; field effect transistor. Alternate years. Messrs. Dahlke, Leenov

461. Theory of Electrical Noise (3)

Definitions; noise temperature, spectral density. Noise sources; quantum thermal, shot and flicker noise. Noisy networks; representation and optimization. Electron tubes and transistors. Mr. Dahlke

462. Noise of Microwave Devices and Networks (3)

Microwave solid state devices and networks. Masers; parametric, point contact, and tunnel diodes. Negative resistance amplifier, mixer and local oscillator. Alternate years. Mr. Dahlke

Professors

JONATHAN BURKE SEVERS, PH.D., *Chairman and Distinguished Professor*

ERNEST NEVIN DILWORTH, PH.D.

JAMES RICHARD FRAKES, PH.D.

FRANK SCOTT HOOK, PH.D.

CARL FERDINAND STRAUCH, PH.D.

Associate Professors

RAY LIVINGSTONE ARMSTRONG, PH.D.

DAVID MASON GREENE, PH.D.

ALBERT EDWARD HARTUNG, PH.D.

Assistant Professors

ADDISON C. BROSS, M.A.

CLOYD CRISWELL, M.A.

JACK ANGELO DEBELLIS, PH.D.

ROBERT RICHARD HARSON, PH.D.

EUSTACE ANTHONY JAMES, PH.D.

ERIC VAN TINE OTTERVIK, PH.D.

JOHN F. VICKREY, PH.D.

Instructors

JOHN ROSS BAKER, M.A.

PETER G. BEIDLER, M.A.

FRANK R. CUNNINGHAM, M.A.

WILLIAM ALBERT DIGEL, M.A.

ROBERT O. RICHARDSON, M.A.

Teaching Assistants

JOSEPH DOMENIC ADAMS, ELIZABETH ANN COTE, ERVENE FRANCES GULLEY, JOHN CAMPION HIRSH, JOEL RAYMOND KEHLER, JONATHAN R. JONES, GEORGE OMER LAPIERRE, JR., GEORGE BUCHANAN MACDONALD, ROBERT DONALD NESS, JR., ANTHONY CHARLES SANTORE, PAUL MICHAEL SORRENTINO, ROBERT S. SPRAGUE, JR., PETER MICHAEL TINKER, WILLIAM FRANK ZAK

English Composition

All students must meet the requirements of six semester hours in freshman composition. This may be done through satisfactory performance in (a) the regular freshman courses, Engl. 1 and 2, (b) the Engl. 11 and 12 program as outlined below, or (c) the Advanced Placement Tests administered by the College Entrance Examination Board. First semester freshmen are divided, on the basis of preliminary tests, into two groups: (1) those whose preparation appears to have been adequate but who do not give evidence of outstanding ability, and (2) those who give evidence of outstanding ability. Students in Group 1 are required to take Engl. 1 and 2; those in Group 2 are given the option of taking either Engl. 11 or 12 (an advanced course in World Literature) or Engl. 1 and 2.

So that superior students may be enabled to satisfy their requirements more rapidly and thus accelerate their progress, those students of Group 2 who elect to take Engl. 11 and 12 will be given credit for Engl. 1 and 2 upon satisfactory performance in Engl. 11 and 12. Thus the superior student can receive twelve credit hours for taking six credit hours of Engl. 11 and 12. If the student does not perform satisfactorily in Engl. 11 and 12 he will not receive credit for Engl. 1 and 2.

A student whose classwork shows that he has been placed in the wrong group may be transferred to a higher or lower group at any time during the year, if his instructor recommends and the chairman of the department approves the transfer.

1. Composition and Literature (3)

Practice in expository writing and the application of rhetorical principles; readings in expository prose; a rapid review of functional grammar. First and second semesters.

2. Composition and Literature (3)

Continuation of Engl. 1. Further practice in expository writing in conjunction with readings in literature. Prerequisite: Engl. 1. First and second semester.

1X. English for Foreign Students (3)

Practice in reading, writing, and speaking the English language, with exercise in listening and note taking. A substitute for Engl. 1 for foreign students who demonstrate a need. Open also to transfer and graduate students. Prerequisite: Consent of chairman of department. First semester.

2X. English for Foreign Students (3)

Continuation of Engl. 1X. A substitute for Engl. 2 for foreign students who demonstrate a need. Prerequisites: Engl. 1X or its equivalent and consent of chairman of department. Second semester.

11. Types of World Literature (3)

A course in composition and literature for superior students who do not need or who have had the basic training of Engl. 1 and 2. In addition to wide and thoughtful reading in world masterpieces, the course requires correct and effective writing of critical essays, original sketches, and documented research papers. Not open to students who have taken Engl. 36. First semester.

12. Types of World Literature (3)

Continuation of Engl. 11. Not open to students who have taken Engl. 36. May be taken independently of Engl. 11. Second semester.

English Literature and Advanced Composition

Students wishing to major in English literature should take as preliminary work Engl. 8 and 9, or such equivalent courses as may be recommended by the chairman of the department. They should then elect a total of ten advanced English courses in the junior and senior years. Students working for honors take a course in which they prepare a thesis as part of the honors requirement.

4. A Study of the Drama (3)

Reading and critical study of the drama; theories of the drama; the drama and the stage; the drama as a criticism of life. Prerequisite: Engl. 2 or 12. First semester.

5. A Study of the Drama (3)

Continuation of Engl. 4. Prerequisite: Engl. 2 or 12. Second semester.

7. A Study of the Short Story (3)

A critical study of the short story, English, American, and

Continental. Class discussions, extensive collateral reading, and reports. Prerequisite: Engl. 2 or 12. First and second semesters.

8. English Literature (3)

A survey of English literature from *Beowulf* through the Pre-Romantics, with selected readings. Prerequisite: Engl. 2 or 12. First semester.

9. English Literature (3)

A survey of English literature from Wordsworth to Housman. Prerequisite: Engl. 2 or 12. Second semester.

18. The Novel (3)

A study of a selection of novels as noteworthy works of literature. Prerequisite: Engl. 2 or 12. First semester.

19. The Novel (3)

Chronological continuation of Engl. 18. Prerequisite: Engl. 2 or 12. Second semester.

20. American Literature, 1607-1855 (3)

A survey of the major writers from the settlement of America to the Civil War. Lectures and class discussions. Prerequisite: Engl. 2 or 12. First semester.

21. Modern American Literature (3)

A study of the development of American literature from Whitman to the present day. Lectures and class discussions. Prerequisite: Engl. 2 or 12. Second semester.

35. Poetry (3)

The analytical and critical reading of poetry, to provide such acquaintance with idiom and technique that poetry may be read with pleasure and understanding. Prerequisite: Engl. 2 or 12. Second semester.

36. Masterpieces of World Literature (3)

A study of great works selected from the literature of epic poetry, the drama, the romance, philosophy, and the essay to illustrate the humanistic traditions of Western civilization. Not open to students who have taken Engl. 11 or 12. Prerequisite: Engl. 2. First and second semesters.

142. Technical Writing (3)

Study and practice in forms and methods of technical exposition, description, definition, classification; the technical report, abstract. Prerequisite: Engl. 2 or 12. First and second semesters.

181. Undergraduate Thesis (3)

Open to advanced undergraduates who wish to submit theses in English. Prerequisite: Consent of chairman of department. First semester.

182. Undergraduate Thesis (3)

Continuation of Engl. 181. Prerequisite: Consent of chairman of department. Second semester.

183. Readings in English Literature (3)

Open to advanced students who wish to pursue special courses of reading in English literature. Prerequisite: Consent of chairman of department. First semester.

181. Readings in English Literature (3)

Continuation of Engl. 183. Prerequisite: Consent of chairman of department. Second semester.

ENGLISH LITERATURE

For Advanced Undergraduates and Graduates

The objective of the graduate program in English is not merely the impartation of knowledge, however wide or deep. Rather it is to instruct and train the student in the methods by which he may pursue the advanced study of literature and literary history. It is to train him in the techniques of criticism and research, so that he may go beyond what has already been done and make an original contribution in his advanced study. To this end, graduate instruction in the department is conducted chiefly by seminars in which enrollment is limited to an average of twelve students and there is opportunity for individual contact between the student and the professor who is guiding his research.

Advanced degrees may be obtained in all areas of English and American literature. Members of the department are particularly interested in advanced work in Chaucer and medieval literature, in Shakespeare and Elizabethan drama, in twentieth-century literature, and in American literature.

In 1966-67, twenty-three Ph.D. and forty M.A. candidates were enrolled in the graduate program in English.

Students desiring to qualify for graduate degrees in this Department should have taken an undergraduate major in English or at least twelve semester hours of advanced courses in English literature. Those with undergraduate deficiencies who are admitted though otherwise well qualified will be expected to make up such deficiencies in addition to satisfying the minimum requirements for the degree sought.

Candidates for the master's degree majoring in English may qualify for the degree under either of two plans offered by the Department. Under Plan I the candidate is required to complete successfully eight semester courses (twenty-four semester hours) and to write a thesis representing the equivalent of six hours of course work, but he is not required to take an examination covering the entire field. Under Plan II no thesis is required; but the student, in addition to completing successfully ten semester courses (thirty semester hours), must pass an examination, usually oral, covering the entire field of English literature. The candidate selects the plan better suited to his needs and abilities, upon the advice and with the approval of the Chairman of the Department.

If his needs and interests make it desirable for him to do so, the candidate for the master's degree is permitted to take collateral work in other departments to the extent of six semester hours in lieu of an equivalent amount in the major field.

Candidates for the doctor's degree are accepted in English only after a consultation among the graduate professors concerning the candidate's qualifications. A reading knowledge of two foreign languages is required, usually Latin, French, or German; and the candidate must give evidence of such knowledge, through examination, either before, or soon after, he is accepted.

For the purposes of the general examination for the doc-

torate in English, each candidate will select the following fields to be examined upon:

1. Major field, in which primary materials (literature) and secondary materials (scholarship and criticism) will be examined.
2. Two minor fields, in which primary materials only will be examined.
3. Three major figures, concerning whom primary and secondary materials will be examined. The three major figures must be chosen outside the major and minor fields in 1 and 2 above, and at least one of them must be a figure not studied in a graduate seminar. They must not be figures already treated by the candidate in a master's thesis or to be treated in the doctoral dissertation.

The three fields (one major and two minor) and the three major figures must be chosen from the following groups, one field and one figure from each group.

Group I

Old English (to 1050)

Middle English (1050-1500)

Renaissance (1500-1600)

Elizabethan and Jacobean Drama (1500-1642)

Group II

Seventeenth Century to Restoration (1600-1660)

Restoration and Augustan (1660-1740)

Age of Johnson (1740-1800)

Group III

Romantic (1800-1835)

Victorian (1835-1900)

American Literature to 1900

English and American Literature 1900 to World War II

The major figures are to be chosen in consultation with the doctoral committee and with the approval of the chairman of the department.

317. The Contemporary Drama (3)

A course in contemporary American and European drama with particular emphasis upon the development of social and philosophical conflicts of the present day. Summer session.

Mr. Hartung

318. American Literature (3)

Movements that have shaped American thought and feelings as expressed in the national literature: Puritanism, Americanism, Romanticism, Transcendentalism, Individualism, the Civil War, Democracy, the West, Realism, Internationalism, and Skepticism, as presented by Jonathan Edwards, Franklin, Paine, Longfellow, Poe, Emerson, Thoreau, Mark Twain, Henry James, and Henry Adams. Summer session.

Mr. Strauch

320. The Novel (3)

The great masterpieces of prose fiction produced in England, in America, and on the Continent during the nineteenth and twentieth centuries; development of types of the novel; the theory and technique of the novel. Summer session.

Mr. James

321. Twentieth-Century American Literature (3)

American literature before World War II. Lectures and class discussion of major fiction and poetry. First semester.

Messrs. Strauch, Frakes

322. Twentieth-Century European Literature (3)

English and Continental literature before World War II. Lectures and class discussion of major fiction and poetry. Second semester.

Messrs. Strauch, Frakes

323. Shakespeare and the Elizabethan Drama (3)

The development of the English drama, including the important plays of Shakespeare. First semester. Mr. Hook

324. Shakespeare and the Elizabethan Drama (3)

Continuation of Engl. 323. Second semester. Mr. Hook

325. English Literature of the Romantic Era (3)

Poetry and prose of the chief romantic writers—Wordsworth, Coleridge, Scott, Byron, Shelley, Keats, Lamb, Hazlitt, De Quincey—with consideration of the political, religious, and social problems of the period as they are exhibited in the literature. Readings and class discussions. First semester.

Messrs. Severs, Harson

326. English Literature of the Victorian Era (3)

Poetry and prose of the chief Victorian writers—Tennyson, Browning, Arnold, Clough, Rossetti, Morris, Swinburne, Macaulay, Carlyle, Mill, Newman, Ruskin—with consideration of the political, religious, and social problems of the period as they are exhibited in the literature. Readings and class discussions. Second semester.

Messrs. Severs, Hartung

331. Milton (3)

The life and works of John Milton in connection with the history of his times and the chief sources of his inspiration. First or second semester.

Mr. Greene

333. Restoration and Augustan Literature (3)

Prose and poetry from 1660 to 1745, with special emphasis upon the works of Dryden, Pope, and Swift. First or second semester.

Mr. Dilworth

334. Age of Johnson

English prose and poetry from 1745 to 1798. Dr. Johnson and his circle and the Pre-Romantics, including Burns and Blake. First or second semester.

Mr. Dilworth

335. History of the English Language (3)

A survey of the development of the English language, in vocabulary, pronunciation, and structure, beginning with its relation to the other Germanic languages and coming down to modern English usage. First or second semester.

Mr. Vickrey

336. Writing for Publication (3)

Comprehensive study of the short story and practice in the various techniques of writing short stories, essays, and poems with a view to publication. First or second semester.

Mr. Criswell

337. The Renaissance (3)

The growth of English non-dramatic literature in the sixteenth century and the stimulus of the Italian Renaissance and northern humanism. Readings in and class discussions of the works of the chief writers—Petrarch, Erasmus, More, Wyatt, Surrey, Llyl, Sidney, and Spenser. First semester.

Mr. Greene

338. The Seventeenth Century (3)

The rich variety of English literature from Donne to Dryden—Donne and the "Metaphysical School"; Jonson and "The Tribe of Ben"; Cavalier and religious poetry; the prose of Bacon, Brown, Burton, Walton, and Bunyan. Second semester.

Mr. Armstrong

339. Chaucer (3)

Reading and critical study of the chief works of Geoffrey Chaucer, with attention to his language and the backgrounds of his works. First or second semester.

Mr. Hartung

340. Principles of Advanced Composition (3)

A study of the principles and rhetorical forms of non-narrative prose with intensive practice in writing at an advanced level. Attention to the theory of language and grammar. Corollary readings, conferences, and class discussions. Prerequisite: English major standing or 2.5 average in freshman English. First or second semester.

Mr. Digel

341. Contemporary American Literature (3)

American literature since World War II. Lectures and class discussion of new writers and of recent works by established writers. First semester.

Messrs. Frakes, De Bellis, James

342. Contemporary European Literature (3)

English and Continental literature since World War II. Lectures and class discussions of new writers and of recent works by established writers. Second semester.

Messrs. Frakes, De Bellis, James

343. American Romanticism (3)

A study of the chief American Romantics, Emerson, Thoreau, Whitman, Hawthorne, Melville, and Emily Dickinson. The European and American philosophical, historical, and social background as well as the formal aesthetic study of romantic masterpieces. First or second semester.

Mr. Strauch

344. American Realism (3)

The rise of realism in prose and poetry in the period roughly from the 1870's to 1914: Twain, Howells, James, Robinson, Norris, Crane, Dreiser and others. First or second semester.

Mr. Frased

345. Themes in American Literature (3)

A study of important themes in American literature, illustrating historical, regional, and social conditions and drawn from works of authors from the colonial period to the present.

Mr. Frakes

346. Middle English Literature (3)

A study of the major literary works of the Middle English period by authors other than Chaucer. Some works will be dealt with in translation, some in the original. In addition to such major figures as Langland, Gower, and the Pearl Poet, the metrical romances will be emphasized. First or second semester.

Mr. Hartung

For Graduates**400. Old English (3)**

A study of the Old English language and literature. First or second semester.

Mr. Vickrey

401. Beowulf (3)
A study of the Beowulf poem and some of the pertinent scholarship. Second semester. Mr. Vickrey

404. Literature of the Fourteenth Century (3)
Types of medieval literature, with special attention to Langland, Gower, and Chaucer. Mr. Severs

405. Chaucer (3)
A study of the life and works of Chaucer. Readings, reports and class discussions. First semester. Mr. Severs

406. Chaucer (3)
Continuation of Engl. 405. Second semester. Mr. Severs

412. Shakespeare's History Plays (3)
A study of the English history plays as an introduction to advanced work in Shakespeare. First or second semester. Mr. Hook

413. Shakespeare's Roman Plays (3)
An intensive critical study of *Julius Caesar*, *Antony and Cleopatra*, and *Coriolanus*. Mr. Hook

414. Sixteenth-Century Drama (3)
A study of plays representing the development of English drama before Shakespeare. Mr. Hook

415. Seventeenth-Century Drama (3)
A study of representative plays from the major Jacobean and Caroline dramatists. Mr. Hook

418. Donne (3)
A study of the complete body of Donne's verse, with especial concern for its meanings. Mr. Armstrong

444. Pope (3)
A study of the works of Pope and their literary background. First or second semester. Mr. Dilworth

447. Eighteenth-Century Prose (3)
Studies in periodical prose (Addison and Steele) and in the satire and comic moralism of Swift, Fielding, Johnson, and Goldsmith. Mr. James

448. Studies in the Eighteenth Century (3)
Studies in, and reports on, one or more authors or issues in eighteenth-century English literature. Mr. Dilworth

452. Keats (3)
A study of the life and works of John Keats. Readings, reports, and class discussions. Mr. Severs

457. Carlyle and Arnold (3)
The major works of Carlyle and Arnold contrasted and compared in terms of Romanticism and Victorian social and religious problems. Mr. Strauch

461. Conrad (3)
A study of Conrad's major novels and tales, with emphasis on the author's style, technique, and attitude. Mr. Greene

465. Joyce (3)
A sequential study of the works of James Joyce, their place in Irish and world literature, and their influence on twentieth-century prose. Mr. Frakes

472. Transcendentalism, Hawthorne, and Emerson (3)
Representative works of the Transcendentalist movement; the major works of Hawthorne and Emerson contrasted and compared in terms of Transcendentalism and Romanticism. First or second semester. Mr. Strauch

473. Melville and Whitman (3)
The major works of Melville and Whitman contrasted and compared in terms of Romantic doctrine. First or second semester. Mr. Strauch

477. Twain and James (3)
Selected works of Twain and James representing the development of American fiction after the Civil War. Mr. Strauch

480. Hemingway and Faulkner (3)
A thematic and stylistic examination of the major works of Hemingway and Faulkner. Mr. Frakes

486. Literary Criticism (3)
A course aimed to correlate and unify the student's previous work in literature by means of wide reading in critical literature and discussions of theories and schools of criticisms. First semester.

487. Literary Criticism (3)
Continuation of Engl. 486. Second semester.

492. Bibliography and Methods of Research (3)
A study of the bibliographical tools essential to an advanced student of English literature. Survey of historical, or critical bibliography, of both printed books and manuscripts; of practical bibliography, including direction in the compilation of a list of books and articles on an assigned subject and in the procedures of thesis writing; and of enumerative bibliographies of English language and literature. First or second semester. Mr. Severs

493. The Teaching of College English (2)
The principles and practice of teaching composition, prose, and other literature on the college level. A consideration of standards, organization, grammar, diction, and style in student writing and the adaptation of a student writing program to readings in prose and other literature. Class discussions, actual teaching, and reports. First semester. Mr. Hartung

494. The Teaching of College English (1)
Continuation of Engl. 493. Second semester. Mr. Hartung

495. Graduate Seminar (3)
An intensive study of the works of one or more English or American authors or of a type of literature. Summer session. Messrs. Dilworth, Frakes Greene, Hartung, Hook, Severs

496. Graduate Seminar (3)
An intensive study of the works of one or more English or American authors, or a type of literature. Subject and instructor vary from semester to semester according to the

English: Speech, Journalism

needs of the students and the wishes of the department. Courses available are Johnson's Literary Criticism (Mr. Dilworth), Approaches to the Short Story (Mr. Frakes), Approaches to Poetry (Mr. Greene), Approaches to Composition (Mr. Hartung), Shakespeare for Teachers (Mr. Hook), Seventeenth-Century Drama (Mr. Hook), Wordsworth (Mr. Severs). Southern Writers of the Twentieth-Century (Mr. DeBellis). First semester.

497. Graduate Seminar (3)

Same as Engl. 496. Second semester.

498. Graduate Thesis (3)

First semester. Mr. Severs and others

499. Graduate Thesis (3)

Second semester. Mr. Severs and others

SPEECH—RADIO—THEATRE

Division of Speech and Dramatics

Professor

H. BARRETT DAVIS, B.L.I., *Chairman*

Associate Professor

THOBURN VAIL BARKER, M.A.

Instructor

RICHARD CHARLES HESS, M.A.

Speech Clinic

For the purpose of diagnosis and treatment of speech defects. Individual instruction provided for students with minor disturbances of voice and speech, as well as those with more serious handicaps. Open to all students in need of corrective treatment and to those desiring speech tests. By appointment. No credit.

11-13. Principles of Theatre Art (1)

The aesthetic process by which plays are translated into theatrical terms for the appreciation and enjoyment of all forms of dramatic art. Students enrolling for their first semester register for Speech 11; for their second semester, Speech 12, etc. First and second semesters.

21-23. Impromptu Speaking (1)

The organization and presentation of short expository speeches and of speeches for special occasions. Content drawn from contemporary events. Students enrolling for their first semester register for Speech 21; for their second semester, Speech 22, etc. First and second semesters.

30. Fundamentals of Speech (3)

A foundation course designed to develop knowledge of the basic principles of speech and ability to speak effectively on the platform. First and second semesters.

31. Business and Professional Speaking (3)

Development of speech for business and professional problems: technique of expository speaking; use of visual graphics; persuasive speaking applied to the emotional or analytical approach in selling; methods of interviewing; techniques of conference. First and second semesters.

32. Conference and Discussion (3)

The technique of investigation, analysis, evidence, inference, briefmaking, and refutation in oral argument; participation in the various forms of discussion—conference table, panel, and symposium—and in various types of debate—conventional, cross-examination, and direct clash. First and second semesters.

33. Parliamentary Procedure (1)

Study and drill in modern rules and methods of conducting organized group-deliberation. First and second semesters.

34-36. Debate (1)

A study of the principles and techniques of debate, analysis, evidence, reasoning, refutation, briefing, speech composition, and delivery skills. Members required to participate in the activities of the Debate Society. Students enrolling for their first semester register for Speech 34; for their second semester, Speech 35, etc. First and second semesters.

61. Dramatics (3)

The practical technique and production of plays; acting, stage-lighting, scenic design and execution, and student direction of plays. Each member must write either an original one-act play or a thesis upon any practical problems of the modern theatre. One play is presented each semester.

62. Dramatics (3)

Continuation of Speech 61. Prerequisite: Speech 61.

For Advanced Undergraduates and Graduates

260. Speech for the Teacher (3)

An orientation course in the field of speech for those engaged in classroom teaching or in directing extra-curricular speech activities. Discussion as a teaching device; integration of speech with other subjects; recognition of common defects of speech; modern emphases in speech contests. Individual investigations, reports, and conferences. Summer session.

Mr. Davis

JOURNALISM

Division of Journalism

Professor

JOSEPH BRENDAN MCFADDEN, M.A., *Chairman*

Associate Professor

ROBERT JOSEPH SULLIVAN, M.A.

Journalism majors must successfully complete at least four semesters of Journ. 1-10, *Brown and White*, taking it during each semester of residence following the declaration of their major. They must also take Journ. 11, 12, 17, 113, 115, 120, 121 and 122 and the following courses: Gk. 21 or Lat. 22, and Phil. 15.

1-10. Brown and White (1 or 2)

Enrollment constitutes membership on the staff of the semi-weekly paper. Student enrolling for their first semester register for Journ. 1; for their second semester, Journ. 2, etc. Prerequisite: Consent of chairman of department. First and second semesters.

FINANCE, MARKETING and LAW

11. News Writing (3)

Definition, determinants, and components of news; news story structure and style; sources; interviewing; practice in gathering and writing news. First semester.

12. Reporting of Public Affairs (3)

Reporting and writing news of government on the local, county, state, and federal levels; civil and criminal courts; labor, science, and entertainment news. Prerequisite: Journ. 11. Second semester.

17. Magazine Article Writing (3)

Writing and marketing non-fiction magazine articles. First or second semester.

21. Creative Writing (3)

The study and writing of fiction, short-stories, especially with a view to developing each student's particular talent. Prerequisite: Engl. 2. First semester.

22. Creative Writing (3)

Continuation of Journ. 21. Prerequisite: Engl. 2. Second semester.

111. Problems in Advanced Reportage (3)

Intensive practice in the reporting of complex events. First semester.

112. Problems in Advanced Reportage (3)

Continuation of Journ. 111. Second semester.

113. Editing (3)

Study of and practice in newspaper desk work; headline writing, make-up, and typography; selecting, editing, and rewriting news and feature copy; use of reference works and morgue. Prerequisite: Journ. 11. First semester.

115. Interpretive Writing (3)

Editorial interpretation of current events; practice in interpretive writing, including editorials. Prerequisite: Journ. 12. Second semester.

118. History of American Journalism (3)

English background of the American newspaper; development of press from Colonial days to the present; influence of newspaper on American life; contributions of outstanding journalists. Second semester.

120. Journalism Proseminar (3)

Survey of the press in its relation to public affairs. Extensive research and reports. Prerequisite: Consent of chairman of department. First semester.

121. Law of the Press (3)

Constitutional development of freedom of the press; rights and responsibilities of the press. First semester.

122. Law of the Press II (3)

Law of and defenses in libel; privacy; contempt; copyright; obscenity. Second semester.

Associate Professors

BRIAN GEORGE BROCKWAY, J.D., *Chairman*

LEON ELWOOD KROUSE, PH.D.

THOMAS CHARLES KUBELIUS, LL.B.

MAX DONALD SNIDER, M.B.A.

Assistant Professor

ADOLPH S. BUTKYS, PH.D.

RICHARD C. LEWIS, LL.M.

Instructor

CARL R. BEIDLEMAN, M.B.A.

RICHARD S. COWAN, JR., M.A.

Teaching Assistant

ROBERT F. COOK

125. Principles of Corporation Finance (3)

An intensive course covering the fundamentals of corporation finance in one semester. Prerequisite: Eco. 3, Acctg. 51 or its equivalent. First and second semesters.

Mr. Beidleman

For Advanced Undergraduates and Graduates

323. Investments (3)

A study, from the standpoint of the investor, of the various types of corporation and government securities, with special reference to owners equities, comparative yields, and the machinery of investment, including stock exchange operations. Prerequisite: A course in corporation finance. First semester.

Mr. Krouse

324. Investments (3)

A project course in investment analysis for advanced students who are already familiar with investment principles. Sources of data and analysis procedures: the securities of industrials, railroads, public utilities, and municipalities. Prerequisite: Fin. 323. Second semester.

Mr. Krouse

326. Problems in Financial Management (3)

Consideration is given to the financial policies of management, with considerable emphasis placed on the corporation's relationship to government and the general economy. Prerequisite: A course in corporation finance. Second semester.

Messrs. Krouse, Schwartz

331. Bank Credit Management (3)

Problems surrounding the extension of loans to customers and the purchase of open-market paper by the individual banker; detailed consideration of legal regulations and restrictions, instruments of bank credit extension, and analysis of the bank borrower's credit position treated in detail. Prerequisite: A course in money and banking. Second semester.

Mr. Krouse

371. Readings (3)

A course of readings in various fields of finance, designed for the student who has a special interest in some field of finance not covered in schedule courses. Prerequisite: Preparation in finance acceptable to the department chairman. First or second semester.

Staff

372. Readings (3)

Continuation of Fin. 371. First or second semester. Staff

For Graduates**421. Financial Management (3)**

A case study of financial management problems of business. Attention is given to the control of current funds, working capital operations, and estimating the need for funds; the problem of long-term capital funds and expansion, and the choice between risk and profitability in the capital structure are also considered. Prerequisite: Fin. 125 and Eco. 129, or equivalent. First and second semesters.

Messrs. Krouse, Schwartz

431. Advanced Investment Analysis and Portfolio Management (3)

This course is designed to integrate the theoretical and empirical aspects of the economic environment with the investment analysis associated with portfolio management program of financial intermediaries and individuals. Particular emphasis will be given in the course to the current impingements of the economic environment upon portfolio management decisions. Prerequisites: A course in investments. Second semester.

Mr. Krouse

471. Special Topics (3)

Selected topics not covered in scheduled courses in the Department. First or second semester. (Offered as required.)

Staff

472. Special Topics (3)

Continuation of Fin. 471. First or second semester. (Offered as required.)

Staff

MARKETING**11. Marketing (3)**

A detailed and critical analysis of the principles of marketing, designed to acquaint the student with the institutions and functions involved in the distribution of goods and services, and with the problems of marketing management. Prerequisite: Eco. 3. First and second semesters.

113. Advertising (3)

The principles, practices, and problems of advertising. Evaluation of techniques utilized in its management and control, with special reference to economic and social aspects. Prerequisite: Mkt. 11. First semester.

115. Retailing (3)

A study of modern retail institutions; principles and methods of retail organization and management; economic, social, and legislative aspects of the retailing structure. Prerequisite: Mkt. 11. Second semester.

For Advanced Undergraduates and Graduates**214. Selling and Sales Management (3)**

Principles and practices of modern selling and sales management; product planning, policy and research; distribution channels, sales planning and promotion; sales force man-

agement; and control of sales operations. Prerequisite: Mkt. 11 or consent of chairman of department. Second semester.

Mr. Butkys

217. Industrial Marketing (3)

Problems in the marketing of industrial as differentiated from consumer goods; product planning and development; industrial marketing research; marketing channels; management of the sales force; industrial advertising; and government regulations. Prerequisite: Mkt. 11 or consent of chairman of department. First semester.

Mr. Butkys

312. Marketing and Distribution Research (3)

Analysis of the techniques of marketing research; determination of research objectives; procedures involved in the conduct of marketing investigations. Prerequisite: Two courses in marketing. Second semester.

Mr. Gross

371. Reading (3)

Selected readings in areas of marketing not covered in scheduled courses. Prerequisite: Preparation in marketing acceptable to the department chairman. First or second semester.

Staff

372. Readings (3)

Continuation of Mkt. 371. First or second semester. Staff

For Graduates**450. Marketing Management (3)**

A study of the factors affecting consumer demand and methods of satisfying it; the structure of the market; marketing methods and problems of various agencies; competitive practices; the management of the selling activities of a business, distribution policies, pricing, and the planning of marketing operation. Prerequisite: Mktg. 11 or equivalent. First and second semesters.

Mr. Snider

471. Special Topics (3)

Individual inquiry into selected areas of marketing. Prerequisite: Preparation in marketing acceptable to the department chairman. First or second semester.

Staff

472. Special Topics (3)

Continuation of Mkt. 471. First or second semester. Staff

LAW**1. Business Law (3)**

The law of contracts, agency, bailments, and sales; legal thought and the judicial process. First and second semesters.

Messrs. Brockway, Lewis

102. Business Law (3)

The law of negotiable instruments, partnership, corporations, real property, insurance, and security devices. Prerequisite: Law 1. Second semester.

Messrs. Brockway, Lewis

103. Business Law for Engineers (3)

The law of contracts, agency, partnerships, corporations, and property rights with special emphasis upon the legal problems of the engineering profession. First semester.

Messrs. Brockway, Kubelius

FINE ARTS

160. Insurance (3)

A non-mathematical course in the economic principles and business practice of insurance, particularly life, fire, and casualty insurance. Prerequisite: Law 1. Second semester.

For Advanced Undergraduates and Graduates

204. Wills, Estates, and Trusts (3)

A study of the basic legal and management principles and practices involved in the planning and administration of wills, estates, and trusts. Prerequisite: A course in business law. Second semester. Mr. Kubelius

211. Legal Concepts (3)

Study of legal reasoning, law as a process of resolving disputes, law as an instrument of social control; selected problems in ownership; provisions for the redress of harm; maintenance of law and order. Mr. Brockway

For Graduates

401. Legal Problems in Business (3)

A course designed to deal with specific legal problems involved in making business decisions. Emphasis is placed on preventive law and the tax consequences of business transactions. Prerequisite: Law 1 or 103. First semester. Mr. Kubelius

Professor

FRANCIS JOSEPH QUIRK, DIPL., *Chairman*

Associate Professor

RICHARD JAMES REDD, M.F.A.

Instructor

KAROL LYNN ROBERTS, M.F.A.

3. Pre-Renaissance Architecture (3)

A study of man's expression through architecture from the prehistoric through the Romanesque period. Conditioning influences, evolution of styles, the development of organic and inorganic types, in relation to structural purposes. Lectures. First semester.

4. Architects and Architecture (3)

Factors determining the development and spread of Gothic, Renaissance, and succeeding styles, the effects of discovery and exploration, the rise of romantic, classic, functional, international, and contemporary movements are examined as periodic expression. Principles of appreciation and aesthetic character in the scientific age. Lectures. Second semester.

5. Fundamentals of Art (3)

An introduction to principles of visual expression. Examples of art from various periods are examined in relation to their historical and cultural context, to their plastic organization and their significance as reflection of human experience. Lectures. First semester. Alternate years.

6. Baroque and Rococo Art (3)

The artistic environment of Europe from the Counter-Reformation to the French Revolution as illuminated by examples of painting, sculpture and architecture provides foundations for better comprehension of artistic principles. Historical, aesthetic and technical aspects of the art as basis for appreciation. Lectures. Second semester. Alternate years.

15. Italian Renaissance Art (3)

Painting and sculpture are examined as the outgrowth of conditions in Italy during the fourteenth, fifteenth, and sixteenth centuries: the influence of medieval thought and tradition, the awakening interest in nature, the effect of antiquity, especially the stimulus it gave to individual effort. Lectures. First semester, alternate years.

31. Elements of Art (3)

Elementary techniques in representation, color theory, composition, surface anatomy, design theory are taught with the use of various media preliminary to the practice of guided creative expression. Portrait models, casts, still life precede landscape study. For beginners and trained students. Evaluation based on individual advancement in the sequential, assigned projects. Studio. First semester.

32. Elements of Art (3)

Essentially the same as F.A. 31 for beginners. Advanced students extend experience and range of media. Emphasis is placed on more effective control of basics, the establish-

ment of individual style, and the incorporation of aesthetic principles in assigned as well as original projects. Studio. Second semester.

33. Painting Practices and Principles (3)

Focus is on the broader aspects of creative expression and the effective production of paintings accenting an area of optional specialization. Assignments in complimentary areas, research and experimentation in combined media. Prerequisites: F. A. 31 or 32, or consent of chairman of department. Studio. First semester.

34. Painting Practices and Principles (3)

Similar to F.A. 33. Further penetration of manners and means of expression in chosen area and style. Easel and mural painting. Assigned projects. Prerequisites: F.A. 31 or 32, or consent of chairman of department. Studio. Second semester.

41. Basics in Architecture (3)

An introduction to rendering, three-dimensional forms, utility, organization of space. Perspective, color, textures of materials, site, and light. Emphasis on contemporary design. Plans. For beginners and trained students. Prerequisites: Either engineering drawing, architectural drawing, or field experience; or consent of chairman of department. First semester.

42. Contemporary Architectural Design (3)

Further study in techniques. Plans and details, models, design problems. Integration of function and aesthetic satisfaction. For beginners and trained students. Prerequisites: Either engineering drawing, architectural drawing, or field experience; or consent of chairman of department. First semester.

131. Advanced Studio Practice (3)

Primarily for students with thorough art foundation. Painting, drawing, graphics. Industrial projects. Wood-block, etching, oil painting, silver-point, tempera. Prerequisite: Consent of chairman of department. First semester.

132. Advanced Studio Practice (3)

Continuation of F.A. 131. Familiarization with variety of media and techniques. Prerequisite: Consent of chairman of department. Second semester.

216. Art in the U. S. (3)

A study of phases of American expression. Painting, sculpture, architecture in relation to cultural progress from Colonial to present time. The analogical and synthetic approaches to art as an index of changing environment. Museum Research. Reports. Second semester.

Mr. Quirk

219. 19th Century Painting (3)

From Neoclassicism through the development of Naturalism. Emphasis on Impressionism from Manet to Cezanne. Written reports. Discussions. The analytical and appreciative approaches. First semester. Alternate years.

Mr. Redd

220. Form and Milieu in 20th Century Art (3)

Sequential movements in contemporary painting and sculp-

ture. Their interrelations as cultural expression. Museum reports and critical interpretation. Second semester.

Mr. Redd

251. Architectural Design (1-3)

Individual study, project or other assignment for advanced students or majors capable of progress beyond general course content or requirement. Content organized by instructor and chairman of department. Conferences and critiques. May be repeated for credit. Prerequisite: Consent of chairman of department. First semester. Staff

252. Architectural Design (1-3)

As in F.A. 251. Second semester.

ART GALLERIES

The North and South Galleries of the Alumni Memorial Building are the scene of teas and receptions marking the opening of the monthly exhibitions held there. This "Meet the Artists" series presents contemporary American and foreign artists and their work. Prints, drawings, paintings, and sculpture are consecutively shown in original exhibitions.

In the Central Gallery cases are periodic displays of Chinese porcelains from the Franklin Baker Collection, Etruscan Bronzes or Roman coins on indefinite loan.

Prints from the Mr. and Mrs. Charles G. Prasse Memorial Collection are shown as groups in the gallery cases.

In the University Center contemporary American paintings from the collection of Mr. and Mrs. Ralph L. Wilson are shown. This expanding collection is located in the Tom Girdler Gallery Lounge and adjacent areas. The multi-purpose rooms house the oriental prints, a group on indefinite loan from the Muriel and Phillip Berman Collection.

The Faculty Lounge houses the Marian Brown Grace Collection of English, Dutch, French, Spanish, and American paintings. Here students, faculty, and friends are afforded contact with excellent examples of such masters as Gainsborough, Romney, Raeburn, Hoppner, Reynolds, Hobbema, Van Ruysdael, Corot, Daubigny, Goya, Inness and others whose paintings admirably accent the decor of the area, provide pleasure and inspiration, and serve as fine reference for scholastic pursuits.

The Cort Room houses framed original contemporary prints. This display, a series of "miniature exhibitions," was made possible by the freshman of the Class of 1962. Admission Offices, Drown Hall gallery, Education Offices and public areas of Whitaker Laboratory present examples from the Permanent Collection of Student Paintings.

In the Grace Lounge and Snack Bar are presented examples of student paintings, including the annual award-winning oils and watercolors, and recent acquisitions.

The music room and student card rooms are hung with prints and paintings appropriate to these areas. Numerous other paintings, either loans or gifts, decorate other major Center rooms.

GEOLOGICAL SCIENCE

The Kenneth L. Isaacs gift of American and European prints and paintings depicting the early development of life along the Lehigh River is situated in Drown Hall where it decoratively presents a picture of the sociological and industrial growth of our community of Colonial times to mid-nineteenth century.

The Offices of the Dean of Arts and Science is hung with oils, watercolors and prints from the Anonymous Loan Collection.

The departmental offices and study areas in Coppee Hall house the collection of etchings, drypoints, lithographs, and engravings, providing basic study material for research. Here, too, is located the collection of more than ten thousand lantern slides and numerous viewers which permit further study or reference. From here are rented more than five hundred framed reproductions for student and faculty use.

Gallery talks, discussions, and lectures are frequently scheduled for on-campus or visiting groups. A continuing reflection of current tendencies in American contemporary expression is presented through the permanent and rotating collections. Guide service may be obtained for groups of ten or more as a Department of Fine Arts service.

Professors

JOHN DONALD RYAN, PH.D., *Chairman*
DALE RODEKOHР SIMPSON, PH.D.

Associate Professors

PAUL BENTON MYERS, JR., PH.D.
JAMES MARSHALL PARKS, PH.D.

Assistant Professors

DONALD F. MCLEROY, PH.D.
THOMAS JOSEPH MORTON SCHOPF, PH.D.

Adjunct Professor

GUNNAR KULLERUD, PH.D., D.S.C.

Teaching Assistants

HOWARD V. DONOHOE, LESTER JOHN STEENBLOCK, JR.,
LAWRENCE A. TAYLOR, ROBERT CARL WEGNER, STANLEY
JEFFRESS WILLIAMS.

1. Principles of Geology (3)

Fundamental concepts of geology; the composition, structure, and development of the earth; processes of geologic change. Lectures, laboratory work, and field trip. First and second semesters.

2. Principles of Geology (3)

A continuation of Geol. 1. Prerequisite: Geol. 1. First and second semesters.

13. Sedimentation (3)

The characteristics of sediments, the processes that control deposition, environments of deposition. Techniques of collection, preparation, and analysis. Lecture and laboratory work. Prerequisite: Geol. 2. First semester. Mr. Parks

14. Rocks and Minerals (1)

Megascopic identification and description of common rocks and minerals. Laboratory. Second semester.

Mr. McLeroy

23. Structural Geology (3)

The major and minor rock structures of the earth's crust. Problems of the type encountered in geological, geophysical, and mining work are studied in the laboratory and field. Prerequisite: Geol. 1. Second semester. Mr. Myers

141. Field Geology (3)

Principles and methods of geologic mapping and field work. Preparation of a report and geologic map based on field work by each student in a specific area. Prerequisite: Geol. 14, 23.

Staff

For Advanced Undergraduates and Graduates

201. Earth Sciences I—Geology (3)

Fundamental concepts of geology; composition and structure of the earth, dynamics of natural processes, evolution and development of the earth. Must be taken concurrently with Geol. 203. Designed for secondary school science teachers. Prerequisites: Graduate standing or consent of chairman of department. Summer session.

202. Earth Sciences II—Meterology and Astronomy (3)
 Comprehensive treatment of the place of the earth in the cosmos; the solar system; and the consequence of solar energy and terrestrial influences on the behavior of the atmosphere. Prerequisite: Graduate standing or consent of chairman of department.

203. Geology Workshop (3)

Field and laboratory exercises in geology. Must be taken concurrently with Geol. 201. Summer session.

281. Geological Research (1-3)

Independent investigation of a special problem in the field, laboratory, or library. Prerequisite: Consent of chairman of department. First semester.

Staff

282. Geological Research (1-3)

Similar to Geol. 281. May be elected as a continuation or separately. Prerequisite: Consent of chairman of department. Second semester.

Staff

301. Introduction to Geophysics (3)

The application of the principles and practices of physics to the solution of problems related to the earth. The origin of the earth; geochronology; temperature of the earth; seismology, gravitation; geomagnetism, terrestrial electricity. Prerequisite: Senior standing or consent of chairman of department. First semester.

Mr. Gallagher

302. Geophysical Prospecting (3)

The application of the principles of geophysics to the problems of prospecting. Geophysical instrumentation. Physical and electrical properties of rocks and formations. Prerequisite: Geol. 301. Second semester, alternate years.

Mr. Gallagher

310. Computer Applications (1)

The use of computers in the solution of geological problems. Prerequisite: Consent of chairman of department. Second semester.

Mr. Parks

311. Paleontology (3)

Morphology of invertebrate fossils, their use in interpreting geologic history; evolution of the faunas and floras. Lectures and laboratory work. Prerequisite: Biol. 21. First semester.

Mr. Schopf

315. Regional Stratigraphy (3)

Studies of sedimentary rock sequences in North America illustrating principles of correlation, facies change, methods of environmental and paleogeographic reconstruction. Prerequisite: Senior standing or consent of chairman of department. First semester.

Mr. Ryan

333. Crystallography (3)

Fundamentals of crystallography and crystal structure; patterns and symmetries, symmetry notations, crystal morphologies and internal structure, principles of crystal chemistry. The anisotropy of crystalline materials with special reference to crystal optics. Lectures and laboratory. Prerequisite: Chem. 3. First semester.

Mr. Simpson

334. Petrology and Petrography (4)

Evolution of crystalline rocks and their distribution in space and time; physical and chemical factors in igneous

and metamorphic processes. Microscopic study of rocks. Lectures, laboratory work, and field trips. Prerequisite: Geol. 333. First semester.

Mr. McLeroy

336. Mineral Phase Relations (3)

Principles of phase equilibria; unicomponent and multicomponent condensed systems and multicomponent systems with volatile phases. The application of phase relation studies to mineralogical and geological problems. Prerequisites: Chem. 3, Geol. 333. Lectures and laboratory. Second semester.

Mr. Simpson

337. Sedimentary Geochemistry (3)

Processes controlling the distribution of the elements in the lithosphere, hydrosphere, atmosphere, and biosphere with particular reference to sediments and sedimentary rocks. Prerequisite: Geol. 315 or consent of chairman of department.

339. Techniques in Geochemistry (1-2)

Study of chemical and physical analytical techniques as applied to sedimentary materials and waters; problems of sampling. Laboratory work. Prerequisite: Geol. 337, previously or concurrently.

351. Geology of Fuels (2)

The geology and geochemistry of oil, gas, and coal. Prerequisite: Geol. 315 or consent of chairman of department.

354. Elements of Mining (4)

Methods of prospecting and exploration; drilling and blasting; development openings; methods of mining; support of workings. Lectures, recitation, and laboratory. Prerequisite: Geol. 23. Second semester. Alternate years.

Mr. Gallagher

357. Economic Geology (3)

The formation of mineral deposits and the occurrence and characteristics of deposits of economic importance. Includes metals, non-metals, and fuels. Lectures, laboratory work, and inspection trips. First or second semester.

Mr. McLeroy

363. Introduction to Oceanography (3)

A survey of the physical, chemical, biological, and geological nature of the oceans. Two lectures, one recitation. Prerequisite: One year of science (Biol., Chem., Geol., or Phys.)

Mr. Schopf

390. Problems of Geology (3)

History and present status of controversial basic geologic problems. Prerequisite: Geol. 312 or consent of chairman of department.

Staff

391. Field Seminar (1)

Study of geological problems using field methods of analysis. Field trips, reading, reports, and discussion. Prerequisites: Geol. 23, 315. First or second semester.

Staff

For Graduates

The graduate program in Geology is mainly directed toward the study of geologic processes. Candidates for the master's degree receive instruction in most fields of geology

and are expected to take courses in appropriate collateral fields of science. Advanced graduate students, working toward the doctorate, specialize in one field of geology.

Research is an important part of the graduate program. In general, students are encouraged to choose research problems which for their solution require the use of integrated laboratory and field studies.

In the fall of 1967, 8 M.S. candidates and 10 Ph.D. candidates were enrolled.

Candidates for the master's degree are required to take a comprehensive examination during the semester in which they expect to take their degree. The examination also serves as a qualifying examination for admission to candidacy for the doctoral degree. Students entering with the master's degree take the comprehensive examination at the end of their first semester of residence.

Candidates for the Ph.D. degree must demonstrate through examination a thorough reading knowledge of one foreign language, generally French, German, or Russian.

Other requirements for graduate degrees are listed in the section of this catalog headed "Degrees," page 77.

Current departmental research activities and special interests include: Geochemistry of phosphate minerals, sulfide mineral phase relations, deoxygenation of crystal surfaces under reducing conditions, Appalachian structure, stratigraphy, Lower Mississippian paleocurrents in Newfoundland, sedimentation during the Laramide Orogeny in the Wyoming Rockies, geology and mineral deposits of the Southern Rockies and Sierra Oriental, carbonate sedimentation, paleoecology of bryozoa, effects of organic films on carbonate equilibrium in sea water, lagoonal sedimentation in New Jersey.

Special departmental research facilities of interest include: Norelco X-ray diffraction unit, Beckman DU spectrophotometer, Beckman infra-red analyzer, Coleman nitrogen analyzer, pH meters, petrographic and binocular microscopes, size analysis equipment for sedimentation studies, chemical balances, hoods, etc., Schmidt-type Askania magnetometer, Worden gravity meter, Gish-Rooney electrical field equipment, standard equipment for geological mapping. Soltzman map projector, furnaces for hydrothermal studies.

401. Seismic Methods (3)

The elements and theory of elastic deformations and wave propagation; refraction and reflection; theory and description of seismographs. Prerequisites: Mathematics through calculus and consent of the instructor. First semester, alternate years.

Mr. Gallagher

402. Electrical Methods (3)

Electrical properties of rocks and minerals; the principles of potential distribution in DC and AC fields. Prerequisites: Mathematics through calculus and consent of the instructor. Second semester, alternate years.

Mr. Gallagher

403. Magnetism and Gravity (4)

Terrestrial magnetism; magnetic properties of rocks and minerals; magnetic instruments. Shape of the earth; gravitational principles and instruments. Prerequisites: Mathematics through calculus and consent of the instructor. First semester, alternate years.

Mr. Gallagher

411. Advanced Paleontology (4)

Classification, evolution, biometrics, and paleoecology; study of fossil and modern populations and assemblages. Lectures and laboratories. Prerequisite: Geol. 311. First or second semester.

Mr. Schopf

417. Sedimentary Petrography (3)

The theory and application of petrographic methods in the study and classification of sedimentary rocks. Prerequisites: Geol. 312, 334. First semester. (Offered alternate years.)

Mr. Ryan

418. Sedimentary Petrogenesis (3)

The origin and development of sedimentary rock types; mineral provenance, environment of deposition, diagenesis, sediments in time, stratigraphic synthesis. Prerequisite: Geol. 417. Second semester. (Offered alternate years.)

Mr. Ryan

421. Tectonics (3)

The major structural features of the earth's crust and the problems of crustal instability; the relationships between major and minor structures; distribution of rock types as related to crustal deformation. First semester. (Offered alternate years.)

Mr. Myers

422. Tectonics (3)

Continuation of Geol. 421. Second semester. (Offered alternate years.)

Mr. Myers

424. Advanced Structural Geology (3)

The theory and application of analytical methods in the study of rock deformation; experimental deformation, petrofabric analysis; statistical field methods. Second semester. (Offered alternate years.)

Mr. Myers

433. Sulfide Phase Equilibria (3)

The thermodynamics of sulfide type ores based on experiments in laboratory systems. First semester.

Mr. Kullerud

435. Advanced Mineralogy (3)

Topics of contemporary interest in mineralogy. Prerequisite: Chem. 302 or equivalent. First semester. (Offered as required.)

Mr. Simpson

436. Advanced Mineralogy (3)

Similar to Geol. 435. Prerequisite: Chem. 302 or equivalent. May be elected separately. Second semester. (Offered as required.)

Mr. Simpson

437. Igneous and Metamorphic Processes (3)

Selected problems on crystalline rocks. Lectures, conferences, assigned reading, field trips. First semester. (Offered alternate years.)

Mr. Simpson or Mr. Myers

438. Igneous and Metamorphic Processes (3)

Continuation of Geol. 437. Second semester. (Offered alternate years.)

Mr. Simpson or Mr. Myers

439. Ore Microscopy (3)

Microscopic study of selected ore mineral suites with special attention toward applications of phase equilibria. Prerequisite: Geol. 433. First semester.

Mr. Kullerud

GERMAN

441. Seminar in Ore Solutions (2)

Presentation of research papers, review of latest literature on the geochemistry and genesis of metallic ore solutions. (Offered as required.) Permission of the Chairman.

Mr. McLeroy

442. Genesis of Metallic Ores (3)

Research on the genesis of metallic ore suites by use of optical, spectrographic, chemical, etc. methods. One lecture, two laboratories. (As required.) Permission of the Chairman.

Mr. McLeroy

451. Examination of Mineral Deposits (3)

Systematic exploration and examination; theory of sampling; statistical analysis. Second semester, alternate years.

Mr. Gallagher

461. Marine Geology (3)

Chemical and physical oceanography; marine ecology; modern sediments. First semester. (Offered alternate years.)

462. Paleoecology (3)

Reconstruction of paleoenvironments based on principles of paleoecology and sedimentary petrology. Prerequisite: Geol. 461. Second semester. (Offered alternate years.)

Mr. Schopf

481. Geological Investigation (1-6)

Research on a special problem; field, laboratory, or library study; report required. Credit above three hours granted only when a different problem is undertaken. First semester.

Staff

482. Geological Investigation (1-6)

Similar to Geol. 481. Credit above three hours granted only when a different problem is undertaken. Second semester.

Staff

483. Thesis (3)

May be elected only by master's degree candidates. First semester.

Staff

484. Thesis (3)

Continuation of Geol. 483. Second semester.

Staff

490. Special Topics (3)

An extensive study of selected topics not covered in more general courses. First semester. (Offered as required.)

Staff

491. Special Topics (3)

Similar to Geol. 490. May be elected separately. Second semester. (Offered as required.)

Staff

Professor

JOHN HARMS UBBEN, PH.D., *Chairman*

Associate Professors

ARTHUR PARCEL GARDNER, PH.D.

ANNA PIRSCENOK HERZ, PH.D.

Instructors

DORIS GARB, B.A.

RONALD L. GOUGHER, M.A.

Teaching Assistants

PETER GANSSMANN, ERNST ULRIK LETTAU.

1. Elementary German (3)

Drill in the fundamentals of German grammar; pronunciation; simple conversation and composition; extensive outside reading of simple vocabulary-building texts. No previous study of German required. First semester.

2. Elementary German (3)

Continuation of Ger. 1. Prerequisite: Ger. 1. Second semester.

11. Intermediate German (3)

German prose and poetry; outside reading; composition. Prerequisite: One year of college German or two units of entrance German. First semester.

12. Intermediate German (3)

Continuation of German 11. Prerequisite: Ger. 11. Second semester.

27. Scientific German (3)

Reading of material with stress on chemistry and physics. Prerequisites: Ger. 2, or three units of entrance German; sophomore standing or consent of the chairman of the department. First semester.

31. Conversation and Composition (3)

Remedial exercises in grammar; phonetics; conversation and composition stressing situations taken from daily life. Prerequisites: Ger. 12, or three units of entrance German. First semester.

32. Conversation and Composition (3)

Continuation of Ger. 31. Oral and written reports, personal and business letters, fundamentals of good style. Prerequisite: Ger. 31. Second semester.

43. Types of German Literature (3)

Lectures and collateral reading. Prerequisites: Ger. 12, or 3 units of entrance German, or consent of chairman of department. First semester.

44. Types of German Literature (3)

Continuation of German 43. Lectures and collateral reading. Prerequisites: Ger. 12, or 3 units of entrance German, or consent of chairman of department. Second semester.

52. Goethe's Faust (3)

Reading of the Faust drama and collateral material. Prerequisite: Ger. 31 or 43, or consent of chairman of department. Second semester.

For Advanced Undergraduates and Graduates

The prerequisite for all "200"-level courses is three years of college German or the equivalent.

202. The German Novelle (3)

Study of the origin and history of the *Novelle* and of contributions by outstanding writers. Prerequisite: three years of college German (or equivalent) or consent of chairman of the department.

Mr. Ubben

203. Nineteenth Century German Drama (3)

Survey of developments and reading of outstanding dramatic works in German literature from the end of the Classical Period through the Age of Naturalism. Prerequisite: three years of college German (or equivalent) or consent of chairman of the department.

Mr. Ubben

205. Twentieth Century German Literature (3)

Study of developments since the downfall of Naturalism; reading of works illustrative of trends and authors. Prerequisite: three years of college German (or equivalent) or consent of chairman of the department.

Mr. Gardner

211. Nineteenth Century German Lyric Poets (3)

A study of selected poems by lyricists from Heine to Conrad Ferdinand Meyer. Discussion and analysis. Prerequisite: Three years of college German (or equivalent) or consent of the chairman of the department.

212. Modern German Lyric Poetry (3)

A study of selected poems by German Lyricists from Nietzsche to Brecht. Discussion and analysis. Prerequisite: Three years of college German (or equivalent) or consent of the chairman of the department.

250. Special Topics (3)

Study of literary and linguistic topics not covered in regular courses, or continuation of study of topics begun in regular courses. May be repeated for credit.

303. German Romanticism (3)

Early and late Romanticists. Prerequisites: Ger. 31, 32, 43, or 44, or consent of chairman of department.

321. Middle High German (3)

Medieval German and its relationship to the development of modern German. Selected works by the great German poets of the period. Prerequisites: Ger. 31, 32, 43, 44, or consent of chairman of department.

322. History of the German Language (3)

The development of the language and its present structure. Prerequisites: Ger. 31, 32, 43, or 44, or consent of chairman of department.

331. The Teaching of German in Secondary Schools (3)

The history of teaching of German in the United States, examination of teaching materials, a study of modern methodology, laboratory practice and techniques, and use of experimental classes. Prerequisites: Ger. 31, 32, 43 or 44, or consent of chairman of department. First semester.

341. Advanced Conversation and Composition (3)

For undergraduates and teachers. Prerequisites: Ger. 31 or 32, or consent of chairman of department.

343. Renaissance-Baroque-Enlightenment (3)

German literature and its position in European literature from Der Ackermann aus Bohmen to Lessing. Prerequisite: Ger. 31 or 43 or 44, or consent of chairman of department. First semester.

Mr. Gardner

344. The Age of Goethe (3)

Selected works from Klopstock to Holderlin, with special emphasis on Herder, Goethe and Schiller. Prerequisite: Ger. 31 or 43 or 44, or consent of chairman of department. Second semester.

RUSSIAN

1. Elementary Russian (3)

Classroom and laboratory introduction to the fundamentals of conversational and grammatical patterns; practice in pronunciation, simple conversation, reading and writing. First semester.

2. Elementary Russian (3)

Continuation of Russ. 1. Prerequisite: Russ. 1. Second semester.

11. Intermediate Russian (3)

Classroom and laboratory practice in conversation. Development of reading and writing skills. Prerequisites: One year of college Russian, or two units of entrance Russian. First semester.

12. Intermediate Russian (3)

Continuation of Russ. 11. Prerequisite: Russ. 11. Second semester.

41. Conversation and Composition (3)

Intensive practice in oral and written Russian; laboratory practice in aural comprehension. Readings and discussions on Russian literature and culture. Prerequisite: Russ. 12, or 3 units of entrance Russian, or consent of chairman of department. First semester.

42. Conversation and Composition (3)

Continuation of Russ. 41. Prerequisite: Russ. 31, or consent of chairman of department. Second semester.

251. Special Topics (3)

Intensive study of literary or linguistic topics. Prerequisite: Russ. 32, or consent of chairman of department.

252. Special Topics (3)

Continuation of Russ. 251. Prerequisite: Russ. 251, or consent of chairman of department.

GOVERNMENT

Professor

WILLARD ROSS YATES, PH.D., *Acting Chairman*

Associate Professor

DONALD DELYLE BARRY, PH.D.

FRANK THOMAS COLON, PH.D.

Assistant Professor

JOHN LOREN WASHBURN, M.A.

Instructors

STEPHEN D. BRYEN, M.A.

HOWARD R. WHITCOMB, M.A.

1. American National Government (3)

Constitutional principles; organization and operation of the national government; the party system, citizenship, and civil rights. First and second semester.

2. American State and Local Government (3)

The position of the states in the union; machinery and functions of state governments; nomination and elections; the various systems of local government. Second semester.

3. Foreign Governments (3)

The governmental systems of foreign countries: the parliamentary systems of Great Britain and France; authoritarian government in the U.S.S.R.; democratic and authoritarian regimes in various other countries of Europe and the Americas. First and second semester.

4. American Political Ideas (3)

A survey of the ideas underlying and associated with the political institutions and practices of the United States. Second semester.

6. Democracy (3)

An analysis of the theory and the practice of democratic government in selected countries. Prerequisite: Sophomore standing. Second semester.

101. History of Political Thought (3)

History of leading political ideas. Analysis of the views of representative ancient, medieval, and modern political philosophers of the western world. First semester.

For Advanced Undergraduates and Graduates

304. Political Parties (3)

The organization, functions and techniques of political parties and pressure groups; nomination and election methods, voting behavior and public opinion; government and politics. Second semester.

311. Teaching Civil Liberties (3)

Consideration of fundamental civil liberties issues in constitutional perspective. Designed for improving the teaching of constitutional freedom in public and private schools. Freedom of speech, religious freedom, racial equality, censorship. Materials and methods for teaching the Constitution and the Bill of Rights. Not open to students who have taken Govt. 352 or Govt. 453 and 454. First semester and summer session.

312. Workshop in Teaching Civil Liberties (3)

Research and library work, outside lectures, observation of

court and administrative procedures pertaining to civil liberties. Must be taken concurrently with Govt. 311 when courses are offered together.

321. Scope and Methods of Political Science (3)

Introduction to the philosophy of the social sciences; approaches to the study of politics; the limits of political analysis; research design and techniques; political bibliography; field study. First semester. Mr. Bryen

322. Developing Countries (3)

Theories of political development in non-Western areas, emphasizing the tasks of modernization and nation building. Field studies and methods will be examined. The contributions of related disciplines such as sociology and psychology will be explored. Second semester. Mr. Bryen

351. Constitutional Law (3)

The law of the Constitution as expounded by the Supreme Court of the United States. First semester.

Mr. Whitcomb

352. Civil Rights (3)

A study of constitutional guarantees designed to protect the individual against arbitrary, unreasonable, and oppressive government. Freedom of speech and of the press, religious freedom, freedom of assembly, property rights. Constitutional problems concerning crime and its punishment. Second semester.

Mr. Whitcomb

354. Administrative Law (3)

Consideration of the authority, procedures, and methods utilized by executive agencies in the administration of public policy. Analysis of the general problem of adjusting the administrative process to traditional constitutional principles. Second semester.

Mr. Barry

357. Urban Politics (3)

The structure and processes of city government in the United States; city-state and federal-city relationships; the problems of Metropolitan areas; political machines and community power structures; the politics of municipal reform; city planning and urban renewal. First semester.

Mr. Bryen

359. Law-making (3)

Organization and procedure of legislative and constituent assemblies. Legislative leadership. Role of administrative and judicial agencies in law-making. Pressure groups, parties, and policy determination. Direct legislation. First semester.

360. Public Administration (3)

The nature of administration; problems of organization and management; public personnel policies; budgeting and budgetary systems; forms of administrative responsibility. Second semester.

Mr. Colon

361. Comparative Administrative Systems (3)

Problems concerning governmental organization and administration; the implementation of public services in selected countries. Comparison of administrative procedures in various jurisdictions or bodies politic with those in the U. S. Prerequisite: Govt. 3 or consent of chairman of department. Second semester.

Mr. Colon

362. The Soviet System of Government (3)

An examination of the roles of the Communist Party, the Council of Ministers, the Supreme Soviet and other governmental and social organizations in governing the U.S.S.R. Second semester.

Mr. Barry

363. Contemporary Political Thought (3)

Analysis of the fundamental concepts of political science. The nature of the state, nationalism, sovereignty, law and liberty. Constitutions; unitary and federal systems of government; authoritarianism and democracy. First semester.

Mr. Washburn

364. Contemporary Political Thought (3)

Recent thought concerning the ethical basis of political authority and the proper role of the state in society. Analysis and appraisal of anarchism, individualism, socialism, communism, syndicalism, fascism, and other doctrines. Second semester.

Mr. Washburn

371. Readings (3)

Readings in political science assigned to properly qualified students in consideration of their special interest in particular political institutions and practices. Prerequisite: Consent of chairman of the department. First semester.

372. Readings (3)

Continuation of Govt. 371. Prerequisite: Consent of chairman of the department. Second semester.

For Graduates

Graduate students desiring to major in political science should have had at least twelve semester hours of undergraduate work bearing on this field or should in other ways satisfy the department that they are qualified to pursue the required program of study.

Candidates for the master's degree in political science may qualify by completing thirty hours of approved course work and passing an examination covering the entire field or by completing twenty-four hours in approved courses and submitting a satisfactory thesis. The choice between these plans shall be made by each candidate upon the advice and with the approval of the chairman of the Department.

All graduate students seeking the master's degree in political science shall enroll for a minimum of eighteen hours of courses in the political science field. International relations courses fall in the political science category. Appropriate courses in other fields, among the economics, history, philosophy, social relations, and public finance may be selected to meet the total of hours required for the master's degree.

The department offers a Master of Arts degree for students interested in a variety of vocations. M.A. candidates are interested principally in pursuance of additional advanced work for the Ph.D. in preparation for college or university teaching; career in state, local or national government; teaching in community colleges and junior colleges; teaching in public schools; governmental and private research programs; or journalism.

The Department has a limited number of students who come together in small seminars where personal attention is the keynote.

441. Public Administration (3)

Administrative theory and practice in the public sphere in the United States; problems of public organization and management; executive leadership; personnel, budgeting, and regulatory administration. First semester.

Mr. Colon

442. Comparative Administration (3)

Theory and practice in the administrative systems of developing nations; comparative comparison of public administrative systems with non-public systems; cultural influences on administration. Second semester.

Mr. Colon

451. American Political Institutions (3)

The federal and state constitutions; congress and state legislatures; the presidency and state governors; federal and state judicial systems. First semester.

452. American Political Institutions (3)

Political parties and pressure groups; nomination and election methods; voting behavior and public opinion. Second semester.

453. Public Law (3)

Origins and basic principles of American constitutionalism; distribution and scope of governmental powers; constitutional limitations; individual freedoms; problems of due process; administrative powers and procedures. First semester.

454. Public Law (3)

Continuation of Govt. 453. Second semester.

463. Political Theory (3)

Theories pertaining to the nature of the political system and its organization: the local community, state, nation, empire, federalism. Theories and doctrines of the governing process; legitimate objectives of government; proper spheres of political authority. First semester.

Mr. Washburn

464. Political Theory (3)

Theories and doctrines pertaining to the political person and to the dimensions of power, justice, equality and freedom. Second semester.

Mr. Washburn

471. Foreign Governments (3)

Governmental and political institutions of the Western and Western-type democracies. Approaches to the study of comparative politics. First semester.

Mr. Barry

472. Foreign Governments (3)

Governmental and political institutions of the USSR and other communist states. Approaches to the study of comparative politics. Second semester.

Mr. Barry

481. Special Topics (3)

Individual inquiry into some problems of government other than the subject of the master's thesis. Reading, field, work, and other appropriate techniques of investigation. Conferences and reports. First semester.

Staff

482. Special Topics (3)

Continuation of Govt. 481. Second semester.

Staff

HISTORY

Professors

JOSEPH ALBERT DOWLING, PH.D., *Chairman*

RAYMOND GIBSON COWHERD, PH.D.

JOHN MCVICKAR HAIGHT, JR., PH.D.

FRANCIS P. JENNINGS, PH.D., *(Visiting Professor)*

LAWRENCE H. LEDER, PH.D., (chairman, as of July 1, 1968)

Associate Professor

GEORGE MARK ELLIS, PH.D.

CHARLES LEON TIPTON, PH.D.

Assistant Professor

WILLIAM GERALD SHADE, PH.D.

Instructor

DAVID C. AMIDON, JR., M.A.

JAMES S. SAGER, M.A.

INDRIKIS STERNS, M.A.

Teaching Assistants

MARK KEITH BAUMAN, WILLIAM PAUL DUNKEL, JOSEPH PAUL

ECKHARDT, WILLIAM ANTHONY GUDELUNAS, JR., ROBERT

FRANK REEVES

11. Western Civilization (3)

The roots of Western Civilization; the evolution of economic, social, and political institutions; the impact of religious and philosophical ideas upon European Culture. First semester.

12. Western Civilization (3)

The modern Western World; the rise of nationalism and imperialism; the growth of science and industrialism; modern thought and ideologies. Second semester.

13. American Civilization (3)

History of American civilization to 1865, emphasizing the development of our cultural heritage. Puritanism; Deism; American Revolution; Constitution; Jeffersonian and Jacksonian Democracy; Abolitionism and Civil War. First semester.

14. American Civilization (3)

American civilization since 1865. Industrialism; Urbanization; Social Darwinism; Pragmatism; the Frontier; Progressivism and the New Deal; the two World Wars. Second semester.

15. English History (3)

An introduction to the history of England to 1688. The origins of representative government, the development of English social institutions, the unification of England, and the Renaissance and Reformation in England will be examined. First semester.

16. English History (3)

The development of English political and social institutions from 1688 to the present. The evolution of parliamentary government, the rise of modern parties, the Industrial Revolution, and recent social philosophies will be studied. Second semester.

25. European History (3)

A survey of some of the major historic forces in Europe from the collapse of the Roman Empire to the end of the seventeenth century. First semester.

26. European History (3)

Continuation of Hist. 25. A survey of major developments in European history from about the year 1700 to the middle of the twentieth century. Second semester.

49. History of Latin America (3)

A survey of the Spanish and Portuguese colonization of America and the struggles for independence, preceded by a brief view of the ancient American civilizations and the Iberian backgrounds. First semester.

50. History of Latin America (3)

Continuation of History 49. The development of the Latin American nations in the nineteenth and twentieth centuries. Second semester.

Attention is called also to the following courses in history offered by other departments: Gk. 21, Ancient History; Lat. 22, Ancient History.

For Advanced Undergraduates and Graduates

319. Seventeenth Century America (3)

A study of the founding and growth of English, French, and Dutch colonies in North America. Attention will be paid to motives behind European expansion as well as to developments in the colonies. *Messrs. Shade, Leder*

320. Eighteenth Century America (3)

Continuation of Hist. 319. A study of American political, economic, and cultural developments including the War for American Independence and the founding of a new nation. *Messrs. Shade, Leder*

321. United States History 1789-1877 (3)

The development of the American people from the establishment of the Republic to the end of Reconstruction in the South. Consideration will be given to political, economic, and social developments with special emphasis on westward expansion, Jacksonian democracy, and the Civil War crisis. *Mr. Shade*

322. United States History since 1877 (3)

The urbanization and industrialization of American society and the political, social, and economic effects thereof. *Mr. Shade*

323. American Constitutional History (3)

The development of American constitutional thought and practice from the colonial period to the Civil War. Consideration of governmental institutions, political parties, and legal thought in the context of American history; special emphasis upon the Confederation, the Constitution, and the states-rights controversy.

324. American Constitutional History (3)

Constitutional thought and practice from the Civil War to the present. Consideration of the new role of government,

problems caused by the Industrial Revolution, and modern issues relating to personal liberties and federal-state relations.

325. American Immigrant History (3)

Immigration in American history. The changing sources of American immigration; successive "first generations" and the process of ethno-cultural transfer; cultural stability and change through post-immigrant generations; "minority groups" in American political history. Mr. Amidon

326. American Urban History (3)

The city in American history from the colonial period to the present. Colonial maritime centers; changing transportation patterns and the diffusion of urban sites; industrialization and urban social structure; urban imperialism and regional rivalries; urban technology; "reformers" vs. "the machine"; suburbanization and nationalization.

Mr. Amidon

327. American Intellectual History (3)

A study of the development of political, social, and religious ideas in America from the colonial period to the Civil War. Prerequisite: Consent of chairman of department.

Mr. Dowling

328. American Intellectual History (3)

A study of economic, political, and religious thought in industrial America, 1860 to the present. Prerequisite: Consent of chairman of department.

Mr. Dowling

329. American Foreign Policy (3)

The French alliance; independence and boundaries; commercial restrictions; French Revolution and neutrality; purchase of Louisiana; War of 1812; acquisition of Florida; Monroe Doctrine; relations with France and Great Britain; Oregon and Texas; the Mexican War; Civil War diplomacy.

Mr. Shade

330. American Foreign Policy (3)

Maximilian in Mexico; Seward and expansion; Alaska boundary; War with Spain; the new Caribbean policies; the World War of 1914-1918 and its aftermath; diplomatic events preceding Pearl Harbor; outbreak and prosecution of the war; plans for peace; the "Cold War"; diplomacy since 1945.

Mr. Shade

343. English History 1471-1660 (3)

The evolution of England under the Tudor monarchy and the problems facing its successors culminating in the Civil Wars and Interregnum. Special emphasis will be placed on political, economic, intellectual and religious developments of the period. First semester.

Mr. Ellis

344. English History 1660-1789 (3)

The development of constitutional monarchy from the Stuart Restoration to the French Revolution. English civilization in an age of oligarchy will be examined especially in the political, social, economic and intellectual sectors. Second semester.

Mr. Ellis

347. The British Empire (3)

The expansion of the English-speaking people from 1603 to 1848; the origins of self-government; the founding of the

Empire in Asia and Africa; the role of Great Britain in world affairs.

Mr. Cowherd

348. The British Empire and Commonwealth (3)

The expansion of the Empire in Asia and Africa since 1848; the growth of federalism and self-government; the independence movements in Ireland and India; the formation of the Commonwealth; the impact of two World Wars; the decline of the Empire since the Second World War.

Mr. Cowherd

349. The Early Middle Ages (3)

An analysis of European institutions and cultural developments from 284 A.D. to the mid-eleventh century. Emphasis upon the evolution of the Church, feudalism and manorialism, the foundations of the Byzantine, Carolingian, and Holy Roman Empires, and the literary and artistic achievements of the period.

Mr. Tipton

350. The High Middle Ages (3)

A continuation of Hist. 349 to about 1400 A.D. Rise of the universities and towns; legal developments and the origins of representative government; rise of the nation-state; the crusades; Scholasticism and the decline of the medieval church; expansion of trade; and literary and artistic developments in late medieval society.

Mr. Tipton

355. European Intellectual History (3)

A study of political and religious thought and other aspects of the history of ideas in Europe from the Middle Ages to about 1700. Prerequisite: Consent of chairman of department.

Mr. Haight

356. European Intellectual History (3)

A continuation of Hist. 355, with special attention given to the impact of the Industrial Revolution upon thought and to the development of nineteenth- and twentieth-century ideologies. Prerequisite: Consent of chairman of department.

Mr. Haight

357. The Renaissance and Reformation (3)

An analysis of the transition from medieval to modern society. Consideration will be given to political, economic, and social forces produced by the Renaissance and the influence of these upon the dominant religious theme of the Reformation era.

Mr. Tipton

358. Age of the Baroque (3)

A study of Europe from 1648 to 1789. The course will treat the growth of absolutism in France, the rise of Prussia, and the social and political and economic conditions in the eighteenth century.

Staff

359. Modern Europe (3)

The study of revolutions and reactions in Western Europe from 1789 to 1870. Emphasis is placed on rise and spread of liberalism and the origins of socialism.

Mr. Haight

360. Modern Europe (3)

A study of contemporary Europe; the origins and consequences of two World Wars; the rise of revolutionary governments in Italy, Germany, and Russia.

Mr. Haight

365. Modern Latin America (3)

Individual investigation and reports on selected nineteenth and twentieth century topics valuable for an understanding of present Latin American culture. Prerequisite: Hist. 49, 50, or consent of chairman of department. Mr. Seager

366. Modern Latin America (3)

Continuation of Hist. 365. Prerequisite: Hist. 49, 50, or consent of chairman of department. Mr. Seager

367. The Iberian Peninsula (3)

A study of Spain and Portugal from the eighth century to the present, emphasizing the historical influence of Iberian culture on the development of colonial institutions. Prerequisite: One year of college Spanish or its equivalent and consent of chairman of department. Mr. Seager

368. The Caribbean (3)

A study of political and social developments from pre-Columbian times to the present with primary emphasis upon the growth of liberalism and nationalism in the twentieth century. Mr. Seager

371. Special Topics in History (3)

Intensive study in an area of history not adequately covered in currently listed offerings. The field of research may be varied from time to time and the course may be administered as a reading program or otherwise as may seem best to meet the needs of students of unusual ability and adequate preparation. Prerequisite: Consent of chairman of department. First semester.

372. Special Topics in History (3)

Continuation of Hist. 371. Prerequisite: Consent of chairman of department. Second semester.

374. Themes in American History (3)

An intensive study of a selected topic in American history primarily for American studies majors. The topic may vary from time to time as the needs of the American Studies program dictate. The aim of the seminar will be to allow study of an aspect of American history in greater depth than is generally the case. Prerequisite: Permission of director of American Studies.

For Graduates

The Lehigh Library is especially rich in materials for advanced study and research in history, and the Department of History offers programs leading to the Master of Arts and Doctor of Philosophy degrees. The graduate programs are designed to provide more intensive and specialized study than is possible at the undergraduate level. Graduate enrollment is limited so that close relations can be maintained between faculty and students. Admission to graduate study in History is competitive and dependent upon the applicant's undergraduate preparation and record.

Besides the general requirements for degrees set forth in the Graduate School section of this catalog, the following special requirements apply to graduate study in History. History 401 is required of all graduate majors. There are two master's programs. Under Plan I, a candidate may earn the degree by successfully completing twenty-four hours of approved course work and submitting a satisfactory thesis.

Candidates declaring Plan II take thirty hours of course work without thesis. Candidates for the master's degree under both plans must take course work in, and pass examinations on, at least two fields, chosen from American, British, European, and Latin American history. Each candidate will select the plan better suited to his needs and abilities, upon the advice and with the approval of the head of the Department.

Candidates for the degree of Doctor of Philosophy in History must prepare themselves in four history fields and one outside minor, pass written and oral examination on these fields, and submit an original dissertation. The four history fields offered by the candidate are chosen upon the advice and with the approval of the chairman of the Department from the seven fields listed below. Dissertations may be written only in the primary fields.

<i>Primary</i>	<i>Secondary</i>
Britain	Medieval-Renaissance
Colonial America	Modern Europe to 1815
United States	Modern Europe since 1815
	Latin-America

401. Methods in Historical Research (3)

Techniques of research in history: training in the critical handling of documentary materials, in measuring the value of evidence, and in formal presentation of the results of research. Required of all graduate students in history. First semester.

Staff

402. Historiography (3)

A continuation of Hist. 401. A study of the aims, methods, and accomplishments of some of the most renowned historians of Europe and America. Second semester.

Staff

405. Early Modern Europe (3)

Research in selected topics in European history from the Reformation to the Wars of Religion.

Staff

406. Age of Absolutism (3)

Research in selected topics in political, social, and intellectual history of Europe from the Peace of Westphalia to the eve of the French Revolution.

Staff

407. Modern Europe, 1789-1870 (3)

The French Revolution; Era of Metternich; Congress of Vienna and reconstruction of Europe; industrial revolution and subsequent social reforms; democracy and nationalism; Second French Empire; unification of Italy and Germany. First semester.

Mr. Haight

408. Modern Europe since 1870 (3)

Latin and Teutonic Europe; nationalism and the new imperialism; World War I and the Treaty of Versailles; League of Nations; national socialism vs. democracy; World War II and its aftermath. Second semester.

Mr. Haight

410. Historical Literature Europe (3)

This course is designed to familiarize teachers with the important literature in the field. Students will analyze the major interpretations of the most significant movements in modern European history.

Staff

History: Honors Seminars

415. Tudor and Stuart England (3)

Selected topics in the religious, political, social, and intellectual history of England from 1485 to 1688. First semester.
Mr. Ellis

416. Hanoverian England (3)

Selected topics in political, social, and intellectual history from 1688 to 1815. Second semester. Mr. Ellis

417. England: The Age of Reform (3)

An intensive study of English industrial history, 1815-1870, emphasizing the liberal and humanitarian reforms. First semester.
Mr. Cowherd

418. England: The Age of Conflict (3)

An intensive study of English history since 1870, including the growth of socialism, the rise of the Labor Party, the formation of the Commonwealth, and the origins and consequences of two World Wars. Second semester.
Mr. Cowherd

420. Historical Literature: America (3)

This course is designed to familiarize teachers with the important literature in the field. Students will analyze the major interpretations of the most significant movements in American history.
Staff

421. America in the Seventeenth Century (3)

An advanced research seminar in British-American colonial history. Varied topics such as the settlement of the English colonies, the growth of colonial institutions, Puritanism and other intellectual currents. First semester.

422. America in the Eighteenth Century (3)

A continuation of Hist. 421. Varied topics, such as the workings of the mercantile system, the evolution of colonial institutions, the development of imperial administration, and the causes, events, and results of the wars with France and the War for American Independence, the Confederation and Constitution. Second semester.

426. The United States, 1800-1850 (3)

Research in selected topics related to Jefferson, the War of 1812 and the Era of Good Feelings, nationalism and sectionalism, the Age of Jackson, and Manifest Destiny. First semester.
Mr. Shade

427. The United States, 1850-1877 (3)

Research in selected topics related to the Civil War and Reconstruction, politics and foreign affairs, and post-war industrialism. Second semester.
Mr. Shade

428. The United States, 1877-1914 (3)

Research in selected topics of the period, including late nineteenth-century industrialism, the growth of labor unions, agricultural discontent, and the rise of reform movements. First semester.
Mr. Dowling

429. The United States Since 1914 (3)

Research in selected topics related to World War I, the 1920's, the depression and New Deal, World War II, and post-war America. Second semester.
Mr. Dowling

431. America as a World Power (3)

The results of the Spanish-American War; the United

States' Pacific possessions; Theodore Roosevelt and world affairs; Knox and "Dollar Diplomacy"; World War I; American neutrality; the United States as a belligerent; the Treaty of Versailles. First semester.
Mr. Amidon

432. America as a World Power (3)

The United States and the League; the reconstruction of Europe; the rise of Hitler; World War II; the Monroe Doctrine; the Good Neighbor Policy; the problems of the Pacific; China and Japan; Japan and the United States; the War with Japan; the aftermath of World War II. Second semester.
Mr. Amidon

481. Graduate Seminar (3)

An intensive study of the history of Latin America, the United States, England, or one or more of the leading countries of Europe. Subject and instructor may vary from semester to semester according to the needs of the students and the availability of faculty members. First semester.
Staff

482. Graduate Seminar (3)

A continuation of Hist. 481. Second semester.
Staff

Honors Seminars

Honors Seminars are open to students admitted to the Interdepartmental Honors Program (see page 20), and occasionally to special students approved by the Honors Council. Enrollment is limited.

Seminars are conducted with a combination of lectures, student reports, and discussion. Emphasis is placed on the development of the student's ability to conduct, report on, and defend independent research. In addition to the scheduled seminar hours, there will be personal conferences with the instructor.

Course titles indicate only the general area in which a seminar will be conducted. The particular concepts to be considered and the material to be studied will be determined by the instructor with the concurrence of the Honors Council.

Creative Concepts 101. The Humanities (3)

A study of concepts significant in man's attempts to understand himself as an individual, his place in and his relation to the universe, the meaning of his existence, and the way in which he should live. Material is drawn chiefly from literature, philosophy, religion, and the fine arts and music.

Creative Concepts 102. The Life Sciences (3)

A study of concepts significant in man's efforts to understand and to control the living world of which he is a part. Material is drawn primarily from biology, psychology, and geology, but also, because of the ultimate inseparability of the natural sciences, from chemistry and physics.

Creative Concepts 103. The Physical Sciences (3)

A study of concepts significant in man's efforts to understand and use the physical universe in which he lives. Ma-

Industrial Engineering

terial is drawn primarily from chemistry, physics, mathematics, and astronomy, but also, because of the ultimate inseparability of the natural sciences, from biology and geology.

Creative Concepts 104. The Social Sciences (3)

A study of concepts significant in man's attempts to understand himself as a social being, his beliefs as to how men should live together and the means he has used to achieve social order. Material is drawn, depending on the orientation of individual seminars, from the political and social sciences.

Creative Concepts 190. Honors Thesis (3-6)

Independent work and thesis on an approved subject in a form appropriate to the field of study. The work is directed throughout by the thesis adviser.

Professors

ARTHUR FREEMAN GOULD, M.S., *Chairman and Alcoa Professor*
GEORGE EUGENE KANE, M.S.
SUTTON MONRO, B.S.
WALLACE JAMES RICHARDSON, M.S.

Associate Professors

JOHN WILLIAM ADAMS, PH.D.
JOHN MILLAR CARROLL, M.A.
WILLIAM ADAMS SMITH, JR., PH.D.

Assistant Professor

GARY E. WHITEHOUSE, PH.D.

Instructors

JOHN JOSEPH BURBRIDGE, JR., M.S.
MIKELL PORTER GROOVER, M.S.
DONALD M. JACKSON, B.S.
JOHN DAVID LANDIS, B.S.
GEORGE LEONARD SMITH, JR., M.S.

Graduate Assistants

ROBERT N. CHAPPELLE, JR., JOSEPH F. PERITORE, LAWRENCE E. WHITE

11. Applied Probability Laboratory (1)

Experimental sampling to approximate the different common models of probability distributions, including distributions of both data and related estimators. Prerequisite: Math. 231 concurrently. Second semester.

17. Introduction to Computing (3)

Basic computer concepts; algorithms and program logic; procedure oriented systems; principles of validation; computer solution to problems. Math. 23 concurrently. First semester.

18. Information Processing Theory (3)

Principles of organizing, sorting, and searching data; representation of data in various file media; analysis of work flow in computer systems; logic structure tables. Prerequisite: I.E. 17. Second semester.

40. Metal Processing Practice (3)

Study of metal processing theory and equipment. Practice in the operation of metal processing equipment at the Bethlehem Vocational High School including use of hand tools and operation of machine tools and welding equipment. Full-time daily schedule of lectures and practice for three weeks. Prerequisite: Met. 63. Summer session.

100. Industrial Employment (0)

Usually following the junior year, students in the industrial engineering curriculum are required to do a minimum of eight weeks of practical work, preferably in the field they plan to follow after graduation. A report is required. Prerequisite: Sophomore standing.

105. Thesis (3-6)

Candidates for the bachelor's degree in industrial engineering may, with the approval of the department staff, undertake a thesis as a portion of the work of the senior year. Prerequisite: Senior standing.

121. Analysis and Design I (5)

An intensive study of the planning activities of industrial engineering, including manufacturing planning, product design analysis, process selection, operation planning, material handling, plant layout, production control. Prerequisites: I.E. 40, Math. 231. First semester.

122. Analysis and Design II (4)

Techniques for analysis and design of man and machine work systems and application to typical problems in work measurement. Time study, predetermined time systems, work sampling, and development of standard data. Control of methods and standards. Prerequisites: I.E. 121 and 221. Second semester.

140. Mfg. Processes Laboratory I (1)

Experiments in application of metal cutting theory with emphasis on the economics of metal removal. Testing of tool life, tool materials, cutting fluids, and determination of machinability of materials. Prerequisite: I.E. 40.

152. Project (2)

Special study of a particular problem involving laboratory work and/or work in local industrial plants. Prerequisite: Senior standing in Industrial Engineering.

166. Production Management (3)

A course for the student not majoring in I.E. Study of functions involved in manufacturing planning and control, including production scheduling, inventory control, quality control, work measurement, methods analysis, and production systems analysis. Prerequisites: Math. 21, Eco. 3. First and second semesters.

For Advanced Undergraduates and Graduates

210. Elementary Design of Experiments (3)

An introduction to the structure of experiments, the analysis of experimental data, and their inter-relation. Measurement error, randomization, pairing, complete blocks, Latin squares, analysis of variance. Prerequisite: Graduate standing or consent of instructor. Mr. Monro

221. Industrial Statistics (4)

Techniques of hypothesis testing, including analysis of variance and distribution free methods; estimation, including regression and prediction. Elementary principles of planning samples. Design of experiments and construction of decision rules. Prerequisite: Math. 231. First semester. Staff

222. Operations Analysis and Design (4)

Use of economic models of interest to industrial engineers. Specific topics include depreciation, replacement economy, break-even analysis, marginal analysis, queuing, and linear programming. Prerequisite: Math. 231. Second semester. Staff

308. Data Processing (3)

Introduction to punched card and electronic data processing. Effects on organizational relationships; preparation of computer applications. Lectures, demonstrations, tours, student projects on computer. Prerequisite: I.E. 122 or I.E. 166. Messrs. Richardson, Carroll

310. File Structure and Processing (3)

Organizing data files for effective processing by computer. Coverage in depth of coding and filing; list processing; search strategy; sorting techniques; randomizing and chaining; use of decision tables; coordinate indices. Demonstrations, student projects on computer. Prerequisite: I.E. 308. Mr. Carroll

321. Experimental Industrial Engineering (3)

Experimental projects in selected fields of industrial engineering, approved by the instructor. A written report is required. Staff

322. Experimental Industrial Engineering (3)

Continuation of I.E. 321.

Staff

325. Production Control (3)

A study of the decision rules, and mathematical and economic models of production forecasting, scheduling, order control, and inventory control. Case problems and laboratory. Prerequisite: I.E. 121 and 222. Mr. Gould

326. Quality Control (3)

Problems involving inspection and test of product and check of process. Study of effect of design and inspection specifications upon cost and value. Problems and project. Prerequisite: I.E. 221. Messrs. Monro, Richardson

333. Industrial Engineering Administration (3)

The policies, organization, and procedures for the industrial engineering function in industry; influence of labor relations, grievance procedures and arbitration. Lectures, case problems, guest lecturers, term project. Prerequisite: I.E. 122 or I.E. 166. Mr. W. A. Smith

339. Industrial Manpower Management (3)

A study of policies and procedures involved in analysis and design of manpower planning and control; study of utilization of human resources on the job with emphasis on wage administration. Lectures, case problems, projects. Prerequisite: I.E. 122 or I.E. 121. Mr. G. L. Smith

340. Production Engineering (3)

Introduction to mechanization and automation of product manufacturing. Partial mechanization, engineering materials utilization, product design analysis, special processing methods, economic analysis of processing design alternatives. Term project. Prerequisite: I.E. 121. Mr. Kane

344. Metal Cutting Theory (3)

Intensive study of metal cutting emphasizing temperature and energy relationships and their effect on tool life, power requirements and surface finish. Economic balancing of metal cutting variables from application of theory. Lectures and laboratory experiments including designing and conducting an original experiment. Prerequisite: I.E. 140, Math. 231. Mr. Kane

352. Methods of Operations Research (3)

An intensive study of the mathematical methods and techniques of Operations Research. Topics include mathematical programming, queueing, and inventory control. Prerequisites: I.E. 222, Math. 205.

For Graduates

A program leading to the Ph.D. degree is offered by the Department of Industrial Engineering in the following fields: Manufacturing Engineering, Information Systems, and Operations Research.

Manufacturing Engineering offers opportunity for work in Work Systems and Manufacturing Processes. The course work given in Work Systems covers design and evaluation as well as administration of direct and indirect labor. Examination is also made of both incentive and measured-day work systems of labor controls. The course work offerings in Manufacturing Processes are directed toward both production and research. The course work given with production emphasis is coupled with industrial project work to give the student first hand experience in professional development. The Manufacturing Processes Laboratory is coupled with course offerings in which the emphasis is on research in manufacturing processes. This laboratory is available for experimental work by the student whose interest is research in manufacturing processes.

Graduate study in the field of information systems is directed toward management information for decision making, operational systems for man-machine activity control, data base development for storage and retrieval, computer application packages, and methods for evaluation of systems. Students are expected to develop substantial skill in utilizing digital computers and in applying operations research techniques in order to improve performance.

The primary interest of the Operations Research group of the Industrial Engineering Department is in the application of Operations Research and Applied Statistics to the fields of Manufacturing Engineering and Information Systems, rather than the development of new Operations Research techniques.

A student who wishes to complete his work for the M.S. in Industrial Engineering in one year of full-time study must have completed a course of study equivalent to that required for the B.S. in Industrial Engineering at Lehigh University.

The minimum program consists of twenty-four hours of approved course work and completion of a satisfactory thesis. Students with less than the required undergraduate program may be required to devote additional time to prerequisite and basic courses. In any event, a satisfactory thesis must be completed by all candidates.

An M.S. program is selected to meet the interests and needs of the student, and courses in other departments for which the student has the prerequisites may be integrated into the major field. Subject to proper approval, the courses required in the major field may include a maximum of nine hours from the following two groups with no more than six hours from each group: (1) "400" level courses in other branches of engineering; (2) Eco. 431, Managerial Economics; Eco. 433, Labor Management Economics; Actg. 422, Managerial Accounting; Psych. 455, Engineering Psychology; I.S. 421, Analysis of Information. As part of a purposeful major program, collateral courses may be taken in other branches of engineering, mathematics, economics, psychology and Information Science.

The laboratories of the department are located in the

James Ward Packard Laboratory and available for graduate work are a modern metal processing research laboratory, a CDC 6400 computer, and a work measurement laboratory.

The department offers courses during the late afternoon for the convenience of students who are employed in local industry and are taking graduate work on a part-time basis. There is no evening program, however.

405. Special Topics in Industrial Engineering (3)

An intensive study of some special field of industrial engineering. Staff

408. Management Information Systems (3)

Integrated and total systems concept for information processing. Real-time, on-line computing systems. Implementation and evaluation of management information systems. Prerequisite: I.E. 308 or consent of the department chairman.

Mr. W. A. Smith, Jr.

409. Industrial Engineering Standardization (3)

Identification of the basic variable that exist in industrial engineering, problem-solving techniques, and investigation of the means for standardization of these variables. Techniques analyzed for standardization include motion and time study, metal process planning, statistical quality control, and production planning and control. Mr. Kane

410. Design of Experiments (3)

Fixed designs for testing hypotheses, including incomplete blocks and fractional factorials. Sequential designs for estimation and optimization. Desirable preparation: Math. 231, Math. 205.

Messrs. Monro, Adams

415. Manufacturing Management (3)

Analysis of the factors entering into the development of manufacturing management philosophy; decision-making process in areas of organization, planning, operation, and control of manufacturing. Influence of the social, technical, and economic environment upon manufacturing management decisions.

Mr. Richardson

416. Dynamic Programming (3)

The principle of optimality; one-dimensional processes, multi-dimensional processes, lagrange multiplier technique; markovian decision processes; applications. Prerequisite: I.E. 352 or equivalent.

Mr. Adams

417. (Mgt. Sci. 417) Advanced Mathematical Programming (3)

Theory and applications of integer programming, parametric linear programming, non-linear programming, dynamic programming, duality theory, and network theory. Prerequisite: A semester's preparation in linear programming.

Messrs. Whitehouse, Turban

418. Simulation (3)

Random number generation, sources of bias, tests of randomness, transformations, estimating run length, clocked and unclocked simulation programs, evaluation of results, applications of simulation to industrial problems.

Mr. Carroll

INTERNATIONAL RELATIONS

420. Analysis of Decision Processes (3)

Methods of making optimum decisions, including decisions under certainty, decisions under risk, decisions under uncertainty, statistical decisions, and simulated decision making. Application to such areas as inventory theory, maintenance policy, and purchasing policy. Prerequisite: Math. 231, Math. 205. Mr. Whitehouse

425. Production Systems (3)

Mathematical models of production systems; dynamic simulation by digital computers for analysis and evaluation; optimization of production systems; interaction of physical system and information system; significance of system parameters. Mr. Carroll

426. Inventory Theory (3)

Optimal policies in deterministic inventory processes; optimal policies in stochastic inventory processes; operating characteristics of inventory policies. Prerequisite: I.E. 352 or equivalent. Mr. Adams

427. Queueing Theory (3)

Single server queueing processes, Poisson input and exponential service times, Poisson input and general service times, derivation of busy period distributions; many server queueing processes; applications. Prerequisite: I.E. 352 or equivalent. Mr. Adams

428. Advanced Work Systems (3)

A critical evaluation of methods improvement and work measurement techniques. Emphasis on the design of complex work systems, and reporting systems to control work. Work sampling, construction of standard data, mathematical models of work systems. Student projects. Mr. Richardson

440. Application of Automation (3)

Study of concepts and principles of design in fully automatic production lines; influence of economic factors; partial automation; integration into existing production systems. Case histories with emphasis on problems involved in application of principles. Plant visits and guest lecturers. Mr. Kane

450. Manufacturing Problems (3)

Discussion and solution of manufacturing problems involving several subfunctions, with emphasis on problem identification and definition; selection of techniques of analysis; procedures for evaluation of proposed solutions. Mr. Gould

490. Research Methods Seminar (3)

Research methods in industrial engineering; discussion and critical analysis of current industrial engineering research; practice in preparation of research proposals. Mr. W. A. Smith, Jr.

Professor

CAREY BONTHRON JOYNT, PH.D., *Chairman*

Adjunct Professor

PERCY ELWOOD CORBETT, M.A.

Associate Professors

HENDERSON BAMPFIELD BRADDICK, PH.D.

AURIE NICHOLS DUNLAP, PH.D.

OLES M. SMOLANSKY, PH.D.

Instructor

FREDERICK ROBERT GLADECK, M.A.

Graduate Assistants

RICHARD LITTLE, VINCENT E. A. OKWUOSA

1. World Politics (3)

An introductory analysis of the major concepts and principles involved in an understanding of international politics. The main focus will be upon nationalism, the balance of power, alliances, the nature of conflict, and the limits of peaceful change. First semester. Mr. Dunlap

2. World Politics (3)

An introduction to the foreign policies of the great powers: United States, Soviet Union, Britain, France, Germany, Japan, India, and China. Second semester. Mr. Dunlap

11. European International Relations 1815-1919 (3)

Politics of the Great Powers; clashes of interests and international crises; development of alliances and other associations of states; wars and peace settlements; unification of Germany and Italy; European imperialism; World War I and the peace treaties. Mr. Braddick

12. European International Relations Since 1919 (3)

The political and strategic structure of Europe in the 1920's; the rise of Germany under Hitler; the politics of international crises, 1935-39; World War II and the new distribution of power in Europe; development of the Cold War; European functional integration; contemporary European international problems; European relations with the United States. Mr. Braddick

21. The Diplomacy of the Far East to 1919 (3)

The opening of China and Japan; the transformation of Japan; the partition of China; international rivalries in Korea, Manchuria, the Philippines, Southeastern Asia, and the Indies; economic and territorial imperialism. First semester. Mr. Gladeck

22. The Diplomacy of the Far East Since 1919 (3)

An analysis of recent and contemporary political and economic problems confronting not only the countries of the Orient but the Western powers with interests in that region; Japan's aspirations to establish a New Order in Greater East Asia; frustration and remotivation of Japan; the spread of communism and its consequences; prerequisites for peace and security in the Far East and the Pacific region. Second semester. Mr. Gladeck

31. The Middle East in World Affairs

An analysis of the political, economic and social forces which have led to the rise of the modern states in the Middle East. Emphasis will be placed upon the role of the area in international politics from the invasion of Egypt by Napoleon to 1918. First semester. Mr. Smolansky

32. The Middle East in World Affairs (3)

The mandates system and the Palestine problem; movements of modernization in Turkey and Iran; the rise of Arab Nationalism; the impact of the Second World War upon the position of Britain and France; the growth in influence of the United States and the Soviet Union; the emergence of Israel and its impact on the Arab states; the rise of Nasserism and the Suez Crisis; the growth of neutralism. Second semester. Mr. Smolansky

133. The Diplomacy of Russia to 1917 (3)

Development and expansion of the Russian Empire; principles of Russian foreign policy and their specific applications under the Tsarist and Provisional Governments, treated partially as backgrounds of Soviet policy; interaction between Russian domestic and foreign affairs. First semester. Mr. Smolansky

134. The Diplomacy of Russia Since 1917 (3)

A topical and chronological survey of Russian foreign relations in the Soviet period; philosophical, psychological, economic, social, and other factors influencing the formulation and execution of foreign policy; interaction between Soviet domestic and foreign affairs. First and second semester. Mr. Smolansky

For Advanced Undergraduates and Graduates**311. World Affairs 1919-1945 (3)**

The structure and politics of the state system after World War I; ideals and realities of the League of Nations; rise of Germany, Japan and Italy to challenge the established order; analysis of the political and strategic background to appeasement; the international crises of the 1930's; the Second World War. Mr. Braddick

312. World Affairs Since 1945 (3)

The impact of World War II upon the State system; the Cold War and the development of bipolar international politics; the United Nations as an instrument for international order and security; the decline of the colonial system and the emergence of new states; development of Communist China and Western Europe as new power centers; contemporary problems in international relations. Mr. Braddick

323. Southeast Asia in World Affairs (3)

Analysis of the period since the beginning of the Second World War with special attention to the effect of the Japanese conquest of the area, the rise of independent states, the development of the foreign policies of the new states, great power influence, and the development of the Vietnam conflict. Prerequisite: Consent of chairman of department. Mr. Gladeck

324. The Far East in World Affairs (3)

Analysis of the period since the Second World War with

special attention to the foreign policy of Communist China, the foreign policy of Japan since the peace treaty and the role of the great powers in the various postwar crises in the area. Prerequisite: Consent of chairman of department.

Mr. Gladeck

334. The Soviet Union in World Affairs (3)

An appraisal of the objectives and tactics of Soviet diplomacy, with particular emphasis upon Russia's status as one of the great powers, and upon contemporary Soviet-American relations and their backgrounds. Prerequisite: I.R. 134 or consent of chairman of department.

341. International Relations (3)

An examination of contemporary theories and basic concepts in world politics, with application to historic and current issues of international politics. Consent of head of department. First semester. Mr. Joynt

342. International Relations (3)

Continuation of I.R. 341. Prerequisite: Consent of chairman of department. Second semester. Mr. Joynt

351. International Institutions (3)

Theory and functioning of the League of Nations and the United Nations with particular reference to the problems of collective security, enforcement, and the pacific settlement of disputes; functional and regional organizations; diplomacy by conference; state sovereignty and inter-state organizations. Mr. Braddick

352. International Institutions (3)

Continuation of I.R. 351, with emphasis upon the United Nations. Second semester. Mr. Braddick

361. International Law (3)

General theories of law and their application to international law; international lawmaking, adjudication and enforcement; personality of states, international organizations, corporations and persons; state succession; title to territory; jurisdiction over territory, waters, airspace, outer space and persons; the state and the foreign corporation. Mr. Dunlap

362. International Law (3)

Privileges and immunities of diplomatic and consular officers and of international organizations; treaties and agreements; pacific settlement; measures short of war; collective security; the legal status of war and the laws of war; war crimes trials and international criminal jurisdiction. Mr. Dunlap

371. Readings in International Relations (3)

Directed studies and readings in the several fields of international relations, designed for the student who has a special competence or interest in some area not covered by regularly rostered courses. May be repeated for credit. Prerequisite: Consent of chairman of department. First semester. Staff

372. Readings in International Relations (3)

Continuation of I.R. 371. May be repeated for credit. Prerequisite: Consent of chairman of department. Second semester. Staff

International Relations

381. Special Topics (3)

An intensive study of some aspects of international politics not covered in another course. Prerequisite: Consent of chairman of department. Staff

382. Special Topics (3)

A continuation of I.R. 381. Prerequisite: Consent of chairman of department. Staff

391. The Teaching of International Relations (3)

Lectures, readings and discussion of fundamental concepts, principles and problems of international relations, with current applications. Open only to present and prospective junior and senior high school teachers. Mr. Dunlap

For Graduates

Thirteen student currently are pursuing the Master of Arts in the Department of International Relations. The Ph.D. is not offered.

Each student's program is planned on an individual basis to take advantage of his previous academic work and his career goals.

A thorough understanding is required of basic theoretical issues and, unless the student comes prepared, he will be expected to undertake a course in theoretical analysis. Emphasis throughout the Department is upon the fundamentals of international politics as they affect international law and institutions and the policies and activities of the great powers.

The Department offers advanced work in theories of international politics and special work in Soviet affairs, Middle Eastern politics, European international relations between the wars, international law and military problems as well as arms control and disarmament studies. The Department feels this is attractive preparation for a student who wishes to continue work toward the doctorate, as a great many departmental majors have done at leading institutions in this country and abroad.

Candidates for the master's degree may qualify either by completing successfully thirty hours of approved course work and passing an examination covering the entire field or by completing twenty-four hours in approved courses and submitting a satisfactory thesis. Each candidate will select the plan better suited to his needs and abilities, upon the advice and with the approval of the Chairman of the Department, and will be required to take a comprehensive oral examination. In addition, each candidate is normally expected to possess an adequate reading knowledge of one modern foreign language.

Students will be encouraged to include in their programs appropriate courses in Economics, Government, History, Psychology, and Social Relations.

441. Seminar in International Relations (3)

Intensive analysis of selected forces and problems of world politics. First semester. Mr. Joynt

442. Seminar in International Relations (3)

Continuation of I.R. 441. Second semester. Mr. Joynt

451. Seminar in International Organization (3)

Intensive analysis of selected agencies and activities of the League of Nations and affiliated institutions. First semester.

452. Seminar in International Organization (3)

Continuation of I.R. 451, with emphasis upon the United Nations. Second semester.

461. Seminar in International Law (3)

Intensive analysis of the principal theories concerning the nature of international law and its fundamental conceptions, with special studies of their application and significance in contemporary international society. First semester.

462. Seminar in International Law (3)

Continuation of I.R. 461. Second semester.

471. Special Topics (3)

Selected topics in the field of international politics not covered in other courses. May be repeated for credit. Prerequisite: Consent of chairman of department. Staff

472. Special Topics (3)

Continuation of I.R. 471. May be repeated for credit. Prerequisite: Consent of chairman of department. Second semester. Staff

MANAGEMENT SCIENCE

Professor

L. REED TRIPP, PH.D., *Acting Chairman*

Associate Professor

JAMES B. HOBBS, D.B.A.

Assistant Professors

FRANK ALOYSIUS DUNN, M.A.

EFRAIM TURBAN, PH.D.

Adjunct Instructor

LANE LOUIS JORGENSEN, M.S.

Graduate Assistant

PRATAP NARAIN MISRA

301. Business Management Policies (3)

A study of business problems and the formulation of policies to meet these problems from the viewpoint of general management, integrating knowledge acquired in other courses in order to develop skill in policy formulation for particular functions and for companies as a whole. Long range goals' attainment and the required administration actions will be emphasized. The course is to be supplemented by case studies, Management Business Simulation Game and interactions with management of local industry. Prerequisite: Senior standing required. Second semester.

Messrs. Hobbs, Turban

302. Survey of Management Science Applications (3)

Survey course of various management science models and methods: mathematical programming, inventory, waiting line (Queuing), maintenance and replacement, simulation, PERT and CPM and Line of Balance. Prerequisites: Eco. 45, Acctg. 111, and one semester of Calculus.

Messrs. Dunn, Turban

313. Linear Programming (3)

Theory and methods of optimizing deterministic linear functions subject to linear constraints; graphical solutions; development of the simplex algorithm; game theory; duality theory. The dual-simplex; the revised simplex; sensitivity analysis. Emphasis is placed on applications such as transportation, production, and assignment. Prerequisite: Eco. 45, Math. 21 or consent of the instructor.

Messrs. Dunn, Jorgenson

321. Business and Organization Behavior (3)

An analysis of various theories of business and managerial behavior emphasizing the business organization and its internal processes. Economic analysis, hierachial management, modern organization theory, human relations, conflict — are the main frameworks examined. First and second semesters.

Messrs. Turban, Tripp

371. Readings (3)

Readings in various fields of management, designed for the student who has a special interest in some field of management not covered by the regularly rostered courses. First or second semester. Prerequisite: Permission of instructor.

372. Readings (3)

Continuation of Mgt. Sci. 371. First or second semester.

417. (I.E. 417) Advanced Mathematical Programming (3)

Theory and applications of the extensions of linear programming: Integer programming, parametric linear programming, non-linear programming, dynamic programming, duality theory and network theory. Prerequisite: a course in linear programming. First semester.

Mr. Turban

418. Seminar in Management Science (3)

Theory of applications of operations research methods and models such as: Inventory, waiting line, simulation, net-work theory, non-linear and dynamic programming. A practical project is carried out by the students. Prerequisite: Mgt. S. 417. Second semester.

Mr. Turban

471. Special Topics (3)

An extended study of an approved topic in the field of management. First or second semester.

Staff

472. Special Topics (3)

Selected topics not covered in scheduled courses in the department. May be repeated for credit with the consent of the Chairman of the Department. First or second semester.

Staff

MATHEMATICS

Professors

ARTHUR EVERETT PITCHER, PH.D., *Chairman and Distinguished Professor*
THEODORE HALPERIN, PH.D.
CHUAN-CHIH HSIUNG, PH.D.
ALBERT WILANSKY, PH.D.

Associate Professors

EDWARD F. ASSMUS, JR., PH.D.
EDWARD HUTCHINS CUTLER, PH.D.
BHASKAR KUMAR GHOSH, PH.D.
SAMUEL LINIAL GULDEN, M.A.
SAMIR ANTON KHABBAZ, PH.D.
JERRY PORTER KING, PH.D.
VORIS V. LATSHAW, PH.D.
GREGORY T. MCALLISTER, PH.D.
GILBERT ALLAN STENGLE, PH.D.

Assistant Professors

GILBERT DARREL FRIEND, PH.D.
GEORGE E. MCCCLUSKEY, PH.D.
ALBERT DEAN OTTO, PH.D.
GERHARD RAYNA, PH.D.
PETER JULES RICCHETTA, PH.D.
WILLIAM HENRY RUCKLE, PH.D.
JOEL C. W. ROGERS, PH.D.
MURRAY SCHECHTER, PH.D.
WILLIAM BANCROFT SKERRY, M.S.
ANDREW KAGEY SNYDER, PH.D.
DOUGLAS HENLEY TAYLOR, PH.D.
DAVID TRUTT, PH.D.

Instructors

DANIEL JOHN FLEMING, M.A.
MARGUERITE B. GRAVEZ, M.A.
MURRAY ROBERT KIRCH, M.S.
GARY BERNARD LAISON, M.A.
BALAKRISHNAN SUBRAMANIAN, M.S.C.

Graduate Assistants

STEPHEN R. ALPERT, RICHARD O. BANAGAN, JEFFREY C. BOSSERMAN, SIHAM C. BRAIDI, GERARD E. COZZOLINO, JOSEPH J. DUBOIS, JAMES N. GUYKER, GAIL C. HERZ, JAMES H. HERZ, PETER N. S. HO, GEORGE A. HUFF, ALAN R. JEFFERY, PETER G. JESSUP, PETEE BETH JUNG, EDWIN J. KAY, RUDOLPH M. KOCH, STEPHEN B. LEONARD, JOHN J. LEVKO III, STEVEN J. MICHAELS, JOHN F. MILLER, JACK NARAYAN, DONALD B. PECHART, STEVE M. ROHDE, EDWARD F. SABOTKA, GEORGE O. SCHNELLER, NATHAN F. SIMMIS, MICHAEL J. STAUFFER, STANLEY L. STEPHENS, LOU W. STERN, JOHN W. TARRANT, JOHN W. TAYLOR, DONALD A. THOMPSON, ELIAS H. TOUBASSI, NEIL S. WETCHER, SCOTT W. WILLIAMS

6. Finite Mathematics (3)

Compound statements; intuitive ideas of set with elementary techniques of union, intersection, complement; combinatorial algebra; probability measures and applications to probability theory; matrices and linear equations; finite Markov chains; linear programming; game theory; and applications to behavioral sciences. First and second semesters.

8. Elementary Statistics (3)

Collection and representation of statistical data; measures of location, dispersion, skewness and kurtosis; sampling distributions studied empirically; fundamental theorems on probability; binomial, Poisson and hypergeometric laws; normal curve; statistical estimation and tests of significance; correlation and regression, least square theorems; the bivariate normal surface; the chi-square tests; analysis of variance and elementary ideas on the design of experiments. Prerequisite: Math. 21. Second semester.

21. Analytic Geometry and Calculus I (4)

Functions and graphs; limits and continuity; derivative and differential; indefinite and definite integral; logarithm and exponential. First and second semesters.

22. Analytic Geometry and Calculus II (4)

Trigonometric and hyperbolic functions; integration; vector algebra and calculus; solid analytic geometry. Prerequisite: Math. 21. First and second semesters.

23. Analytic Geometry and Calculus III (4)

Series; Taylor's Theorem; approximations; partial derivatives, multiple integrals; line and surface integrals; differential equations. Prerequisite: Math. 22. First and second semesters.

Mathematics 31 and 32 is an accelerated calculus sequence which is equivalent to Mathematics 21, 22, and 23.

31. Calculus (4)

Functions and graphs; limits and continuity; derivative and differential; indefinite and definite integral; logarithm, exponential, trigonometric and hyperbolic functions; integration; vector algebra and calculus. Math. 31 may be used in place of Math. 21 to satisfy prerequisites. Prerequisite: Consent of the chairman of the department. First semester.

32. Calculus (4)

Vector calculus; solid analytic geometry, series; Taylor's Theorem; approximations; partial derivatives; multiple integrals; line and surface integrals; differential equations. Math. 32 may be used in place of Math. 23 to satisfy prerequisites. Prerequisite: Math. 31. Second semester.

54. Advanced Geometry (3)

An introductory course in projective geometry and non-euclidean geometry. Prerequisite: Math. 22 or consent of chairman of department. First semester.

105. Computer Programming (3)

The translation of simple mathematical and logical problems into forms permitting their solution by digital computers, with emphasis on machine-language programming of several typical types of computers. First and second semesters.

Mr. Rayna

171. Reading Courses in Mathematics (1)

Credit not to exceed one hour per semester, total credit not to exceed three hours; approval of program and written report required. Prerequisite: Consent of chairman of department. First and second semesters.

For Advanced Undergraduates and Graduates

For students who have not taken their elementary mathematics at Lehigh, the prerequisites for certain advanced courses are stated in terms of the number of semester-hours of calculus.

205. Linear Methods (3)

Matrices; systems of linear equations; determinants and rank; characteristic roots; linear differential equations; eigenvalue problems; analytic functions; Bessel's equation. Designed for undergraduates in science and engineering. Prerequisite: Math. 23 or Math. 32. First and second semesters.

Staff

208. Complex Variables (3)

Functions of a complex variable; calculus of residues; contour integration; applications to conformal mapping and Laplace transforms. Prerequisite: Math. 23, or nine semester hours of differential and integral calculus. First and second semesters.

Staff

219. Principles of Analysis I (3)

The real number system; limits; continuous functions; differentiation; integration; infinite series; absolute and uniform convergence. Prerequisite: Math. 23 or nine semester-hours of differential and integral calculus. First and second semesters.

Staff

220. Principles of Analysis II (3)

Continuation of Math. 219. Functions of several variables; line and surface integrals; implicit functions; Fourier series. Prerequisite: Math. 219. First and second semesters.

Staff

221. Differential Equations (3)

Techniques for solving first order and higher order linear differential equations, Laplace transform methods; method of successive approximations, fundamental existence theorem, properties of linear equations; solutions in series, Legendre Polynomials. Prerequisite: Math. 23 or nine semester-hours of differential and integral calculus. First and second semesters.

Staff

224. Probability and Numerical Analysis (3)

Probability; least squares and its application in the study of errors; formation of empirical formulas; numerical methods. Designed for students engaged in experimental or observational work. Prerequisite: Math. 23 or nine semester-hours of differential and integral calculus. First and second semesters.

Mr. Latshaw

230. Numerical Methods (3)

Numerical solution of non-linear equations and systems; linear systems and the algebraic eigenvalue problem; difference calculus and interpolation; numerical differentiation and quadrature; numerical solution of ordinary differential equations. Students will use the digital computer. Prerequisite: Math. 204. First or second semester.

231. Statistical Inference (3)

Probability, distribution of random variables; hypergeometric, binomial, Poisson, normal, gamma and beta distributions, moments, samples, populations, classification of data, random sampling; sampling distributions of mean

and variance; chi-square, t , F ; testing of hypotheses and estimation, Neyman-Pearson Lemma and likelihood ratio tests, methods of maximum likelihood and moments; application of chi-square, t and F ; correlations and regression theory of two variables; brief introduction to non-parametric methods and analysis of variance. Prerequisite: Math. 23 or nine semester-hours of calculus. First and second semesters.

Staff

241. Matrices and Vector Spaces (3)

Vector spaces; linear transformations; matrices; systems of linear equations; determinants; equivalence and similarity; characteristic vectors and values; diagonalization; Cayley-Hamilton theorem; bilinear and quadratic forms. Prerequisite: Consent of chairman of the department. First semester.

Staff

242. Modern Algebra (3)

The basic concepts of higher algebra; group theory including the Sylow theorems; ring theory with emphasis on Euclidean rings; field theory including an introduction to Galois theory. Prerequisite: Math 241. Second semester.

251. Mathematical Methods (1-4)

An introductory survey of topics in analysis for graduate students in fields other than mathematics. Topics may include: differential equations, techniques of series expansion, numerical methods, matrix and vector analysis, complex variables, calculus of vector fields. Formal applications are emphasized. Prerequisites: graduate standing and consent of the instructor. With consent of the department chairman, may be repeated for credit. First semester.

252. Mathematical Methods (1-4)

A survey of topics in analysis for graduate students in fields other than mathematics, either continuing topics treated in Math. 251 or introducing new topics. Prerequisites: Graduate standing and consent of the instructor. With consent of the department chairman, may be repeated for credit. Second semester.

284. Number Theory (3)

Divisibility, congruences, quadratic residues, primitive roots, diophantine equations. First or second semesters.

301. Vector and Tensor Analysis (3)

Elementary vector identities. Gauss's theorem and Stokes's theorem. Elementary differential geometry of curves and surfaces. Calculus of tensors. Prerequisite: Math. 23 or Math. 32 or nine semester-hours of differential and integral calculus.

Mr. Hailperin

303. Mathematical Logic (3)

A course, on a mathematically mature level, designed not only to acquaint the student with the logical techniques used in mathematics but also to present symbolic logic as an important adjunct in the study of the foundations of mathematics. First semester.

Mr. Hailperin

304. Axiomatic Set Theory (3)

A development of set theory from axioms; relations and functions; ordinal and cardinal arithmetic; recursion theorem; axiom of choice; independence questions. Prerequisite: Math. 219 or consent of the instructor. Second semester.

Mr. Hailperin

307. General Topology I (3)

An introductory study of topological spaces, including metric spaces, separation and countability axioms, connectedness, compactness, product spaces, quotient spaces, function spaces. Prerequisite: Math. 219. First semester.

308. Algebraic Topology I (3)

Polyhedra, fundamental group, simplicial and singular homology. Prerequisite: Math. 307 and Math. 327. Second semester.

Messrs. Khabbaz, Taylor

309. Theory of Probability (3)

Probabilities on discrete and continuous sample spaces; events on a discrete sample space; random variables and probability distributions; transformations; simplest kind of law of large numbers and central limit theorem. The theory will be applied to problems in physical and biological sciences. Prerequisite: Math. 23 or nine semester hours of differential and integral calculus. First or second semester.

Messrs. Ghosh, Stengle

315. Theory of Functions of a Complex Variable I (3)

Algebra of complex numbers; analytic functions; Cauchy-Riemann equations; Laplace's equation; conformal mapping; integrals of complex functions; Cauchy's theorem; power series; Taylor's theorem; Laurent's theorem, residues. Prerequisite: Math. 219. First or second semester.

Messrs. Skerry, King, Trutt

320. Ordinary Differential Equations (3)

The analytical and geometric theory of ordinary differential equations, including such topics as linear systems, systems in the complex plane, oscillation theory, stability theory, geometric theory of non-linear systems, finite difference methods, general dynamical systems. Prerequisite: Math. 220 previously or concurrently and Math. 221. First or second semester.

Messrs. Schechter, Stengle, McAllister

322. Methods of Applied Analysis I (3)

Fourier series, eigenfunction expansions, Sturm Liouville problems. Fourier integrals and their application to partial differential equations; special functions. Emphasis is on a wide variety of formal applications rather than logical development. Prerequisite: Math. 205 or Math. 221 or consent of chairman of department. First and second semesters.

Staff

323. Methods of Applied Analysis II (3)

Green's functions; integral equations; variational methods; asymptotic expansions, method of saddle points; calculus of vector fields, exterior differential calculus. Prerequisite: Math. 322. Second semester.

Mr. Stengle

327. Groups and Rings (3)

An intensive study of the concepts of group theory including the Sylow theorems, and of ring theory including unique factorization domains and polynomial rings. First semester.

Messrs. Assmus, Otto

331. Numerical Analysis (3)

Examination of some commonly used numerical methods for the solution of linear and non-linear equations, quadrature, and the solution of ordinary differential equations.

Special attention is given to the analysis of errors resulting from rounding, discretization, and truncation. The course work involves the use of a digital computer. Prerequisite: Math. 219. First semester. Messrs. McAllister, Schechter

334. Mathematical Statistics (3)

Populations and random sampling; sampling distributions; theory of statistical estimation; criteria and methods of point and interval estimation; theory of testing statistical hypothesis; analysis of variance; non-parametric methods. Prerequisite: Math. 309 or, with the consent of the instructor, Math. 231. First or second semester. Mr. Ghosh

350. Special Topics (3)

A course covering special topics not sufficiently covered in the general courses. Prerequisite: Consent of the chairman of department. First or second semester. May be repeated for credit.

Staff

362. Computer Languages (3)

An examination of a number of high-level computer programming languages, and of the concepts and techniques which are used in the design of the compilers which translate them. Prerequisite: Math. 105 or consent of the instructor. First or second semester.

Mr. Rayna

371. Readings in Mathematics (3)

The study of a topic in mathematics under appropriate supervision; designed for the individual student who has studied extensively and whose interests lie in areas not covered in the listed courses. Prerequisite: Consent of the chairman of the department. First or second semester. May be repeated for credit.

381. Probability and Statistics (3)

Combinatorial problems, theory of probability, various frequency distributions, standard deviation, sampling, correlation. Prerequisite: Open to secondary school teachers who present at least eighteen hours of undergraduate mathematics.

382. Algebra (3)

Fundamentals of algebra, axiomatic method, set theory, notions of group, ring, integral domain, and field. Prerequisite: Same as Math. 381.

385. Higher Geometry I (3)

Logical systems, postulates, synthetic projective geometry, analytic projective geometry, affine, Euclidean and non-Euclidean geometry. Prerequisite: Same as Math. 381.

387. Intermediate Analysis (3)

The real number system, functions, limits, continuity, derivative, law of the mean, Taylor's formula, definite integral. Prerequisite: Open only to secondary school teachers of mathematics who present at least 18 semester-hours of undergraduate mathematics including a course in analysis.

For Graduates

The Department of Mathematics and Astronomy offers a graduate program in mathematics leading to the Ph.D. degree. The first of these degrees was awarded in 1939. In

the fall of 1967 there are about sixty graduate students of mathematics, of whom about twenty are engaged in writing Ph.D. theses. The M.S. degree in mathematics may be taken as a terminal degree or as an incidental step on the road to a Ph.D. degree.

To begin graduate work in mathematics, a student must present evidence of adequate study of mathematics as an undergraduate. His program should have included at least a year of advanced calculus, a semester of linear algebra, and a semester on groups, rings, and fields.

The program for the M.S. degree will ordinary include Math. 307, 308, 315, 327, 401, 423, and 428. A student with unusually strong background, or specialized interests, may be permitted to make substitutions.

The M.S. degree requires either a thesis or a comprehensive examination at the discretion of the department chairman. The same examination is used as the comprehensive examination for the M.S. degree and the qualifying examination for the Ph.D. degree. Thus it is usually required for the M.S. degree for those students who plan to continue to the Ph.D. A syllabus for the examination is available.

The plan of work for the Ph.D. degree will ordinarily include courses in algebra, analysis, geometry, and topology at the 400 level and several courses including seminars in the field in which the dissertation is to be written. The department accepts candidates for the Ph.D. who wish to specialize in and to write a dissertation on some aspect of any of the following areas of advanced work: analysis with emphasis on pure mathematics or applied mathematics, algebra, functional analysis, differential geometry, mathematical logic, probability, statistics, and topology.

One may wish to refer to the description of the Center for the Application of Mathematics on page 88.

401. Theory of Functions of a Real Variable (3)

A study of significant classes of real valued functions, distinguished by such properties as continuity, semi-continuity, bounded variation, absolute continuity, differentiability, integrability. Prerequisite: Math. 307. Second semester.

Messrs. Schechter, Ruckle

402. Measure and Integration (3)

The general theory of measure and integration, with Lebesgue measure and integration as a significant example. Prerequisite: Math. 401. First semester.

Messrs. Laison, Pitcher

404. Mathematical Logic (3)

Advanced topics in quantification theory relevant to formalized theories, recursive functions, Gödel's incompleteness theorem; algorithms and computability. Prerequisite: Math. 303. Second semester.

Mr. Hailperin

405. Partial Differential Equations (3)

Classification and transformation of equations; theory of characteristics; initial and boundary value problems; Cauchy's problem for hyperbolic equations; Dirichlet's problem for elliptic equations; potential theory; Green's function; harmonic and sub-harmonic functions; difference equations; applications to equations of physics. Prerequisite: Math. 220 and Math. 221. First semester.

Messrs. McAllister, Stengle

406. Partial Differential Equations (3)

Continuation of Math. 405. Prerequisite: Math. 405. Second semester. Messrs. McAllister, Stengle, Schechter

407. Transforms (3)

The properties and use of the Fourier transform, the Laplace transform, the finite transform and generalized functions. Prerequisites: Math. 220, Math. 221, and either Math. 208 or Math. 315. Messrs. Gulden, Schechter

408. Boundary Value Problems (3)

The study of boundary value problems with attention to integral equations, special functions, variational methods, and eigenvalue problems. Prerequisites: Math. 220, Math. 221, and either Math. 208 or Math. 315.

Messrs. Schechter, Rogers

409. Mathematics Seminar (3 or 6)

An intensive study of some field of mathematics not offered in another course. Prerequisite: Consent of chairman of department. First or second semester.

Staff

410. Mathematics Seminar (3 or 6)

Continuation of the field of study in Math. 409 or the intensive study of a different field. Prerequisite: Consent of chairman of department. First or second semester.

Staff

416. Theory of Functions of a Complex Variable II (3)

Continuation of Math. 315, with more advanced topics, such as theory of conformal mapping, bilinear transformations, analytic continuation, summability of series, multiple-valued functions, Riemann surfaces, infinite products, Weierstrass's factor theorem, Mittag-Leffler's theorem, special classes of functions. Prerequisite: Math. 315. Second semester.

Messrs. King, Skerry, Trutt

419. Linear Operators in Hilbert Space (3)

Algebra and calculus of bounded and unbounded operators in Hilbert space, with applications to differential operators and integral equations. Spectral analysis of self-adjoint, normal, and unitary operators. Emphasis will be given to those aspects of the theory which have applications in the physical sciences. Prerequisite: Math. 208 or Math. 315. First or second semester.

Mr. Trutt

421. Probability (3)

Measure theoretic approach to probability; random variables, characteristic functions; the uniqueness theorem; limit theorems; stochastic processes with discrete and continuous states; Kolmogorov equations; Markov chains, the ergodic theorem. Prerequisite: Math. 309. First or second semester.

Messrs. Ghosh, Stengle

423. Differential Geometry I (3)

The differential geometry of curves and surfaces in Euclidean space, including problems in the large. First semester.

Mr. Hsiung

424. Differential Geometry II (3)

Multilinear algebra; differentiable manifolds; tensor bundles; exterior differential forms; theorems of Stokes and Frobenius; imbedding theorem; affine connections; holonomy groups; Riemannian manifolds. Prerequisite: Math. 423 and Math. 308.

Mr. Hsiung

425. Differential Geometry III (3)

Continuation of Math. 424 Curvature tensor; manifolds of constant curvature; Gauss-Bonnet formula; completeness; harmonic forms; curvature and homology; infinitesimal transformations; conjugate points and Morse index theorem; Lie groups and Lie algebras. Prerequisite: Math. 424.

Mr. Hsiung

428. Fields and Modules (3)

Field theory, including an introduction to Galois Theory; the theory of modules, including tensor products and classical algebras. Prerequisite: Math. 327. Second semester.

Messrs. Assmus, Otto

431. Calculus of Variations (3)

Fundamental existence theorems; necessary conditions and sufficient conditions for relative minima of single integrals; the index theorem; application to boundary value problems. Prerequisite: Math. 401. First semester.

Messrs. McAllister, Pitcher

435. Functional Analysis I (3)

Transfinite induction; linear space; convex sets, separation theorems; linear topology; Frechet, Banach, Hilbert and Minkowski spaces, and Banach algebra; ordered spaces; reflexivity, weak and product topologies; open mapping, uniform boundedness; basis and orthogonal series; representation theorem; applications to classical analysis. Prerequisite: Math. 307. First semester.

Mr. Wilansky

436. Functional Analysis II (3)

Continuation of Math. 435. Prerequisite: Math. 435. Second semester.

Mr. Wilansky

443. General Topology II (3)

A continuation of Math. 307, with such topics as filters and nets, topological products, local compactness, paracompactness, metrizability, uniformity, function spaces, dimension theory. Prerequisite: Math. 307. Second semester.

Mr. Gulden

444. Algebraic Topology II (3)

Continuation of Math. 308. Cohomology theory, products, duality. Prerequisite: Math. 308. First semester.

Mr. Khabbaz

445. Algebraic Topology III (3)

Homotopy theory, obstruction theory, spectral sequences. Prerequisite: Math. 444. Second semester.

Mr. Khabbaz

449. Advanced Topics in Algebra (3)

An intensive study of some topics in algebra with emphasis on recent developments. May be repeated for credit. Prerequisite: Consent of chairman of department. First or second semester.

453. Topics in Function Theory (3)

The development of one or more topics in function theory, such as analytic continuation, maximum modulus principle, conformal representation, Taylor series analysis, integral functions, Dirichlet series, functions of several complex variables. Prerequisite: Math. 416. First semester.

471. Homological Algebra (3)

Modules, tensor products, categories and functors, homology functors, projective and injective modules. Prerequisite: Math. 428. First or second semester.

Messrs. Assmus, Taylor

472. Finite Groups (3)

An intensive study of the structure of finite groups and their automorphisms. Prerequisite: Math. 428. First or second semester.

Mr. Otto

ASTRONOMY

I. Descriptive Astronomy (3)

The earth as an astronomical body; the solar system; a brief introduction to sidereal astronomy. First and second semesters.

Mr. McCluskey

2. General Astronomy (3)

The solar system; the sidereal system, with an introduction to celestial mechanics and astrophysics. Prerequisite: Math. 21. Not open to Freshmen. First or second semester.

104. Stellar Astronomy and Astrophysics (3)

Introduction to astrophysics; the sun considered as a star; physical characteristics of the stars; stellar motions; binary stars; theory of binary star orbits; stellar aggregations; cosmogony. Prerequisites: Math. 22, and Phys. 16 or Phys. 3. First or second semester.

Mr. McCluskey

250. Topics in Astronomy (3)

A course covering one or more topics not covered in other courses. Prerequisite: Consent of the chairman of department. First or second semester. May be repeated for credit.

MECHANICAL ENGINEERING

Professors

ALAN HUGH STENNING, SC.D., *Acting Chairman*
JERZY ANTONI OWCZAREK, PH.D.

Associate Professors

RUSSELL EDWARD BENNER, PH.D.
JAMES VANDEUSEN EPPES, M.S.
THOMAS EDGAR JACKSON, M.S.

Assistant Professors

EDWARD K. LEVY, M.S.
ROBERT ALAN LUCAS, M.S.
BENJAMIN EDWARD NEVIS, PH.D.
JAMES P. RIES, PH.D.
RICHARD ROBERTS, PH.D.
THEODORE ALFRED TERRY, PH.D.

Instructors

LAWRENCE PETER GOLAN, M.S.
FRANK WATERS PAUL, M.S.
LUIS PUJOL, M.S.

Graduate Assistants

JOSEPH MICHAEL HARTH, NATHAN KALOWSKI, GARY B. LEWIS,
DOUGLAS H. YANO.

Research Assistants

STANLEY E. PACE, ERIC F. J. VON EUW

10. Analysis of Engineering Problems I (1)

Elementary analyses of problems in the field of mechanical engineering. Methods and techniques of solution. Use of digital computers. Prerequisite: Consent of chairman of department.

100. Industrial Employment (0)

Usually following the junior year, students in the mechanical engineering curriculum are expected to do a minimum of eight weeks of practical work, preferably in the field they plan to follow after graduation. A report is required. Prerequisite: Sophomore standing.

101. Mechanical Engineering Design I (3)

A project oriented course to develop student capability in mechanical engineering design. Design methodology, the functional behavior of mechanical elements, and engineering problem modeling. Special attention is given to defining design problems, organizing information, proposing solutions and evaluating alternatives.

102. Mechanical Engineering Design II (3)

Continuation of M.E. 101. Prerequisite: M.E. 101.

103. Mechanical Engineering Design III (5)

Consideration of dynamic loading on design of machines. Vibration and balancing. Attention to logical methods of investigating unfamiliar problems. Prerequisites: M.E. 102; Math. 221.

104. Thermodynamics I (3)

Basic concepts and principles of thermodynamics with emphasis on universal applications. First and Second Law development. Energy equations. Reversibility and irrevers-

ability. Entropy and probability. Thermodynamic functions. Properties of pure substances. Prerequisite: Math. 23, Phys. 3.

105. Thermodynamics II (3)

Thermodynamics applications. Reversible and irreversible processes and cycles with various fluids. Gas and vapor mixtures. Compressible and incompressible fluid flow. Prerequisite: M.E. 104.

108. Laboratory I (2)

Lectures and laboratory exercises relating to various phases of engineering laboratory technique and procedures. Includes planning, execution, and analysis of tests and writing of reports. Prerequisite: M.E. 105.

109. Laboratory II (2)

Continuation of M.E. 108 with emphasis on project investigations.

110. Thesis (1-3)

Candidates for the degree of B.S. in M.E. may, with the approval of the director of the curriculum, undertake a thesis as a portion of the work during the senior year.

160. Thermodynamics (3)

Fuels; combustion; principles of engineering thermodynamics; properties of steam; steam power plant equipment and cycles; internal combustion engines. Prerequisites: Math. 23; Phys. 3.

161. Mechanical Engineering Laboratory (1)

Testing of mechanical engineering equipment. Prerequisite: M.E. 160, or M.E. 104.

166. Procedures for Mechanical Design (2)

General design procedures, motion analysis, force analysis, static, repeated and impact types of loading, modes of failure, stress analysis, failure theories. Applications to the design of typical machine elements. Prerequisite: Mech. 11.

168. Elements of Mechanical Design (4)

Elements of mechanical design: motion and force analysis, sizing of members, selection of materials for failure prevention, production requirements. Selected examples of mechanical component and system design. Prerequisites: Mech. 11, Mech. 102 previously or concurrently.

For Advanced Undergraduates and Graduates

220. Thermodynamics (3)

Principles of classical thermodynamics with applications to engineering problems. Introduction to statistical thermodynamics. Prerequisites: Phys. 3 and Math. 23.

231. Fluid Mechanics (3)

Fundamental concepts. Physical similarity. Kinematics of fluid flow. Equations of flow in integral form. Equations of flow of perfect fluids. Plane irrotational flow of incompressible fluids. Navier-Stokes equation; hydrodynamic stability; turbulence. Two-dimensional boundary layers in incompressible flows; separation of flow; wakes; drag. Effects of compressibility on fluid flow. Hydraulic treat-

ment of losses in flows in ducts. Flows with free surface. Basic measurement techniques. Prerequisite: Math. 221 or Math. 205.

242. Mechanical Vibrations (3)

Physical modeling of vibrating systems. Single degree of freedom systems under free, forced and transient loading conditions. Lagrangian and matrix formulation for multiple degree of freedom systems. Simple continuous and non-linear systems. Engineering applications. Prerequisite: Mech. 102.

310. Projects (3-6)

Analysis and synthesis of selected mechanical engineering systems and devices. Case studies chosen from topics such as design of fluid machinery, power plants, internal combustion engines. Consideration of mechanical design and thermodynamic influences, with emphasis on the creative phase of design. Prerequisites: Consent of chairman of department. Staff

320. Thermodynamics III (3)

Kinetic theory of gases, statistical thermodynamics. Advanced and specialized topics in thermodynamics. Prerequisite: M.E. 105. Second semester. Mr. Owczarek

321. Heat Transfer (3)

Analytical, numerical, and analog solutions to steady and transient, one and two-dimensional conduction problems; thermal radiation, free and forced convection of laminar and turbulent character inside cylindrical tubes and over external surfaces; thermal design of heat exchangers. Prerequisites: M.E. 104, M.E. 231. Messrs. Nevis, Levy

322. Gas Dynamics (3)

Dynamics and thermodynamics of compressible flow; subsonic and supersonic flow in nozzles and ducts, heat addition, compressible flow with friction, linearized analysis of subsonic and supersonic flow, similarity rules, normal and oblique shocks, method of characteristics, applications to design of wind tunnels, rockets, ram-jets, turbines. Prerequisites: C.E. 121; M.E. 105; Math. 221. First semester. Mr. Owczarek

324. Aerospace Propulsion Systems (3)

Cycle analysis of air-breathing engines. Optimum configurations for different flight regimes. Chemical and nuclear rocket engines. Electrical propulsion devices. Rankine and Brayton cycles for space power plants. Component design. Prerequisite: M.E. 105. Mr. Stenning

331. Fluid Mechanics (3)

Kinematics of fluid flow, equations of flow in integral form, and two dimensional potential flow theory of incompressible fluids with applications. Navier-Stokes equations, dynamic similarity, laminar flows, turbulence, and boundary layers. Introduction to flow of compressible fluids. Measurement techniques. Flows in and performance analysis of turbomachinery; introduction to the design of cascades. Flow of non-Newtonian fluids. Hydrodynamic lubrication. Prerequisites: C.E. 121 and C.E. 123. Mr. Owczarek

340. Advanced Mechanical Engineering Design (3)

Design of mechanical systems and components requiring

applications of advanced principles of mechanics and material behavior. Advanced design topics, including optimization, reliability and sensitivity analysis. Prerequisite: M.E. 103. Second semester. Messrs. Benner, Terry

342. Mechanical Vibration Analysis (3)

Analysis of physical systems and setting up equations: development of significant engineering relationships. Emphasis on engineering application. Prerequisite: Math. 221. Second semester. Mr. Terry

343. Instrumentation and Automatic Control (3)

Selection, design and operation of measuring instruments. Analysis of automatic control systems for thermal, hydraulic and mechanical processes. Stability and response criteria. Prerequisite: Math. 221. Mr. Ries

For Graduates

During the 1966-67 academic year 56 students were engaged in graduate work in mechanical engineering of whom 18 were beyond the master's degree.

In the thermal-fluid sciences research is in progress on boundary layers under various conditions with application to turbomachinery. Study is also being made on the flow instabilities and heat transfer in two-phase flows. Investigation continues on the basic fluid phenomena and performance of pneumatic diodic devices for possible applications in control systems. A specially designed closed jet water tunnel is in use for research on the boundary layer flow in adverse pressure gradient with distributed wall-suction. Three-dimensional flows in axial compressors are being studied using a large single-stage test apparatus.

The Department is well equipped for experimental stress investigations including instrumentation for research with resistance strain gages, photo-elasticity, photostress, and Moire fringes. Recent investigations have been made on viscoelastic materials as well as metals. Research in crack propagation and fatigue is underway which involves students and faculty within several departments—mechanical engineering, mechanics, and metallurgy and materials sciences. Equipment is also available for vibration and other dynamic studies.

A master's degree program in design is available with the objectives of educating students in advanced design methods and encouraging the initiation and implementation of innovative design projects. The two core courses are in advanced engineering design (M.E. 445, M.E. 446). In addition the student will register for six hours of M.E. 460, Design Project, and submit an acceptable design project as his thesis.

For the master's degree a thesis will normally be required. The taking of mathematics courses which are required in the undergraduate mechanical engineering curriculum may be considered as making up a deficiency so that a larger number of credits than the minimum may be necessary. Subject to proper approval courses from other engineering curricula, such as mechanics, chemical engineering, and metallurgy and materials science, may be included in the major.

A student who plans to work for the doctor's degree should submit a general plan to the chairman of the department during his first year and arrange for the qualifying examination.

420. Advanced Thermodynamics (3)

Critical review of first and second laws, entropy, and general thermodynamic equations and relations; applications to current problems in technology and research.

Messrs. Owczarek, Stenning

421. Topics in Thermodynamics (3)

Emphasis on theoretical and experimental treatment of combustion processes including dissociation, flame temperature calculations, diffusion flames, stability and propagation; related problems in compressible flow involving one-dimensional, oblique shock waves and detonation waves. Methods of measurement and instrumentation.

Mr. Owczarek

423. Boundary Layer Analysis (3)

Navier-Stokes equations, laminar boundary layer theory, analysis of friction drag, heat transfer and separation; transition from laminar to turbulent flow. Turbulent boundary layer theory, Karman integral equations, Prandtl mixing length, turbulent friction drag, heat transfer and layer thickness. Flow in ducts, waves and jets.

Messrs. Owczarek, Stenning

424. Advanced Mechanical Vibrations (3)

Comprehensive study of vibrating systems; non-linear vibrations; aeroelasticity; study of current literature. Prerequisite: M.E. 440.

Mr. Long

425. Convective Heat Transfer (3)

Boundary layer theory; forced convection of both a laminar and turbulent character inside cylindrical tubes and over external surfaces; convective heat transfer in high speed flows; free convection from plates, spheres, and cylinders. Prerequisite: M.E. 321.

Messrs. Nevis, Levy

426. Thermal Radiative Transfer (3)

Principles of radiative transfer. Radiation properties of real substances; radiative interchange between bodies with and without a radiatively participating intervening medium; radiative transfer through absorbing, emitting, and scattering media.

Mr. Nevis

431. Advanced Gas Dynamics (3)

Continuation of M.E. 322. Small perturbation theory. Methods of solution of two-dimensional subsonic steady flows. The supersonic blunt body problem. Similarity rules of high-speed flow. Transonic flow. Hypersonic flow. Introduction to magnetogasdynamics. Prerequisite: M.E. 322.

Mr. Owczarek

432. Topics in Gas Dynamics (3)

The equilibrium thermodynamic properties of a dissociating mixture of gases. Equilibrium flow of dissociating gases. Vibrational and chemical nonequilibrium. Criteria for thermodynamic equilibrium of gas flow. Chemical kinetics of gaseous reactions. Equations of flow of a reacting gas mixture. Nonequilibrium flows. Application to design of ram-jets and rock etnozzles and of re-entry vehicles. Prerequisites: M.E. 320, M.E. 322.

Mr. Owczarek

439. Fluid Mechanics of Turbo-machinery (3)

The Euler equation. One-dimensional analysis of turbo-

machinery. Performance characteristics. Limitations on performance imposed by real fluid effects. Cascade flow. Two and three dimensional flow. Surge and stall. Prerequisite: M.E. 322

Messrs. Owczarek, Stenning

440. Dynamics of Machinery (3)

Fundamental principles of dynamics; variational dynamics; variable mass systems; gyroscopic theory and devices; applications to mechanical systems.

441. Stress Analysis in Design (3)

Application of methods of the theory of elasticity to mechanical design problems. Direct, approximate, and numerical methods of analysis applied to problems in plane stress, plane strain, torsion, thermal stresses, and residual stresses. First semester.

Messrs. Benner, Long

442. Analytical Methods in Engineering I (3)

Analytical Methods of Solution for Discrete and Continuous engineering systems. Theoretical, numerical and approximate methods of solution applied to equilibrium, characteristic value and propagation types of engineering problems. First semester.

Messrs. Erdogan, Lucas

443. Analytical Methods in Engineering II (3)

Continuation of M.E. 442. Second semester.

Messrs. Erdogan, Lucas

444. Experimental Stress Analysis in Design (3)

Applications of experimental stress analysis to mechanical design problems. Second semester.

Mr. Benner

445. Advanced Engineering Design (3)

The application to mechanical systems of the systems engineering process, environmental and needs research, the economic theory of demand and value, decision making, systems analysis and synthesis techniques. Computer-aided design including simulation, optimum seeking methods, and design-logic programming. Prerequisite: Math 231, previously or concurrently.

Mr. Benner

446. Advanced Engineering Design (3)

Continuation of M.E. 445. Reliability engineering for mechanical systems and components including system effectiveness, data collection and analysis procedures, redundancy, reliability allocation, prediction and testing. Maintainability analysis.

Mr. Benner

447. Control Systems (3)

Design of compensating elements for linear systems. Describing functions, phase plane, series approximation and other selected topics in nonlinear systems analysis. Prerequisite: M.E. 343.

Mr. Ries

450. Special Topics (3)

An intensive study of some field of mechanical engineering not covered in more general courses.

Staff

451. Seminar (1-3)

Critical discussion of recent advances in mechanical engineering.

Staff

460. Design Project (1-6)

Selected design project in an area of student and faculty interest where the need for creative design work is recognized. Economic as well as physical and functional aspects are considered. Laboratory testing and data acquisition is carried out as needed to promote design development. Prototypes are constructed and tested, when practical.

Messrs. Benner, Terry

MECHANICS

Professors

FERDINAND PIERRE BEER, PH.D., *Chairman*
FAZIL FRODOGAN, PH.D.
GEORGE RANKIN IRWIN, PH.D.
ARTURS KALNINS, PH.D.
PAUL C. PARIS, PH.D.
RONALD S. RIVLIN, SC.D.
GEORGE C. M. SIH, PH.D.
GERALD F. SMITH, PH.D.
ERIC VARLEY, PH.D.

Associate Professors

JOSEPH C. OSBORN, M.S.
ROBERT PEH-YING WEI, PH.D.

Assistant Professors

RONALD JOHN HARTRANFT, PH.D.
WILLIAM C. LENNOX, PH.D.
ROBERT JOHN RAVERA, PH.D.
ERIC PAUL SALATHE, PH.D.
DEAN P. UPDIKE, PH.D.

Research Associates

TEKIN OZBEK, PH.D.
ERWIN A. SOMMER, DR. RER. NAT.

Instructors

WILLIAM C. LENNOX, PH.D.
ROBERT JOHN RAVERA, M.S.

Teaching Assistants

THOMAS S. COOK, GEORGE TYLER EMBLEY, WALTER R. HENKEL, MARLIN EUGENE KIPP, PHILIP EDWARD KOZAK, GARY B. LEWIS, BRUCE D. MACDONALD, ALBERT M. PACELLA, DAVID HENRY SEITZ, GEORGE TREVINO, CHARLES CHUN-SHU TSENG.

Research Assistants

KEMAL ARIN, VAHRAM BIRICIKOGLU, TONY CHEN, MATTHEW CREAGER, PETER S. DOBREFF, DOUGLAS S. DRUMHELLER, HOWARD C. HAGENDORF, ERHAN B. KIRAL, JOHN D. LANDES, ROBERT B. LEONESIO, JOHN F. LOEBER, MOHAN M. RATWANI, DAVID H. SEITZ, HIROSHI TADA, MARIAN J. TOMIN, UMUR YUCEOGLU.

I. Statics (3)

Composition and resolution of forces; equivalent force systems; equilibrium of particles and rigid bodies; centroids and centers of gravity; analysis of simple structures; internal forces in beams; friction; moments and products of inertia; method of virtual work. Prerequisites: Math. 22 and Phys. 1. First and second semesters.

11. Mechanics of Materials (3)

Strength and elasticity of materials; theory of stresses and strains; deflection of beams and shafts; torsion; buckling of struts. Prerequisites: Mech. 1; Math. 23, previously or concurrently. First and second semesters.

13. Materials Testing Laboratory (I)

Experiments to study the mechanical properties of engineering materials; correlation of the properties of different materials, of their behavior under different types of load application, and of mechanical properties to design criteria.

Verification of certain assumptions used in Mech. 11. Prerequisite: Mech. 11, preferably concurrently. First and second semesters.

102. Dynamics (3)

Kinematics and kinetics of particles and rigid bodies; relative motion; dynamic equilibrium; work and energy; impulse and momentum; mechanical vibrations. Prerequisites: Mech. 1; Math. 23. First and second semesters.

For Advanced Undergraduates and Graduates

201. Advanced Mechanics of Materials (3)

Introduction to two-dimensional theory of elasticity; theories of failure; bending and torsion of prismatic bars; principles of indeterminate analysis; instability. Prerequisite: Mech. 11; 221, previously or concurrently. First semester. Messrs. Paris, Sih, Wei

302. Advanced Dynamics (3)

Fundamental dynamical theorems and their application to the study of the motion of particles and rigid bodies, with particular emphasis on three-dimensional motion. Use of generalized coordinates; Lagrange's equations and their applications. Prerequisites: Mech. 102; Math. 205. Second semester. Messrs. Beer, Osborn, Paris

303. Mechanics of Continua I (3)

Fundamental principles of the mechanics of deformable bodies. Study of stress, strain, velocity and acceleration fields. Compatibility equations, conservation laws. Applications to viscous and non-newtonian fluids, perfectly plastic and perfectly elastic materials. Prerequisites: Mech. 201 and Mech. 231. First semester. Messrs. Sih, G. F. Smith

304. Mechanics of Continua II (3)

Formulation of constitutive equations; invariance principles. Large elastic deformations; theory of dislocations; couple-stress theory; hereditary materials and viscoelasticity; elements of crystal physics and continuum physics. Prerequisite: Mech. 303. Second semester. Messrs. Sih, G. F. Smith

313. Fracture Mechanics (3)

Fracture behavior patterns in solids and liquids, the Griffith Theory and extensions to linear elastic fracture process models; stress analysis of cracks; plasticity, fatigue, corrosion and temperature effects; fracture toughness testing and fracture control plans. Prerequisites: Mech. 11; Math. 205. First semester. Messrs. Irwin, Paris

326. Aerodynamics (3)

Fundamentals of fluid dynamics applied to aircraft; the Prandtl theory of lift and drag; performance calculations; theory of stability and control. Prerequisite: Mech. 231. Second semester.

350. Special Topics (3)

A study of some field of Engineering Mechanics not covered in the general courses. Prerequisite: Consent of chairman of department. First or second semester. Staff

For Graduates

The graduate courses in Mechanics are open in general to students who have been graduated from a curriculum in engineering mechanics, engineering mathematics, engineering physics, civil engineering, or mechanical engineering at a recognized institution.

A candidate for the M.S. degree in Applied Mechanics is expected to possess a thorough knowledge of undergraduate mathematics and mechanics. Math. 205, 208 and 322, and Mech. 201 and 302, or their equivalents, are considered prerequisites for graduate work in Applied Mechanics. Any of these courses which have not been taken by the student as an undergraduate should be included in his graduate program. He may then be required to present a larger number of credits than the minimum required for graduation. A thesis carrying 3 to 6 credit hours is required of all candidates for the M.S. degree.

Current departmental research activities of interest include programs as follows:

CONTINUUM MECHANICS. Formulation of field equations and constitutive equations in non-linear continuum mechanics. Problems in finite and linear elasticity theories. Mechanics of viscoelastic solids and fluids. Plasticity theory. Generalized continuum mechanics. Thermo-mechanical and electro-mechanical interactions. Stress birefringence. Wave propagation.

Fracture Mechanics. Stress analysis of media containing inclusions or perforations, including visco-elastic, non-homogeneous, and anisotropic materials. Analysis of crack growth under static, periodic, and random loadings and environmental effects. Optimization of fracture control.

Stochastic Processes. Response of systems to stochastic inputs, including the effects of multi-dimensional fields and non-stationary processes. Prediction theory. Cumulative damage under random loads.

Theory of Thin Shells. Fundamentals of linear and non-linear theories of shells. Free and transient vibrations of shells. Concepts of stability of rotationally symmetric shells.

FLUID MECHANICS. Finite amplitude waves in stratified gases and fluids. Shock propagation and problems related to the sonic 'boom'. Non-equilibrium and low density flows. Boundary layer separation and wake models. Flows of non-Newtonian fluids in flexible tubes, with application to hemorheology. Magneto-fluid mechanics. Wing theory. In 1966-67, there were three M.S. candidates enrolled and 21 Ph. D. candidates.

Special departmental facilities of interest to the graduate student include the latest mechanical, electrodynamic and servocontrolled hydraulic testing machines.

402. Advanced Analytical Mechanics (3)

Fundamental dynamical theorems and their application to advanced problems; generalized coordinates; Lagrange's equations; fixed and moving constraints; non-holonomic systems; Hamilton's principle; Hamilton's canonical equations; contact transformations; Hamilton-Jacobi partial differential equation. Prerequisite: Mech. 302 or consent of chairman of department. First semester. Mr. Beer

404. Advanced Vibrations Analysis (3)

Sturm-Liouville theory; variational problems for deform-

able bodies; methods for estimating the natural frequencies and their bounds for continuous elastic systems. Wave propagation in a continuous elastic medium; Rayleigh waves; viscoelastic waves. Prerequisites: Math. 205; Mech. 305, or equivalent introductory course in vibrations analysis. Second semester.

Mr. Erdogan

405. Response of Systems to Random Loads (3)

Stochastic processes; correlation functions and power spectra; response of mechanical systems to one-dimensional and multidimensional random load fields; probability theory for several random variables; statistical properties of the random vibrations of mechanical systems; application to failure prediction. Prerequisite: Consent of chairman of department. Second semester.

Mr. Beer

409. Theory of Elasticity I (3)

Theoretical foundations of the mechanics of linear elasticity theory. Kinematics of deformation; analysis of stress, stress-strain relations; strain-energy. Reciprocal and uniqueness theorems; St. Venant's principle; minimum and variational principles and their applications. Methods for boundary value problems; theory of biharmonic functions; Galerkin, Papkovich, Neuber functions; integral transforms. Fundamental problems in two- and three-dimensions; singular solutions; torsion, bending and plane problems. Prerequisites: Math. 205; Mech. 201, or C.E. 309, or equivalent introductory course in theory of elasticity. First semester.

Messrs. Sih, G. F. Smith

410. Theory of Elasticity II (3)

Advanced topics in the theory of elasticity. The subject matter may vary from year to year and may include, e.g., theory of potential functions, linear thermoelasticity, dynamics of deformable media, integral transforms and complex-variable methods in classical elasticity. Problems of boundary layer type in elasticity; current developments on the micro-structure theory of elasticity. Prerequisites: Mech. 409, Math. 208, or consent of chairman of department. Second semester.

Messrs. Sih, G. F. Smith

412. Theory of Plasticity (3)

Mechanical behavior in the plastic range; foundations of the theory of plasticity; axisymmetric problems; limit analysis theorems; plane strain and slip line theory; applications to metal forming; introduction to plastic analysis of structures. Prerequisites: Math. 205; Mech. 201, or C.E. 309, or equivalent course in theory of elasticity. First semester.

Mr. Updike

413. Fracture Mechanics (3)

Introduction to the Griffith-Irwin theory of static strength of bodies containing cracks; stress-intensity-factor methods; application to fatigue crack growth; complex variable methods of stress analysis of cracks for extension and bending of plates, for torsion and flexure of bars, and for thermal stress problems; viscoelastic, anisotropic, and non-homogenous effects. Prerequisites: Mech. 201, Math. 208 or consent of chairman of department.

Messrs. Paris, Sih

415. Stability of Elastic Structures (3)

Basic concepts of instability of a structure: bifurcation, energy increment, snap-through, dynamic instability. Analytical and numerical methods of finding buckling loads of

METALLURGY AND MATERIALS SCIENCE

columns. Postbuckling deformation of cantilever column. Dynamic buckling with nonconservative forces. Buckling of columns on elastic foundation. Effects of initial imperfections. Inelastic buckling. Buckling by torsion and flexure. Variational methods. Buckling of frames. Instability problems of thin plates and shells. Prerequisite: Math 205. First semester.

Mr. Kalnins

416. Theory of Plates and Shells (3)

Governing equations of classical theory of plates. Solutions for rectangular and circular plates. Reissner's theory of plates. Vibration of circular plates. Nonlinear theories of plates. Differential geometry of surfaces. Governing equations of bending of thin elastic shells. Methods of solution for cylindrical, spherical, and arbitrary shells of revolution. Shallow shells. Approximate theories of shells. Prerequisites: Math. 205; Mech. 201, or C.E. 309, or equivalent introductory course in theory of elasticity. Second semester.

Mr. Kalnins

421. Fluid Mechanics (3)

Kinematics of fluid flow. Lagrangian and Eulerian descriptions. Basic conservation laws. Review of thermodynamics. Constitutive relations. Vorticity, circulation, irrotational flow. Bernoulli theorems. Vortex motion, velocity potential, stream function. Potential flow in two and three dimensions. Compressible flow: sound waves, simple waves; gas dynamic discontinuities. First semester.

Messrs. Salathe, Varley

422. Fluid Mechanics (3)

Similarity and dimensional analysis. Exact solution for viscous incompressible flow. Singular perturbation theory, with application to flows at low and high Reynolds number. Hydrodynamic stability. Depending on interest, additional topics from magnetohydrodynamics, kinetic theory, wing theory, turbulence, water waves, flows in flexible tubes. Prerequisite: Mech. 421. Second semester.

Messrs. Salathe, Varley

450. Special Problems (3)

An intensive study of some field of applied mechanics not covered in more general courses. First or second semester.

Staff

451. Phys. 471 Nonlinear Continuum Mechanics (1-3)

An introduction will be given to the nonlinear continuum theories of the mechanics of solids and fluids. This will include a discussion of the mechanical and thermodynamical bases of the subject, as well as the use of invariance principles in formulating constitutive equations. Applications of the nonlinear theories to specific problems will be given.

Mr. Rivlin

Professors

JOSEPH FRANCIS LIBSCH, SC.D., *Chairman and Alcoa Professor*

GEORGE POWELL CONARD II, SC.D.

RALPH WAYNE KRAFT, PH.D.

RICHARD MOORE SPRIGGS, PH.D.

ROBERT DANIEL STOUT, PH.D.

Associate Professors

BETZALEL AVITZUR, PH.D.

WALTER CHARLES HAHN, JR., PH.D.

GEORGE KRAUSS, JR., SC.D.

ALAN WIGGINS PENSE, PH.D.

STEPHEN KENNETH TARBY, PH.D.

JOHN DUDLEY WOOD, PH.D.

Assistant Professors

RICHARD WARREN HERTZBERG, PH.D.

ROBERT BENJAMIN RUNK, PH.D.

RICHARD NORMAN TAUBER, PH.D.

Instructors

JAMES ANDREW BEGLEY, B.S.

JEFFREY BRATSPIES, B.S.

JAMES PAUL HICKERSON, JR., B.S.

MELVIN ROBERT JACKSON, B.S.

JOHN DONALD OAKLEY, M.S.

JOHN HERBERT WEBER, JR., B.S.

Teaching Assistants

RONALD NORMAN CARON, RONALD CHARLES GOWER, RICHARD FRANKLIN LYNCH, JAMES W. SIMPSON

Research Assistants

CHARLES A. APPLE, BOAZ AVITZUR, THOMAS G. DIGGES, JR., KENNETH H. ECKELMEYER, JOSE H. FUEYO, VINCENT J. GENTILCORE, GEORGE S. HALL, WILLIAM R. HOOVER, CLIFFORD W. HUNTER, KURT J. KAHLOW, HAN J. KIM, KARL D. LIBSCH, MICHAEL R. NOTIS, VICTOR S. ROBINSON III, CHARLES J. P. STEINER, LAWRENCE N. SUCCOP, ZEEV ZIMERMAN.

10. Metallurgy Laboratory (1-2)

Elementary analysis of metallurgical problems for programming in computer solution; application of equipment for laboratory study of structure and properties of metals. Prerequisite: Met. 63 or 91 previously or concurrently. Second semester.

63. Engineering Materials and Processes (3)

A study of engineering materials and properties. Methods and effect of fabrication and treatment. Application and use of materials in engineering. Primarily metals, but including plastics, ceramics, and other engineering materials. Prerequisites: Chem. 3 or 13; Phys. 16 or 1. First and second semesters.

67. Engineering Materials Laboratory (2)

Laboratory study and discussion of the processing, structure and properties of engineering materials. Analysis of thermal and mechanical means of controlling the properties of materials with emphasis on quantitative approaches to metallurgical design. Prerequisites: Met. 63 or Met. 91, Phys. 3.

91. Elements of Materials Science (3)

Introductory study of the relationship between structure (on the atomic, crystallographic or molecular, micro and macro scales) and physical and mechanical properties of metallic, ceramic, and polymeric materials. Influence of processing variables on structure and properties. Lectures and recitation. Prerequisites: Chem. 3, 13 and Phys. 3 or 16 previously or concurrently. First and second semesters.

100. Industrial Employment

In the summer following the junior year students in the curriculum of metallurgy and materials science are required to secure at least eight weeks of experience in industrial plants or research organizations.

101. Professional Development (1)

Meetings with the department staff for the purpose of developing a professional outlook of the engineering student. Required reading, oral reports and term papers. Prerequisite: Junior standing. Second semester.

191. Experimental Metallurgy (3)

Application of research techniques to a project in metallurgy or materials science selected in consultation with the senior staff. Prerequisite: Met. 340.

For Advanced Undergraduates and Graduates**207. Electronic and Crystal Structure (3)**

Atomic theory, chemical bonding, lattice concepts, and theory of X-rays. Nature of crystalline phases, imperfections, and atom movements. Electron theories of solids. Lectures and laboratory. Prerequisites: Met. 10, Met. 91 or 63, and Phys. 4. First semester.

208. Phase Diagrams and Transformations (3)

Thermodynamic basis for equilibrium. The phase rule. Equilibrium phase diagrams and non-equilibrium considerations. Solidification and solid state phase changes. Rationalization of microstructures. Recovery, recrystallization, and grain growth. Lectures and laboratory. Prerequisites: Met. 207, Met. 210. Second semester.

210. Metallurgical Thermodynamics (3)

The application of thermodynamic relations to metallurgical processes with emphasis on solving specific problems for processes such as the open hearth for steel, heat treating atmospheres, alloy equilibrium diagrams, and others. Lectures and problem sections. Prerequisites: Met. 10, Math. 23, Chem. 91 or 95 concurrently. First semester.

Mr. Hahn

218. Mechanical Behavior of Materials (3)

Study of the deformation and fracture behavior of materials. Elastic and plastic behavior, with emphasis on crystallographic consideration. Strengthening mechanisms in solids. Static and time dependent fracture from metallurgical and continuum viewpoints. Lectures and laboratory. Prerequisites: Mech. 11, Met. 207. Second semester.

278. Metallurgical Reports (3)

An opportunity for the advanced student to develop familiarity with current metallurgical literature and to present oral reports and a comprehensive written survey. Prerequisite: Senior standing.

304. Extractive Metallurgy I (4)

A unit process study of extractive metallurgy techniques. Includes chemical principles, thermochemistry, and kinetics; also phases in pyrometallurgical systems, combustion of fuels, and refractories. The preparation, treatment, and handling of materials for primary crude metal production. Lectures plus laboratory. Prerequisite: Ch.E. 60, Met. 210. Second semester.

Mr. Hahn

305. Extractive Metallurgy II (3)

Continuation of Met. 304. A detailed engineering analysis of important metallurgical processes. A study of the thermodynamic and kinetic aspects of these processes. Development of mathematical models of processes by computer programming. Lectures, laboratory, and plant trips. A three day inspection trip is required. Prerequisites: Met. 304. First semester.

Mr. Tarby

307. Structure and Behavior of Materials (3)

Correlation of structure and properties of engineering materials. Design of thermal, chemical, and mechanical treatments to develop optimum properties in metals, ceramics and polymers. Lectures and laboratory. Prerequisites: Met. 218, Met. 208. First semester.

313. Materials Fabrication (3)

Basic concepts of stress, strain, and stress-strain behavior under load. Analysis and description of metal forming, metal cutting, casting, joining, and powder metallurgy. Lectures and laboratory. Prerequisites: Met. 208 or equivalent. First semester.

315. Physical Ceramics (3)

Correlation of internal structure with physical and mechanical behavior of ceramic materials. Effect of processing on structure and behavior. Sintering and grain growth. Lectures and laboratory. Prerequisites: Met. 208 and 218 or consent of chairman of department.

Messrs. Spriggs, Runk

316. Physical Properties of Materials (3)

Consideration of observed electrical, magnetic, thermal, and optical properties of crystalline materials with emphasis on their relationship to electron configuration and crystal structure. Lectures and laboratory. Prerequisites: Met. 207 and 208 or equivalent.

Messrs. Conard, Tauber

318. Theoretical Physical Metallurgy (3)

Atomic structure. Theories of alloying and transformation. Dislocations. Prerequisites: Met. 208 and 218 or equivalent. First semester.

Messrs. Conard, Krauss

333. X-ray Methods (3)

Introduction to the fundamentals and experimental methods of X-ray techniques. Application to various materials problems including diffraction, radiography, fluorescent analysis. Lectures and laboratory work. Prerequisite: Physics 4, Met. 91 or equivalent.

Messrs. Kraft, Runk

334. Electron Microscopy (3)

Study of theory and application of electron diffraction and microscopy methods for investigation of the structure of matter. Specific topics include electron optics and replica

and transmission electron microscopy. Special laboratories will be given in cooperation with other departments as required. Prerequisite: Consent of chairman of department.

Messrs. Krauss, Wood

338. Metallurgical Colloquium (2)

An opportunity for the student to develop an acquaintance with the current metallurgical literature, the ability to interpret such literature clearly, and skill in presenting oral engineering reports. Prerequisite: Consent of chairman of department.

340. Research Techniques (2-3)

Study, analysis, and application of experimental techniques in metallurgical and materials research. Analysis of experimental data and methods of presentation. Design of experimental programs. Recitations and laboratory.

358. Selection of Materials (3)

Study of problems relating to design and service requirements of material components. Selection of materials-fabrication, and finishing processes. Failure analysis. Discussion of specific examples to develop approach to and judgment of engineering problems involving materials. Lectures, problems. Prerequisites: Met. 307 and Met. 313, or consent of chairman of department. Second semester. Messrs. Libsch, Wood

361. Physics of Materials (3)

Consideration of principles of quantum mechanics and statistical thermodynamics. Intended to provide a basic understanding of the principles underlying the study of structure and properties of materials. Prerequisites: Met. 91 or equivalent, Math. 205. Mr. Fouchaux

362. Structure and Properties of Materials (3)

Study of structure and transformation in materials and correlation of structure with the physical and mechanical behavior of materials. Intended, in conjunction with Met. 361, to provide an integrated background sequence for further studies in the science of materials. Prerequisite: Met. 361 or equivalent. Mr. Conard

For Graduates

The department of Metallurgy and Materials Science has both a large enough staff and graduate enrollment to enable it to offer programs to suit the needs of students whose interests range from the science of materials through materials engineering and metallurgy. At the same time, those advanced students who desire it are usually provided the opportunity to gain experience in teaching under the guidance of the senior staff.

The Department has established specific recommended programs for the Master of Science or Doctor of Philosophy degrees in five areas of metallurgy and materials science. These programs are not rigid, and with the help of a faculty advisor, each student plans a course of study to satisfy his needs and interests. The *Physical Metallurgy* program has usually drawn the greater portion of the graduate students. The extension of physical metallurgy research to electronic and magnetic behavior of materials has led to the development of a program in *Materials Science*. With the impetus provided by the establishment

of the Materials Research Center, the development of a cooperative program with Western Electric, and the addition of several ceramists to the department faculty, this program now accounts for approximately one third of the graduate effort. The program in *Chemical Metallurgy* has recently been strengthened and expanded by development of a cooperative "Chem.-Met." Program with the Chemical Engineering Department. Through cooperation with the Mechanical Engineering Department similar arrangements are now being made to extend the *Materials Engineering Program* to include an option in Materials Design. The emphasis of the *Mechanical Metallurgy Program* is on the analysis of metal forming operations. Many students, however, have specialized in other areas of Mechanical Metallurgy, such as deformation and fracture analysis, either through combined programs in Physical and Mechanical Metallurgy or through cooperation with the departments of Mechanics or Mechanical Engineering and the Materials Research Center.

A number of graduate students in Metallurgy and Materials Science do their thesis work in the Materials Research Center. The list of research activities notes the many areas of interest and the asterisks indicate research of an interdisciplinary nature. Departmental research activities:

- * 1. Band structure and precipitation phenomena in PbS, PbSe, and PbTe.
- * 2. Characterization of metal oxide films.
- 3. Control of preferred orientation and its effect on mechanical and physical behavior.
- 4. Correlation of microstructure with mechanical behavior of low-alloy-high-strength steels, especially fatigue, creep and brittle fracture.
- 5. Correlation of structure with mechanical and physical behavior.
- * 6. Electron fractography.
- * 7. Environmental crack propagation.
- 8. Fine structure produced by cyclic martensitic transformation.
- 9. Hydrostatic extrusion of high-strength alloys.
- 10. Induction heating.
- 11. Influence of deformation and magnetic annealing on magnetostriction.
- 12. Influence of environment on high-temperature mechanical behavior.
- 13. Influence of pressure on the carbon-oxygen reaction in C-Fe melts.
- 14. Influence of solid-state transformations on magnetic properties.
- 15. Kinetic aspects of slag-metal reactions.
- 16. Kinetics of solid-state transformations.
- *17. Material behavior during fatigue crack propagation.
- 18. Mathematical modeling of metallurgical processes.
- *19. Mode of deformation and fracture in 2-phase metallic and non-metallic materials.
- 20. Phase transformations in ferrous alloys.
- *21. Physical metallurgy of sintered carbides.
- *22. Physical properties of ceramics.
- *23. Preparation and properties of materials for solid-state devices.
- 24. Solidification and segregation phenomena in tool steels.
- *25. Solidification, structure, and mechanical behavior of unidirectionally solidified eutectic alloys.

- *26. Strengthening mechanisms of thermomechanically processed polycrystalline ceramics.
- 27. Structure and properties of diffusion coatings.
- *28. Structure and properties of sputtered, evaporated, and plated thin films.
- 29. Structure and properties of weld metal.
- *30. Superconducting, magnetic, and thermoelectric behavior of unidirectionally solidified eutectic structures.
- 31. Theoretical analysis of metal forming methods and correlation with metallurgical parameters.
- 32. Thermodynamic properties of liquid metal solutions at high temperatures.
- 33. Thermodynamic properties of solid oxides.
- 34. Weldability of steels, especially the influence of composition and structure of the base and weld material.

The foundation for successful graduate work in the Department includes sound preparation in chemistry, physics, and mathematics, and adequate breadth of general education. Candidates entering the Department who have obtained their previous degrees in fields other than metallurgy or materials science may be required to take certain undergraduate courses without credit toward the graduate degree or to pass an examination to demonstrate a satisfactory foundation for advanced work.

The requirements of the Graduate School for either the master's degree or the degree of Doctor of Philosophy are explained on page 77. In this department, a candidate for the degree of Master of Science must complete a thesis. This represents six of the thirty semester hours required for this degree.

A candidate for the degree of Doctor of Philosophy prepares a preliminary program of courses and research providing for specialization in some phase of metallurgy, materials science, or materials engineering (largely through research) in consultation with his advisor. Prior to formal establishment of the doctoral program by his special committee and to his admission to candidacy, he must pass a qualifying examination which should be taken early in the first year of doctoral work.

Of the courses listed only those in the 300-series are available for graduate credit for students in Metallurgy and Materials Science. There are many additional offerings in materials under the listings of other departments. A partial listing of such courses may be found on pages 112 and 113. Besides the industrial fellowships that are offered in the areas of welding, electronic materials, and magnetic materials, graduate students of the department also are awarded various government traineeships and fellowships, i.e. NSF and NASA Traineeships, and NDEA Fellowships. For details of Graduate Scholarships and Fellowships please refer to page 83.

401. Metallurgical Investigation and Thesis (3)

Experimental investigation of some problem in the areas of mechanical, chemical, and physical metallurgy or materials science. The study must be embodied in a written report. Prerequisite: Undergraduate metallurgical courses in the field of investigation. First and second semesters. Staff

402. Metallurgical Investigation and Thesis (3)

Continuation of Met. 401. First and second semesters. Staff

404. Materials for Modern Technology (3)

Detailed study of the chemical, mechanical and physical behavior of one or more of the materials in modern technology, such as cryogenic, nuclear, or aerospace technologies. This course may be repeated for credit beyond three hours with permission of the instructor. Prerequisites: Met. 208 and Met. 218, Met. 305 or consent of chairman of department. Staff

406. Solidification (3)

Structure, theory and properties of liquids. Homogeneous and heterogeneous nucleation, theory and experimental results. Solidification phenomena in pure, single and multi-phase materials including the nature of the freezing interface, segregation, constitutional super-cooling, dendritic growth, crystallographic effects, the origin of defects, crystal growing. Zone processes. Prerequisite: Consent of chairman of department. Mr. Kraft

407. Theory of Alloy Phases (3)

Consideration of the application of the principles of thermodynamics, physics, and crystallography to the explanation of structure, physical properties and behavior of crystalline materials. Prerequisite: Met. 208. Desirable preparation: Physics 363. Mr. Conard

408. Transformations (3)

A description of phase equilibria and phase transformations with emphasis on the solid state. Phase diagrams and their thermodynamic basis. Physical and kinetic aspects of various types of phase transformations. Prerequisites: Met. 208, Met. 210. Mr. Krauss

409. Recent Developments in the Theory of Materials (3)

Current topics and theoretical developments in materials. This course may be repeated for credit with permission of the instructor. Prerequisite: Consent of the chairman of the department. Staff

410. Physical Chemistry of Metals (3)

Discussion of the thermodynamic properties of solid and liquid metals and alloy systems. Treatment of solution laws, methods of determining thermodynamic properties by experimentation and computation, changing standard states, and interaction parameters developed for liquid ferrous alloys. Prerequisite: Met. 210 or equivalent. Mr. Tarby

411. The Principles of Modern Welding (3)

The foundations upon which the welding processes rest; the present limitations of the various processes; the trends in new developments; the engineering and metallurgical aspects of welding. Prerequisite: Met. 208 and 218. Messrs. Stout and Pense

412 Electrical and Magnetic Properties of Materials (3)

The study of semiconducting, dielectric, magnetic and similar materials and their properties. Brief discussion of band theory, conduction and emission mechanisms and related topics. The relation between structure (including imperfections) and physical properties. Prerequisites: Met. 316 or Physics 363 Chem. 195; or consent of chairman of department. Messrs. Conard, Tauber

413. Analysis of Metal Forming Processes (3)

Three dimensional stress and strain analysis. Yield criteria, plastic flow and the upper and lower bound theorems. Analysis of metal forming processes, including drawing and extrusion, press work, rolling and spinning. The emphasis is on presenting several approaches to each problem.

Mr. Avitzur

414. Physical Chemistry of Metallurgical Reactions (3)

Development of quadratic formalism for representation of the thermodynamic properties of binary and ternary metallic solutions. A study of the thermodynamic and kinetic aspects of process metallurgy reactions. Emphasis on the kinetic behavior of important slag-metal reactions. Prerequisite: Met. 410.

Mr. Tarby

415. Physics of Ceramic Solids (3)

Lattice dynamics of ceramic materials including theoretical bases for thermal, optical, dielectric, and elastic behavior. Defect properties including ionic conductivity, ferroelectricity, ferrimagnetism, color centers, and crystal field theory. Prerequisites: Met. 315 or Met. 316 or consent of chairman of department.

Mr. Runk

416. Atom Movements (3)

Phenomenological and atomistic development of the laws of diffusion and their solution. Influence of gradients of concentration, potential, temperature and pressure. Effects of structural defects on diffusion in metals and non-metals. Prerequisite: Math. 23 and Chem. 195 or the equivalent.

Mr. Hahn

417. Imperfections in Crystals (3)

Study of the types of imperfections in crystals and their effects on the behavior of materials, with particular emphasis on dislocation concepts. Prerequisite: Met. 208, 218 or equivalent.

Mr. Conard

418. Deformation and Fracture (3)

Study of slip and twinning in metals. Theories of deformation texture formation. Evaluation of atomistic, microstructural, and continuum fracture theories and their interrelation. Consideration of ductile and brittle fracture, fatigue, creep, and failure of composite materials. Utilization of electron fractography. Prerequisite: Met. 218 or equivalent.

Mr. Hertzberg

419. Alloy Steels (3)

Structures and transformations in iron and iron based alloys. Design and heat treatment of alloys for strength, toughness, creep, and corrosion resistance. Prerequisite: Met. 307.

Mr. Pense

421. Surface Treatment of Metals (3)

Study of metallic surfaces. Preparation of surfaces by machining, grinding, polishing; methods of surface hardening; corrosion and surface protection of metals; analysis of surface stresses as related to fatigue life. Prerequisite: Met. 307.

Mr. Libsch

425. Sintering and Related Phenomena (3)

Kinetics and mechanisms of sintering and grain growth of powdered materials. Powder characterization. Compaction phenomena. Application and behavior of fabricated metal,

ceramic, and polymer shapes. Prerequisites: Met. 208, Met. 218. Desirable preparation: Met. 315, Chem. 392.

Messrs. Spriggs, Libsch

433. X-ray Metallography (3)

Scattering theory using the interference function and reciprocal lattice concepts. Diffuse scattering of X-rays and the radial distribution method, including applications. Brief treatment of crystal structure determination. Structural evaluation of materials by X-ray topographic, X-ray microscopic, and microradiographic methods. Prerequisite: Met. 333.

Mr. Kraft

458. Metallurgical Design (3)

Analysis of design requirements for metal components. Selection of materials and processes. Study of failures in process and service and application of recent metallurgical knowledge for improved design. Solution and discussion of industrial problems, and outline of experimental approach. Prerequisite: Consent of chairman of department.

Messrs. Libsch, Wood

MUSIC

Professors

ROBERT BENJAMIN CUTLER, M.A., *Chairman*
JONATHAN BRITTON ELKUS, M.A.

Instructor

JAMESON N. MARVIN, M.A.

1-4. Instrumental Music (1)

Study and performance of instrumental music. Participation in the appropriate ensemble, as determined by the Department of Music, is an integral part of the course. Students enrolling for their first semester register for Mus. 1; for their second, Mus. 2, etc. Prerequisite: Consent of chairman of department. Mus. 1 and 3, first semester only.

5-8. Choral Music (1)

Study and performance of choral music. Participation in the appropriate vocal ensemble, as determined by the Department of Music, is an integral part of the course. Students enrolling for their first semester register for Mus. 5; for their second, Mus. 6, etc. Prerequisite: Consent of chairman of department.

20. Introduction to Musical Literature (3)

An approach to musical style through the study of works by representative composers from 1600 to the present.

22. Sacred Choral Music (3)

The functional aspects of choral music and its relationship to the church, beginning with Gregorian Chant. Compositions of the Renaissance and Baroque masters are studied, with special attention given to the works of Bach. A survey is made of the outstanding sacred choral works of the 18th, 19th, and 20th centuries, observing the shift in emphasis from the church to the concert hall. Prerequisite: Consent of chairman of department.

23. Chamber Music (3)

A survey of works for smaller instrumental ensembles from the forerunners of Haydn to Stravinsky. Prerequisite: Consent of chairman of department.

25. Keyboard Music (3)

Study of keyboard music with particular reference to the styles of Scarlatti, Bach, Mozart, Beethoven, Chopin, and Bartok; demonstration of performance techniques on the various instruments; description of the mechanics of keyboard instruments, such as the organ, harpsichord, and piano. Prerequisite: Consent of chairman of department.

30. Aesthetics and Criticism of Music (3)

An analytical approach to writings of Hanslick, Nietzsche, Stravinsky, Thomson, Langer, and others with particular attention to the questions of meaning, intent, and expressive values in music. Prerequisite: Consent of chairman of department.

31. The Viennese Classic Period (3)

Exercises in tonal harmony and study of forms and procedures in western music 1750-1825. Prerequisite: Consent of chairman of department. Fall semester.

32. The Viennese Classic Period (3)

Intensive study of works for various media of Haydn, Mozart and Beethoven, with emphasis on form and style. Prerequisite: Mus. 31 or consent of chairman of department. Alternating spring semesters.

251. Special Topics (1-3)

Study of musical topics or work in musical composition not covered in regular courses, or continuation of study of topics or of projects in composition begun in regular courses. May be repeated for credit. Prerequisite: Consent of the chairman of the department.

THE LEHIGH UNIVERSITY BAND

Band may be elected by suitably qualified undergraduates. The Band will consist of a concert, varsity, and marching band and will perform music, as specified by the director, for concerts, convocations, and athletic events.

Except during the fall season, rehearsals will be held twice weekly and, in addition, provision may be made for required section rehearsals.

Band uniforms and certain musical instruments are furnished by the University. A deposit of \$25 is required from each member of the band for the uniform issued him. Members of the Concert Band will purchase their own blazers, which are worn for certain performances.

Students serving in the band receive the following awards: a sweater for two years of satisfactory service; for three years, \$20 in cash; and four years, an additional \$20 in cash.

THE LEHIGH UNIVERSITY GLEE CLUB

Glee Club may be elected by suitably qualified undergraduates.

The Glee Club will perform at concerts on the campus and away, and will collaborate with choruses of women's colleges in performing major works with orchestra.

Rehearsals will be held twice weekly, and, in addition, provisions may be made for required additional section rehearsals.

Members will purchase their own blazers and trousers which are worn for all performances.

PHILOSOPHY

Professors

DONALD JOHN HILLMAN, M.LITT., *Chairman*
HERBERT RUBENSTEIN, PH.D.

Associate Professors

ROBERT FEATHERSTON BARNES, PH.D.
THOMAS MORRIS HAYNES, PH.D.
NORMAN PAUL MELCHERT, PH.D.
JOHN J. O'CONNOR, PH.D.

Assistant Professor

JOHN RALPH LINDGREN, PH.D.

Instructor

NICHOLAS ANTHONY LAPARA, M.A.

Teaching Assistants

W. RALPH HILTON, MICHAEL B. LEIBOWITZ.

Research Assistants

JAMES S. GREEN V., ROBERT C. HEISER, DAVID M. REED.

Frog



11. Philosophic Problems (3)

A study of the character and relevance of philosophic problems through discussion of contemporary philosophic topics. Sensitivity to the philosophic aspects of everyday issues rather than recall of detailed information will be emphasized. First and second semesters. Staff

14. Logic (3)

An introductory study of the methods used in clear thinking and in the detection of fallacies. Examination of the principles used in testing scientific hypotheses and in the discovery of causes. Illustrations are drawn from the problems of everyday life. First and second semesters.

15. Ethics (3)

A critical study of classic and contemporary ethical theories as analyses of moral life. Special attention is given to problems concerning the nature of moral responsibility and moral judgment, the relation of man to his world, and the scientific status of moral theory. First and second semesters. Mr. Haynes

42. The Scientific Process (3)

A study of the ways in which scientific conceptions of nature are generated. Study of the historical development of some landmark achievements in science provides the background for understanding the logic of this intellectual activity. Second semester. Mr. LaPara

100. Philosophy of Contemporary Civilization (3)

A philosophical analysis of the theoretical foundations of our culture, providing a useful method for formulating policies in private and public life. Special attention is given to the nature and integration of ideals of family, industry, education, art, science, religion, law, and politics. First and second semesters. Mr. Haynes

For Advanced Undergraduates and Graduates

261. Philosophy of the Natural Sciences (3)

An analysis of the logical structure and significance of scientific knowledge and methodology. Scientific method,

whether logic of discovery or logic of testing. The rationality of scientific method. The meaning of scientific laws, universal and statistical. The structure of theories, whether explanation or correlation. Science and value. First semester. Mr. LaPara

271. Readings in Philosophy (2 or 3)

A course of readings designed primarily for undergraduate philosophy majors. Prerequisite: Consent of chairman of department. First semester. Staff

272. Readings in Philosophy (2 or 3)

A course of readings designed primarily for undergraduate philosophy majors. Prerequisite: Consent of chairman of department. Second semester. Staff

301. Philosophy of the Social Sciences (3)

An analysis of the social sciences considered as programs for achieving understanding and control of man and society. Study is made of assumptions basic to, and problems incurred in, scientific methodology in general; the implications of these for the various social sciences is stressed. First or second semester. Mr. Haynes

316. Contemporary Ethics (3)

The course includes a preliminary survey of major types of ethical theory, but consists essentially of a critical reading of contemporary books and journal articles which reflect current concerns and philosophic methods in ethics. Topics dealt with include analysis of various types of meaning (descriptive, evaluative, directive, emotive, etc.) embodied in moral language, and a study of the logic of moral discourse. The relations of the latter to social sciences will be studied. Prerequisite: Phil. 15 or consent of the instructor. Second semester. Mr. Haynes

331. Ancient Philosophy (3)

A historical study of philosophy in ancient times from its origin in Ionia through its flowering with Plato and Aristotle to its decline with the Roman Stoics and Neo-Platonists. Special attention will be given to the interaction of religious, political and scientific thought with philosophy during the period. First semester. Staff

335. Modern Philosophy (3)

A historical study of the major philosophies from the Renaissance to the end of the 18th Century; the work of Descartes, Spinoza, Leibniz, Locke, Berkeley, Hume, and Kant. Special attention will be given to the interaction of scientific and philosophical thought during the period. First semester. Mr. Lindgren

337. Nineteenth Century Philosophy (3)

A historical study of the major philosophers of the last century, including Mill, Hegel, Kierkegaard, Feuerbach, Marx, Schopenhauer and Nietzsche. Special emphasis will be given to such issues as social philosophy, the philosophy of history and theory of knowledge. Second semester. Messrs. Lindgren, Melchert

339. Twentieth Century Philosophy (3)

A study of major contemporary philosophic movements in the West, including pragmatism, idealism, realism, existentialism, logical positivism, and linguistic analysis. Special

emphasis is given to the positions of the various schools regarding the problems of meaning, method, and the philosophic role of scientific knowledge. Second semester.

Mr. Melchert

341. The Evolution of Scientific Ideas (3)

A study of the leading concepts, theories and revolutions in the history of science, and the changing conceptions of the nature of the scientific enterprise. Topics to be treated include: ancient cosmology and physics; late medieval and renaissance developments, from alchemy to chemistry; theories of evolution; classical mechanics and astronomy; philosophical aspects of relativity and quantum theory. First semester.

Mr. LaPara

351. Analytical Philosophy and Religion (3)

A critical look from the viewpoint of contemporary analytic philosophy at some of the main problems of religion: the nature of religious belief and language, the meaning and justification of religious symbols, and the problems of evil, the meaning of "God", the existence of God, and religious truth. First or second semester.

Messrs. Melchert, LaPara

362. Issues in the Philosophy of Science (3)

Critical study and review of crucial philosophical problems arising from research into the logical and epistemological foundations of science, with attention directed at alternative approaches to their resolution. Prerequisite: Phil. 261 or consent of chairman of the department. Second semester.

Mr. LaPara

364. Logic and Language (3)

A study of the properties of natural and formal languages and an investigation of the logical and semantical problems which arise. Special attention will be given to the following topics: the construction of logical models of language and their role in the analysis of communication; logico-linguistic grammars for the generation of language; the use of contemporary logical theories of language to examine the problems of meaning and reference. Second semester.

Mr. LaPara

388. Philosophy of Mathematics (3)

An investigation of the philosophical foundations of mathematics, with special emphasis on the "classical" views of the nature of mathematics—logicism, formalism, and intuitionism—and on their contemporary counterparts. Second semester.

Mr. Barnes

For Graduates

The Department of Philosophy offers advanced programs in two major areas of concentration, in each of which it is possible to proceed to the M.A. or M.S. degree and the Ph.D. degree.

The first field of concentration is that of the information sciences, embracing such topics as mathematical logic, combinatorics, logical algebras, topology, graph theory, computers and control languages, information systems, scientific methodology, epistemology, philosophy of science, philosophical analysis, computational linguistics, syntactic structures and model theory. The Department of Philosophy has strong research interests in these fields, and

offers opportunities for well-qualified graduate students to participate in sponsored research programs.

In these research activities, the Department cooperates with the Center for the Information Sciences, which fosters interdisciplinary programs of study and research. The Division of the Information Sciences offers a graduate program leading to the M.S. degree (see p. 173). This program is separate from, but very closely related to, the M.A. offered by the Philosophy Department in the foundations of the information sciences. The Ph.D. in the information sciences is offered as an advanced degree in philosophy.

The second area of concentration for graduate study in philosophy is of a more traditional character, emphasizing work in the history of philosophy, ethics, value theory, contemporary philosophical issues, logic, epistemology and the philosophy and history of science. This program is designed primarily for the student who wishes to pursue a career in philosophy as one of the liberal arts.

Adequate preparation for graduate study in either of these programs will normally include undergraduate courses in basic logic. Additional course work for the program in the information sciences should include training in mathematics and methodology. However, students with a sound background in a systematic discipline may also be admitted to this program. Additional preparation for the program in traditional philosophy should include undergraduate courses in ethics and the history of philosophy.

A candidate for the M.A. degree may qualify for the degree either by completing successfully twenty-four hours of approved course work and submitting a satisfactory dissertation, or by completing thirty hours in approved courses and passing an examination covering his chosen area of concentration. Each candidate will select the plan better suited to his needs and abilities with the advice and approval of the Chairman of the Department.

A candidate for the Ph.D. degree is required to submit a general plan to the Chairman of the Department at the beginning of the first year of doctoral studies. This plan must be approved by the candidate's special committee at the time of his admission to candidacy.

The doctoral program in the information sciences will be based on the candidate's approved plan of original and specialized research. A program of courses and seminars at the 400 level will also be formulated in the field in which the dissertation is to be written.

The doctoral program in traditional philosophy is also based on original research and collateral course work. In this area of concentration, the Department accepts candidates who wish to specialize in one of the following fields: history of philosophy; contemporary philosophy; ethics and value theory; logic and methodology; philosophical analysis; philosophy of science.

The doctorate in the information sciences serves to qualify students for careers in universities, government, industry and research.

Support in the form of fellowships, research assistantships and graduate assistantships is provided for a restricted number of well-qualified students.

401. Philosophy of Mind (3)

An examination of several problems in the philosophy of mind: the current status of the mind-body problem, knowl-

edge of other minds, the "logical geography" of mind-talk, the scientific status of psychoanalysis, and problems of mind and machine. First semester (offered alternate years).

Mr. Melchert

416. Value Theory (3)

A review of major types of practical problems deriving from conflict and confusion in evaluation is followed by a critical study of value theory, with emphasis on such topics as these: types of value and modes of value judgment; evidence and authority of value judgments; the logic of normative discourse; techniques of normative analysis; the relation of value judgments to science. Exemplification will be made largely in the fields of morality and law, with some references to politics, economics, art and religion. Prerequisite: Consent of the instructor. Second semester.

Mr. Haynes

421. Plato (3)

Intensive study of the mature thought of Plato, dealing with both the epistemological and moral issues in the later *Dialogues*. First semester (offered alternate years).

Mr. Lindgren

423. Aristotle (3)

Advanced study of selected themes which appear throughout the Aristotelian Corpus. Students will read widely in the *Organon*, *Physics*, *De Anima*, *Metaphysics*, *Nic. Ethics* and *Politics*. First semester (offered alternate years).

Mr. Lindgren

424. The Rationalists (3)

Detailed study of the principal works of Descartes, Spinoza and Leibniz. Second semester (offered as required). Staff

426. The Empiricists (3)

Detailed study of the principal works of Locke, Berkeley and Hume. Second semester (offered as required). Staff

428. Kant (3)

Intensive analysis of Kant's metaphysic of human experience as set forth in the *Critique of Pure Reason*. Second semester (offered as required).

Mr. Lindgren

429. Kant Seminar (3)

A study of the *Critique of Practical Reason* and the *Critique of Judgment*, or of the later moral philosophy of Immanuel Kant. (Offered as required).

Mr. Lindgren

430. Nineteenth Century German Philosophers (3)

A study of the writings of major figures in German philosophy of the last century, focusing principally upon Hegel, Schopenhauer, and Nietzsche. Second semester (offered as required).

Staff

432. Nineteenth Century English Philosophers (3)

A detailed study of the principal works of Bentham, Mill and Bradley. Second semester (offered as required).

Staff

439. Epistemology (3)

Selected topics in the theory of knowledge, such as the phenomenism-realism debate, the *a priori* and empirical

knowledge, and the development of alternative epistemological systems. First semester.

Mr. Melchert

443. The Analysts (3)

A detailed and critical study of the main works of one or more recent analytical philosophers, e.g., Russell, Moore, Wittgenstein, or the schools of logical positivism or ordinary language philosophy. First semester (offered as required).

Mr. Melchert

445. The Phenomenologists (3)

An examination of phenomenology as found in the writings of Husserl, with study of the tradition after him, e.g., Merleau-Ponty, Sartre or Heidegger. First semester (offered as required).

Mr. Melchert

447. The Pragmatists (3)

A critical examination of the principal writings of one or more philosophers usually placed in the pragmatic tradition: Peirce, James, Dewey, or Lewis. First semester (offered as required).

Staff

451. Logical Investigations (3)

A study of formal and natural languages for the problem of content analysis. Topics to be treated include: theory of representation; logical analysis; linguistic correlates of syntactic, semantic and pragmatic features; applications to retrieval theory. First semester.

Staff

461. Special Topics in Philosophy of Science (3)

Intensive study and research on certain selected topics, such as the philosophical assumptions and implications of recent physical science; the foundations of probability; the meaning and status of laws and theories; the concepts of space and time. Prerequisite: Phil. 261 or consent of chairman of department. First or second semester.

Staff

464. Semantics (3)

An investigation into problems of meaning and reference, including disputes about analyticity and the *a priori*, making use of recent literature on the subject. Second semester.

Mr. Melchert

471. Graduate Thesis (3)

First semester.

472. Graduate Thesis (3)

Second semester.

485. Model Theory (3)

Metamathematical investigations of the relationships between formal properties of logics and structural properties of their models. Attention will center upon such topics as: topological aspects of completeness theorems; model-theoretic separation theorems; hierarchies of definability; mathematical vs. metamathematical properties of structures; applications of models in the non-formal sciences. Prerequisite: Math. 404 or consent of the instructor. First or second semester.

Mr. Barnes

490. Special Topics (3)

An intensive study of selected topics not covered in more general courses. Second semester.

Staff

DIVISION OF INFORMATION SCIENCES

Professors

DONALD JOHN HILLMAN, M.LITT., *Chairman*
HERBERT RUBENSTEIN, PH.D.

Associate Professor

JOHN J. O'CONNOR, PH.D.

Graduate Assistants

ANTHONY FRANCIS AMICO, RONALD RAY ANDERSON,
AKKANAD MATHAI ISAAC, DENNIS G. POTTER,
PHYLLIS REISNER.

The rate of change in information technology demands that the practitioner have the conceptual background necessary to participate in and contribute to existing and developing systems. Within this framework, the M.S. and Ph.D. degree programs offered by the Division of the Information Sciences are designed to fulfill several objectives. Each program provides a broad base of both theory and application. Emphasis is on fundamentals, rather than techniques. Basic to the program of the Information Sciences at Lehigh University is the concept that research and instruction reinforce one another. Consequently whenever possible, students are expected to participate in research and operations on a part-time basis.

The curriculum in the Information Sciences is based on a B.S. degree in an engineering or scientific discipline. Desirable preparation consists of at least 12 hours of mathematics, including 9 hours of differential and integral calculus and one course beyond the calculus. In recognition of the flexibility and cross-disciplinary nature of the subject, exception to this requirement may be granted to those students with training in a systematic science. A course in computer programming or programming experience is desirable. Mathematics 105, Computer Programming, is available, without graduate credit, for those without computer background.

A candidate for the degree of Master of Science in the Information Sciences is required to complete at least twenty-four hours of approved course work and to submit a dissertation. Each student's schedule will be chosen in consultation with the head of the Division. Three core areas are at the heart of the M.S. program: information processing systems; information retrieval theory, and analysis of information. Beyond this basic core, student schedules are planned on an individual basis to fit previous academic experience and career goals. Two options are open for specialization, dependent on background, ability, and interests: Systems and Logico-Mathematical.

Systems

— the integration of machine and human capabilities and techniques.

Logico-Mathematical

— theoretical and systematic consideration of information systems and processes.

Maximum advantage is taken of courses in other departments on the campus. Consequently a student's program will be a combination of courses in the Information Sciences, together with offerings by the Departments of Electrical Engineering, Industrial Engineering, Mathe-

matics, Philosophy, Psychology, Social Relations, and others. For a more detailed description of the Ph.D. program in information Science, see description of graduate study in Philosophy.

201. Computers and Language (3)

The role of computers in such activities as natural language processing, mechanical translation, speech recognition, and augmentation of human reasoning. First semester.

Staff

301. Descriptive Linguistics (3)

Techniques for the description of the phonology, morphology and syntax of natural languages. Special attention to transformational generative grammar. First semester.

Mr. Rubenstein

302. Psycholinguistics (3)

Study of the experimental and observational literature on the production and comprehension of utterances and on the acquisition of language. Consideration of performance models of the language user. Prerequisite: I.S. 301. Second semester.

Mr. Rubenstein

361. Theory of Formal Grammars (3)

The study of the structure of formal languages as determined by their formation-rule grammars. Comparison of grammars of differing strengths (finite-state, context-free, context-sensitive, etc.); considerations of applications in logic (Turing machines, decidability) and in linguistic (phase-structure and transformational grammars). First semester.

Mr. Barnes

371. Information Retrieval Theory (3)

An introduction to the problems of theory-construction for information storage and retrieval systems. Special attention is given to the logical and mathematical foundations of retrieval operations, content analysis, the measurement of relevance, automatic document characterization, and the methodology of evaluation. Computer applications will be discussed. First semester.

Mr. Hillman

402. Seminar in Psycholinguistics (3)

Selected topics in psycholinguistics examined in depth and in detail. Prerequisite: I.S. 301. Second semester.

Mr. Rubenstein

403. Seminar in Semantic Analysis (3)

Discussion of methods for the componential analysis of the English lexicon and consideration of projection rules for the semantic interpretation of sentences. Prerequisite: I.S. 301. (Offered as required).

Mr. Rubenstein

418. Special Topics in Linguistics (3)

Selected topics in linguistics not covered in other courses. (Offered as required).

421. Analysis of Information (3)

History, theory, and structure of coding and classification systems for the organization of information; comparative analysis of selected retrieval schemes; experimental methods for developing coding systems and analyzing subject content.

PHYSICS

431. Subject Document Retrieval (3)

Purposes of a subject document retrieval system, methods of subject indexing, index vocabulary organization thesauri, classifications, etc.), subject request negotiation, subject indexing and natural language text searching by computer, citation indexes, and evaluation. Introduction to the principal questions and ideas in the field. Emphasis on critical discussion and (whenever feasible) empirical testing of ideas. First semester.

Mr. O'Connor

432. Mechanized Subject Document Retrieval (3)

Purpose of a subject document retrieval system; subject indexing, vocabulary organization, and request modification by computer; computer searching of natural language text; natural language retrieval requests to a computer; man-machine compromises; evaluation. Critical survey of the problems and ideas in the field. Prerequisite: I.S. 431. Second semester (alternate years).

Mr. O'Connor

434. Retrieval System Evaluation (3)

Purposes and costs of systems that retrieve documents by subject; defining and measuring effectiveness and cost and the variables that affect them; interpretations of empirical test results. Critical survey of the problems in the field. Prerequisite: I.S. 431. Second semester (alternate years).

Mr. O'Connor

462. Retrieval Languages (3)

The study of formal indexing and retrieval languages, with special attention to the interaction between syntactic structure and retrieval properties. Examples will be drawn from actual and experimental systems to show the effect of syntactic structure upon system capabilities. Second semester.

Mr. Barnes

464. Mathematical Models in Linguistics (3)

Discussion of the goal and function of models in linguistics and of various criteria of adequacy for such models. Development and comparison of relational, algebraic, categorial, and other mathematical models for description of linguistic structure. Prerequisite: I.S. 361. Second semester (alternate years).

Mr. Barnes

472. Retrieval Structures (3)

Advanced study of the application of mathematics and mathematical logic to the problems of model construction in retrieval system design. Attention will be given to the applications of: graph theory; point-set topology; set-theory; linear transformations; Markov processes; computational linguistics. Prerequisite: I.S. 371 or consent of chairman of department. Second semester.

Mr. Hillman

481. Thesis (3)

482. Thesis (3)

492. Special Topics in the Information Sciences (3)

Selected topics in the information sciences not covered in other courses. (Offered as required).

Professors

RAYMOND JAY EMRICH, PH.D., *Chairman*

CASSIUS WILD CURTIS, PH.D.

ROBERT THOMAS FOLK, PH.D.

JAMES ALAN MCLENNAN, JR., PH.D.

WESLEY JOHNSON VAN SCIVER, PH.D.

Associate Professors

WYMAN BEALL FOWLER, JR., PH.D.

RUSSELL ALLEN SHAFFER, PH.D.

WESLEY RICHARD SMITH, PH.D.

WILBER OEVILLA BERNHART SPATZ, PH.D.

DONALD BINGHAM WHEELER, JR., PH.D.

Assistant Professors

GAROLD JOSEPH BORSE, PH.D.

FRANK J. FEIGL, PH.D.

ROBERT DARROW FOUCHAUX, PH.D.

ALVIN SHELDON KANOFSKY, PH.D.

SHELDEN HENRY RADIN, PH.D.

SHUANG YUAN SHIEH, PH.D.

SEYMOUR TRESTER, PH.D.

Research Associate

HARTWIG R. F. BLUME, PH.D.

Instructors

CHIANG-SHUEI CHENG, M.S.

JAMES WELLONS DUFFY, M.S.

ALBERT BARRY KUNZ, M.S.

SOLOMON MUSIKANT, M.S.

Teaching Assistants

HAROLD E. CLARKE, PAUL B. CORKUM.

Graduate Assistants

ERIK W. ASLAKSEN, ROBERT L. BATEMEN, JR., STEPHEN L. BORST, BARBARA J. BYRD, GEORGE DUDASCIK, JR., JOHN GBUR, IRWIN GOLDBERG, PAUL J. HUTTA, MUNAWAR KARIM, PAUL A. KUEHNER, STEPHEN A. MACK, THOMAS E. TAUBER, RICHARD F. VERHANOVITZ, JOSEPH F. ZALESAK.

Research Assistants

DONALD R. BECK, JOHN A. BRESLIN, EDUARDO CALABRESE, MARCO P. FONTANA, NUNZIO LIPARI, JOHN W. OSTERMAYER, FRANK ROACH, BRUCE A. RYAN, NEIL C. SCHOEN, PETER D. VAN DYKE.

1. Mechanics of Mass Points (3)

Introduction to physics through a study of the laws of motion and conservation principles. Two lectures and one recitation-laboratory period per week. Prerequisite: Math. 21, previously or concurrently. First and second semesters, summer session.

3. Heat and Electricity (4)

Introduction to heat, laws of thermodynamics, sound, and steady electric fields and currents. Two lectures, one recitation, and one laboratory period per week. Prerequisites: Math. 23, previously or concurrently; Phys. 1. First and second semesters.

4. Electricity, Light, and Atomic Physics (4)

Continuation of Phys. 3. Electromagnetism, induced electromotive forces, electrical transients in circuits, geometrical and physical optics, introduction to quantum phenomena. Two lectures, one recitation, and one laboratory period per week. Prerequisites: Math. 23, previously or concurrently; Phys. 3. Second semester, summer session.

16. General Physics (3)

A survey of the subject matter of heat, electricity, light, and atomic physics for students in the Colleges of Arts and Science and of Business Administration. Lecture demonstrations and recitations. Prerequisite: Phys. 1. First semester.

Mr. Borse

17. General Physics Laboratory (2)

A laboratory course in general physics to accompany Phys. 16. Prerequisite: Phys. 16, preferably concurrently. First semester.

Mr. Borse

62. Contemporary Physics (3)

Atomic view of matter; quantum mechanics and probabilities; interactions between atoms and radiation; classical and quantum mechanical properties of aggregates of atoms. Prerequisites: Math. 205 and Phys. 4 previously or concurrently. Second semester.

90. Electrical Phenomena (1)

Laboratory studies of elementary electric and magnetic effects. Elementary laboratory techniques. Prerequisite: Phys. 4, preferably concurrently. Second semester.

Messrs. Wheeler, Spatz

100. Industrial Employment

Eight weeks industrial employment during the summer following the junior year, with submission of a written report.

171. Physics Proseminar (1)

Discussion of current problems in physics. Intended for seniors majoring in the field. Second semester.

Mr. Shaffer

191. Laboratory Techniques (2)

Thermometric, calorimetric and vacuum techniques. Advanced electrical measurements. Prerequisite: Phys. 4 or 17. First semester.

Messrs. Wheeler, Fouchaux

192. Advanced Physics Laboratory (1 or 2)

Laboratory experiments in modern physics designed to introduce students to measuring techniques and phenomena of current interest. Work is of a project nature, and the student is placed largely on his own initiative. Intended for seniors majoring in the field.

193. Advanced Physics Laboratory (1 or 2)

Continuation of Phys. 192. Intended for seniors majoring in the field. Second semester.

Staff

For Advanced Undergraduates and Graduates**212. Electrostatics (3)**

Principles of electrostatics; Poisson's equation; steady cur-

rents and their sources. Prerequisites: Phys. 4 and Math. 205. First semester.

213. Electromagnetism (3)

A continuation of Phys. 212. Electromagnetic induction; magnetic fields of steady currents; magnetic materials; development of Maxwell's equations; electromagnetic radiation. Prerequisite: Phys. 212. Second semester.

215. Particles and Fields I (3)

Aims and fundamental concepts of theoretical physics; foundations of mechanics of mass points, systems of particles, and continuous media; waves; fields; conservation laws. Prerequisites: Phys. 4, Phys. 212 previously or concurrently. First semester.

216. Particles and Fields II (3)

Generalized coordinates; variational methods in theoretical physics; the Lagrangian and Hamiltonian; basic concepts of the special theory of relativity; survey of the general theory of relativity. Prerequisite: Phys. 215. Second semester.

252. Optics (3)

Wave theory of light, interference, diffraction, polarization. Prerequisites: Phys. 4 and Math. 23. Second semester.

Mr. Wheeler

254. Optics Laboratory (2)

Optical instruments and techniques. Examination of phenomena, of measuring procedures, and of light sources and recording devices. Prerequisite: Phys. 4. Second semester.

Messrs. Curtis, Fouchaux

266. Modern Physics (3)

General foundations of quantum theory, special theory of relativity, atomic theory of origin of spectra, wave mechanics, atomic and nuclear structure, interaction of particles with matter, radioactivity, nuclear structure. Intended for non-physics majors. Prerequisites: Math. 23, Phys. 4. First semester.

Messrs. Spatz, Trester

281. Basic Physics I (3)

A course designed especially for secondary school teachers in the master teacher program. Presupposing a background of two semesters of college mathematics through differential and integral calculus and of two semesters of college physics, the principles of physics are presented with emphasis on their fundamental nature rather than on their applications. Open only to secondary school teachers and those planning to undertake teaching of secondary school physics. Summer session.

282. Basic Physics II (3)

Continuation of Phys. 281. Summer session.

340. Heat, Thermodynamics and Pyrometry (3)

Basic principles of heat, thermodynamics and kinetic theory of gases with emphasis on physical systems.

Mr. W. R. Smith

362. Atomic and Molecular Structure (3)

Structure of atoms and molecules, especially as related to their spectra. Prerequisite: Phys. 62 or Chem. 91. First semester.

Mr. Curtis

363. Physics of Solids (3)

Recent developments in the theory of solids with particular reference to the physics of metals. Prerequisite: Phys. 266 or 362, or Met. 361 (E.E. 361), or consent of chairman of department. Second semester.

Mr. Fowler

364. Nuclear Physics (3)

Properties of stable and unstable nuclei and experimental methods of measuring them; radioactive decay; detectors of nuclear radiation; types of nuclear reaction and methods of producing them; cosmic rays. Prerequisite: Phys. 369. First semester.

Mr. Kanofsky

365. Physics of Fluids (3)

Basic concepts of classical fluid mechanics; continuum and molecular approaches; shock waves; high temperature properties of reacting ideal gases; plasma dynamics. Prerequisites: Phys. 213 and 340. Second semester.

Mr. W. R. Smith

369. Introduction to Quantum Mechanics (3)

Principles of quantum mechanics; applications to atoms and molecules. Prerequisites: Phys. 62, 216, Math. 322. First semester.

Mr. McLennan

372. Special Topics in Physics (1-3)

Special topics in physics not sufficiently covered in the general courses. Lectures and recitations or conferences. First and second semesters.

Staff

For Graduates

The department of Physics has concentrated its research activities within a few fields of physics, with the consequence that several projects are available in each area. Members of the department have particular interest in advanced work in the following areas: experimental and theoretical solid-state physics, experiment and theory in the structure and dynamics of fluids, non-equilibrium statistical mechanics, elementary particle theory, and nuclear structure theory. A program in experimental high energy physics makes use of the 3 Bev accelerator in Princeton, New Jersey, 60 miles southeast of Bethlehem.

Candidates for advanced degrees normally will have completed, before beginning their graduate studies, the requirements for a baccalaureate degree with a major in physics, including advanced mathematics beyond differential and integral calculus. Students lacking the equivalent of this preparation will make up deficiencies in addition to taking the specified work for the degree sought.

Doctoral candidates are required to demonstrate a reading knowledge of two languages, usually chosen from French, German, and Russian. Some graduate work in mathematics usually is required; and certain advanced courses in other fields, notably mechanics, metallurgy and materials science, electrical engineering, and chemistry, may be included in a graduate program. Further details regarding the special requirements for degrees in physics may be obtained on application to the chairman of the department. At least eight semester hours of general college physics using calculus are required for admission to all 200 and 300-level courses. Additional prerequisites for individual courses are noted in the course descriptions. Admission to

400-level courses generally is predicated on satisfactory completion of corresponding courses in the 200 and 300 groups or their equivalent.

Special departmental facilities which complement teaching and research activities include six shock tubes with advanced instrumentation; optical and cryogenic equipment for solid state studies; crystal preparation facilities at the Materials Research Center; and access to the CDC 6600 computer at New York University.

Current departmental research activities include the following:

Solid State Physics (Experimental) —

Studies are being carried out by W. Van Sciver on the optical properties of thallium-doped alkali halides, in an effort to determine the properties of the $(\text{TI}^+)^2$ center.

R. Fouchaux is studying the point defect structure of silver halides at high temperatures by measuring the transport of ionic charge.

S. Trester is carrying out measurements on the effect of radiation damage of organic crystals, by measuring current-voltage characteristics and by observing the recombination luminescence of injected electrons and holes.

Feigl is making spin-resonance measurements in several solid systems.

By impacting bars and by shock tube loading of the end of a bar, deformation of solids under rapid stress application is studied by C. Curtis.

Solid State Physics (Theoretical) —

W. Fowler is engaged in three projects. The first of these involves energy band calculations for a number of insulating crystals including the alkali and cuprous halides. A second project involves calculations of excited states of the F center in alkali halides, while a third involves general investigations into the properties of impurities in insulating solids.

Hartree-Fock calculations of the electronic states of the Ti^+ ion are being performed under the direction of W. Van Sciver.

Theoretical studies are being made by R. Folk of the macroscopic formulation of strain propagation in a crystal.

Nuclear Theory —

Theoretical work is presently being done by G. Borse on the structure of $(2s-1d)$ nuclei.

R. Folk is carrying out a detailed study of very light nuclei, in an attempt to improve the understanding of nuclear forces.

Physics of Fluids —

Current studies in continuum fluid dynamics by R. Emrich involve the mechanism of transition from laminar to turbulent shock tube boundary layers and the microscopic fluctuations of small particles in inhomogeneous gases.

W. Smith is studying shock-wave-induced reactions in gases. These studies involve vibrational energy transfer in CO_2 , and vapor-liquid condensation on a surface with microsecond time resolution.

Statistical Mechanics —

Current work of J. McLennan is toward development and application of a more general formalism for the theory of non-equilibrium processes.

S. Radin is carrying out investigations of the properties of kinetic equations, with particular interest focused on the properties of plasmas in external fields.

Fundamental Particle Physics (Experimental) —

A. Kanofsky is currently involved in two experiments being carried out at the Princeton Pennsylvania Accelerator. One of these is an experiment on proton-proton scattering at high energies, while the other is a study of streamer chambers. Bubble chamber experiments are being analyzed using a film-scanning facility on campus.

Fundamental Particle Physics (Theoretical) —

R. Shaffer is pursuing three areas of research. The first of these concerns an extremum principle, based upon maximizing certain decay parameters, for the calculation of elementary particle masses. A second project involves a new method for handling certain divergent expressions encountered in unrenormalizable field theories, while a third area consists of a study of the electrodynamics of vector mesons which may participate in weak interactions.

A new method in the theory of potential scattering has been proposed by S. Shieh and is being studied. Shieh is also studying the transition radiation which is emitted when an electron passes from one medium to another.

In 1966-67 there were 15 master's and 31 doctoral candidates enrolled in physics.

420. Theoretical Physics (3)

Development of the classical theory of particles and fields. This and the three courses Phys. 421, 422, and 423 cover classical mechanics, electrodynamics, and the theory of relativity. First semester.

Mr. Wheeler

421. Theoretical Physics (3)

Continuation of Phys. 420. Prerequisite: Phys. 420. Second semester.

Mr. Emrich

422. Advanced Theoretical Physics (3)

Continuation of Phys. 420 and 421. Prerequisite: Phys. 421 or equivalent. First semester.

Mr. Shieh

423. Advanced Theoretical Physics (3)

Continuation of Phys. 422. Prerequisite: Phys. 422. Second semester.

Mr. Shieh

424. Quantum Mechanics (3)

General principles of quantum theory; approximation methods; spectra; symmetry laws; theory of scattering. Prerequisite: Phys. 369 or equivalent. Second semester.

Messrs. McLennan, Borse

425. Quantum Mechanics (3)

A continuation of Phys. 424. Relativistic quantum theory of the electron; theory of radiation. First semester, alternate years. (Not offered, 1967-68).

Mr. Shaffer

428. Methods of Mathematical Physics (3)

The equations of theoretical physics and the methods of their solution. First semester.

Mr. Folk

429. Methods of Mathematical Physics (3)

Continuation of Phys. 428. Second semester. Mr. Folk

431. Theory of Solids (3)

Theory of the structure and properties of solids. Symmetry properties, lattice dynamics, elastic and thermal properties. Quantum theory of electronic structure, energy bands, cohesion. Magnetic properties. Desirable preparation: Physics 363, 424. First semester, alternate years. (Not offered 1967-68).

Mr. Fowler

434. Solids and Radiation (3)

Phenomena in solids resulting from interaction with electromagnetic radiation or charged particles. Current theories of energy absorption, transport, and emission. Prerequisite: Phys. 363 or equivalent. First semester, alternate years. (Not offered 1967-68).

442. Statistical Mechanics (3)

General principles of statistical mechanics with applications to thermodynamics and the equilibrium properties of matter. Prerequisites: Phys. 340 and 369. First semester.

Messrs. McLennan, Radin

443. Statistical Mechanics (3)

A continuation of Phys. 442. Applications of kinetic theory and statistical mechanics to non-equilibrium processes; non-equilibrium thermodynamics. Prerequisite: Phys. 442. Second semester, alternate years. (Not offered 1966-67).

Mr. McLennan

462. Theories of Elementary Particle Interactions (3)

Relativistic quantum theory with applications to the strong, electromagnetic and weak interactions of elementary particles. Prerequisite: Physics 425. Second semester, alternate years. (Not offered 1967-68).

Mr. Shaffer

465. Nuclear and Elementary Particle Physics (3)

Nuclear structure and phenomena; interactions among elementary particles and methods of studying them. Second semester, alternate years. (Not offered 1967-68).

Mr. Grismore

467. Nuclear Theory (3)

Theory of low energy nuclear phenomena within the framework of non-relativistic quantum mechanics. Second semester, alternate years. (Not offered 1966-67).

Mr. Borse

471. (Mech. 451.) Nonlinear Continuum Mechanics (1-3)

An introduction will be given to the non-linear continuum theories of the mechanics of solids and fluids. This will include a discussion of the mechanical and thermodynamical bases of the subject, as well as the use of invariance principles in formulating constitutive equations. Applications of the nonlinear theories to specific problems will be given.

Mr. Rivlin

472. Special Topics in Physics (1-3)

Selected topics not sufficiently covered in the more general courses. May be repeated for credit. First or second semester.

Staff

PSYCHOLOGY

474. Seminar in Modern Physics (3)

Discussion of important advances in experimental physics.
First or second semester. Staff

475. Seminar in Modern Physics (3)

Discussion of important advances in theoretical physics.
First or second semester. Staff

491. Research (3)

Research problems in experimental or theoretical physics.
First and second semesters. Staff

492. Research (3)

Continuation of Phys. 491. May be repeated for credit.
First and second semesters. Staff

Professors

FRANCIS JOSEPH WUEST, PH.D., *Chairman*
JOSEPH MARIA BROZEK, PH.D.

Associate Professors

ARTHUR LIONEL BRODY, PH.D.
THEODORE MILLON, PH.D.
CHARLES M. MORRIS, PH.D.

Assistant Professors

GEORGE D. MARSH, JR., PH.D.
SAMUEL GILBERT NORD, PH.D.
MARTIN L. RICHTER, PH.D.

Adjunct Professors

LLOYD HITCHCOCK, JR., PH.D.
RANDALL M. CHAMBERS, PH.D.

Teaching Intern

GEORGE B. WALZ

Graduate Assistants

DANIEL J. GALLAGHER, MERIN L. LEVY, CHARLES T. ROSE.

Research Assistants

MIN-CHUN CHAD, JOSEPH G. GELLINGS, JACK LIEF.

3. Psychology as a Natural Science (3)

Introduction to psychology as a science of behavior. Emphasis on principles of sensation, perception, maturation, learning, motivation, emotion and the physiological bases of behavior. First semester.

4. Psychology as a Social Science (3)

Introduction to psychology as a science of behavior. Emphasis on principles of human development, intelligence, abilities, perception, motivation and learning and a general survey of personality theory and social psychology. Second semester.

11. General Experimental Psychology (3)

A survey of basic data and research methods in learning, sensation, perception and personality. Laboratory exercises provide direct experience in the application of research methods. Prerequisite: Psych. 3 or 4; Math. 8, previously or concurrently. Second semester.

106. Motivation (3)

Evaluation of contemporary research and theories of animal and human motivation. Prerequisite: Psych. 3 or 4. First semester. Offered in 1969-70 and alternate years.

107. Developmental Psychology (3)

Contemporary theories, outstanding research contributions and methods of analysis concerning the sequential and interrelated patterns of physiological and social development. Prerequisite: Psych. 3 or 4. First semester. (Offered in 1968-69 and alternate years.)

111. History and Systems (4)

Development of psychology from its roots in the thought of Greek philosophers to the formulation of contemporary systems. Prerequisites: Psych. 3 or 4. First semester.

160. Independent Study (1-3)

Readings on topics selected in consultation with a staff member. Research on assigned problems. Supervised field studies. Prerequisites: Psych. 3, 4, and 11 and consent of chairman of department. May be repeated for credit. First and second semesters.

For Advanced Undergraduates and Graduates**201. Industrial Psychology (3)**

The application of psychological concepts and methods to business and industry. Includes personnel selection, placement and training; studies of work environment, motivation and morale; consumer research and advertising. Prerequisite: Psych. 3 or 4. Second semester.

203. Engineering Psychology (3)

Experimental psychology as applied to the optimal design of machines and tasks. Survey of human capacities and limitations. Introduction to problems of information input, information processing and decision making for the human operator. Prerequisite: Psych. 3 or 4. First semester. Offered in 1968-69 and alternate years.

302. Theories of Personality (3)

A systematic survey of the major theoretical approaches to personality with emphasis on personality as a product of social learning. Critical evaluation of the work of Freud, Adler, Fromm, Horney, Sullivan, Erikson, Lewin, Miller, and Dollard and others. Prerequisite: Three semester hours of psychology or social relations. Second semester. Offered jointly with Department of Social Relations in 1968-69 and alternate years.

303. Mathematical Models in Psychology (3)

The application of mathematics in psychology, including models for psychophysics, learning acquisition curves, discrimination learning, concept formation and probability learning. Prerequisite: Psych. 3, 4, and 11 or consent of chairman of department. First semester. Offered in 1968-69 and alternate years.

304. Psychometric Methods (3)

Principles of psychological measurement as related to test construction, psychophysical methods, attitude scales. Prerequisite: Psych. 3, 4, and 11. Second semester. Offered in 1969-70 and alternate years.

361. Personality (4)

Survey of research approaches used to conceptualize personality and to relate personality variables to behavior. An independent research project is required of students in this course. Prerequisites: Psych. 4 and 11. First semester.

363. Learning (4)

Basic data and major theories of learning. Laboratory provides an opportunity for repetition of basic experiments using animal and human subjects. Prerequisites: Psych 3, and 11. Second semester.

364. Sensation and Perception (4)

Receptor processes of vision, audition, touch, taste and smell are considered with particular emphasis on problems of sensory intensity, sensory discrimination functions and

perceptual processes. Quantitative methods are stressed. Laboratory exercises provide an opportunity to apply these methods. Prerequisites: Psych. 3, and 11. Second semester.

365. Physiological Psychology (4)

The physiological basis for psychological processes. Three hours of class presentation and one laboratory session. Prerequisites: Psych 3 or 4. First semester.

369. Senior Seminar (3)

Study in depth of selected topics of importance in contemporary psychology. Topics will be selected according to the interests of individual students. Independent study and research are required. Prerequisite: Consent of chairman of department. First semester.

370. Senior Seminar (3)

Continuation of Psych. 369. Culminates in presentation of a research paper or scholarly essay. Prerequisite: Consent of chairman of department. Second semester.

381. Psychological Testing (3)

An introduction to psychometric and projective tests utilized in the appraisal of intelligence, aptitudes, interests and personality with special emphasis on applications in educational situations. Principles of test construction and validation will be stressed. Prerequisites: Psych. 3 or 4, or consent of chairman of department. Open only to graduate students from the School of Education.

382. Child Psychology (3)

A systematic analysis of the critical periods of development from infancy through adolescence. Alternate theories and recent research will be stressed. Prerequisite: Psych. 3 or 4, or consent of chairman of department. Open only to graduate students in the Department of Education.

383. Personality (3)

Review and analysis of psychological concepts and data relevant to the development and functioning of personality. Comparison and critical examination of the major historical schools of personality theory. Prerequisites: Psych 3 or 4, or the consent of the chairman of the department. Open only to graduate students in the School of Education.

For Graduates

The Department of Psychology offers the M.S. and Ph.D in selected areas of experimental psychology, namely, learning, sensation and perception, mathematical psychology and engineering psychology. Special opportunities for interdisciplinary work exist in sensory psychophysiology, engineering psychology, social psychology, and information sciences. The primary purpose of the program is to educate psychologists for careers in research and college teaching.

The Graduate Program is designed for students who wish to complete work to the Ph.D. Most students earn the M.S. en route. For all students, successful completion of the program is dependent upon successful performance in research, course work and special examinations, each with equal weight. A low student-faculty ratio, approximately 2:1, makes it possible for all students to establish a close working relationship with the faculty.

Since independent research activity is demanded of the Ph.D. in psychology, the research competence of all students will be continuously evaluated from the first semester. Emphasis throughout is on the ability of the student to initiate research and carry it through all phases of execution to the final written report. From the earliest stages, research effort is directed toward work which is publishable. Required research participation is as follows:

Semester 1—Psych. 426. Research Methods (3). This course is intended to provide an introduction to research activities of the department and culminates in the completion of an independent research project.

Semester 2—Psych. 428. Thesis (3) or Psych. 461 Research.

Semester 3—Psych. 428 (3) or Psych. 429 (3) Thesis

Semester 4—Psych. 429 (3) or Psych. 461 Research.

All students past the fourth semester, and those entering with the M.S., are expected to engage in doctoral dissertation research or schedule Psych. 461 research during all semesters remaining. All students are encouraged to do research in topics other than the dissertation area for course credit during the academic year and the summer.

There is no fixed number of course credits required for the Ph.D., although 60 semester hours beyond the B.A. or 30 hours plus a masters degree is typical. Beyond the required participation in research courses noted above, only Psych. 421 and 422, Analysis and Design of Experiments, and Psych. 464, Instrumentation, are required. A selection of courses beyond these is made by the student with the approval of the department chairman. Certain courses are particularly recommended in order to assure broad coverage of basic psychological thought and research. These include:

- Psych. 432 Perception
- Psych. 433 Conditioning and Learning
- Psych. 434 Personality
- Psych. 435 Social Psychology
- Psych. 436 Physiological Psych.
- Psych. 437 Psychophysical Measurement
- Psych. 438 History of Psychology

All doctoral candidates will be required to take 12 semester hours of integrated course work relevant to their special interests, in a department other than psychology. Choice of this minor area will be made by the student with the approval of the department chairman.

The following special examinations are required of all students. A qualifying examination covering all major areas of psychology with particular emphasis on contemporary theory and research must be passed in order to qualify for candidacy for the doctoral degree. This examination is given twice a year at the start of each semester. Students entering Lehigh with a B.A. must take this examination not later than the start of their third semester in residence. It is recommended that those students entering Lehigh with an M.S. take the qualifying examination at the start of their second semester in residence. For both groups of students only one re-examination is possible in the event of failure on the first testing.

All students completing a masters thesis will be examined orally on the content of the thesis by the faculty of the department. Departmental approval of the thesis is contingent on successful completion of this examination.

The three remaining examinations are required by the Graduate School. (a) All graduate students in psychology must demonstrate competence in one language chosen, usually, from French, German and Russian. Course work taken for the outside minor is accepted in lieu of the second language. (b) The General Examination is a comprehensive examination in which the student is given the opportunity to demonstrate his overall competence in psychology. This examination is given when required and, normally, is taken one year in advance of completion of the degree requirements. (c) The Final Examination is an oral exam conducted by the Doctoral Committee. While its primary focus is on the dissertation research, it may range over broad aspects of psychology in related fields.

All doctoral candidates must have two semesters of teaching experience. Usually this is accomplished by serving as a teaching assistant in the departmental undergraduate courses. There are also opportunities to serve as a Teaching Intern. This program affords advanced students the opportunity to have supervised teaching experience in other colleges of the area.

The Department is located in recently renovated quarters in Williams Hall. This building includes adequate laboratories for individual and group experiments with human subjects. Several research laboratories are reserved exclusively for the use of graduate students. These include a laboratory for visual psychophysics and a laboratory for the study of concept learning. The Bioelectric Laboratory, a privately endowed facility for psychophysiological research with humans and lower animals, is also available for the use of graduate students. Three laboratories used primarily for instructional purposes are equipped with sound and light treated research cubicles which are regularly used by graduate students for individual research projects. Additional facilities within the department include electronic, wood, and metal shops, desk calculators, a library including microfilm copies of commonly used journals, and individual office-study space for graduate students. The University Computer Center, as well as other general purpose facilities, are regularly available for sponsored and unsponsored graduate student research.

The minimum prerequisite for graduate work in psychology is a course in general psychology, a course in experimental psychology including a laboratory and a course in statistics, plus collateral courses in biology, mathematics and the physical sciences. Additional course work, the equivalent of major in psychology, is desirable but not necessary. Promising students with majors other than psychology or those who lack the full requirements may be accepted with the understanding that deficiencies in the undergraduate program will be added to the minimum graduate program. Normally, applications are reviewed starting on March 1 of the year preceding admission. For those students requesting financial aid it is essential that completed applications forms be submitted to the University Office of Admission not later than February 15. In addition to the usual transcripts and letters of recommendation, the department requires that Graduate Record Examination scores on the verbal and quantitative aptitude tests and the advanced test in psychology be submitted.

Financial aid is regularly available in the form of Teaching and Research Assistantships, Graduate Fellowships and

Scholarships. In addition, there are now available a limited number of Teaching Internships as well as NASA Fellowships and NSF Traineeships.

421. Analysis and Design of Experiments (3)

Set theory, probability theory, inferential statistics, parametric and non-parametric statistical tests with emphasis on the analysis of variance, curve-fitting, trend analysis, regression analysis. First semester. Mr. Richter

422. Analysis and Design of Experiments (3)

Continuation of Psych. 421. Emphasis on experimental design. Prerequisite: Psych. 421. Second semester.

Mr. Richter

423. Seminar in Statistical Methods (3)

Selected topics in statistics applied to psychological research. May be repeated for credit. First or second semester.

Messrs. Brody, Richter

426. Research Methods (3)

Planning of experiments under both laboratory and industrial conditions. Appraisal of research ideas, methodology, and instrumentation. First semester.

Mr. Brody

428. Thesis (3)

Original investigation for the master's thesis.

Staff

429. Thesis (3)

Continuation of Psych. 428.

Staff

432. Perception (3)

Evaluation of contemporary research and theories of human perception. Second semester. Offered in 1969-70 and alternate years.

Mr. Richter

434. Personality (3)

Traditional theories of personality will be reexamined in light of current research, particularly in the fields of learning and neurophysiology. Second semester. Offered in 1968-69 and alternate years.

Mr. Millon

435. Social Psychology (3)

Evaluation of contemporary research and theories of group behavior. First semester. Offered in 1968-69 and alternate years.

Mr. Jones

436. Physiological Psychology (3)

The study of the anatomical, physiological and biochemical bases of behavior. Second semester. Offered in 1968-69 and alternate years.

Mr. Nord

437. Psychophysical Measurement (3)

An analysis of theoretical and methodological problems in psychological measurement with particular emphasis on psychophysical threshold determination and scaling. First semester. Offered in 1968-69 and alternate years.

Mr. Wnestr

438. History of Psychology (3)

Interpretation of selected works of authors who have contributed significantly to the growth of scientific psychology. Second semester.

Mr. Brozek

450. Mathematical Models of Learning (3)

Stochastic models of learning; application of game and decision theory to learning. Offered as required. Mr. Brody

451. Vision (3)

A systematic survey of the methods and chief results in the study of visual processes. First semester. Offered as required.

Mr. Wnestr

453. Advanced Topics in Learning (3)

An intensive study of some topic in learning with emphasis on current research, e.g., discrimination learning, avoidance learning, concept learning, problem solving, verbal learning. May be repeated for credit. First or second semester.

Messrs. Brody, Marsh, Richter

454. Theories of Learning (3)

Critical survey of major theories of learning. Second semester. Offered in 1969-70 and alternate years.

Mr. Brody

455. Topics in Engineering Psychology (3)

Selected topics related to the application of experimental psychology to man-machine systems, e.g., sensory load and performance; perception and motion; man-computer interaction; system development; psychophysiology of human performance. May be repeated for credit. First or second semester. Offered as required.

456. Advanced Social Psychology (3)

Intensive treatment of theory and empirical research in an area of current interest in social psychology. Second semester. Offered as required.

Mr. Jones

458. Sensory Psychophysiology (3)

An analysis of the neurological bases of sensation based upon an investigation of receptor mechanisms, afferent processes and central integrative activities. Second semester.

Mr. Nord

459. Advanced Topics in Psychophysics (3)

A topic or topics of current interest in psychophysics will be covered intensively, e.g., adaptation level theory, theory of signal detectability, multidimensional scaling. May be repeated for credit. Offered as required.

Mr. Wnestr

460. Special Study (1-3)

Study of some special topic not covered in the regular course offerings.

Staff

461. Research (1-3)

Original research not connected with master's or doctoral thesis.

Staff

463. College Teaching of Psychology (1)

The seminar will be devoted to the consideration of problems in the preparation and presentation of college courses in psychology. Ancillary problems associated with the pro-

RELIGION

session of psychology will be considered. Practice in teaching. First and second semesters. May be repeated for credit. Staff

464. Instrumentation (1)

Demonstrations and practical work covering the basic mechanical, electronic, optical and photographic techniques used in psychological research. An introduction to computer programming will be included. First and second semesters. May be repeated for credit. Staff

482. Abnormal Psychology (3)

Principles underlying the major forms of behavior pathology. Prerequisites: Psych. 383. Open only to graduate students specializing in guidance and counselling or reading in the School of Education. Offered as required.

Mr. Millon

483. Individual Testing (3)

A practicum course on the use of individual tests in the assessment of intelligence and personality. Prerequisites: Psych. 381, 383 and Educ. 473. Open only to graduate students specializing in guidance and counselling or reading in the School of Education. Offered as required.

Mr. Millon

484. Projective Techniques (3)

Administration, scoring and basic interpretive principles of the Rorschach and TAT. Critical examination of these and allied techniques. Prerequisites: Psych. 381, 482, and Educ. 473. Open only to graduate students specializing in guidance and counselling or reading in the School of Education. Second semester. Offered as required. Mr. Millon

486. Theories of Psychotherapy (3)

Review of theoretical formulations underlying the major approaches of psychotherapy. Discussion of principles of therapeutic interviewing, psychoanalysis and group treatment methods. Prerequisites: Psych. 482. Open only to graduate students specializing in guidance and counselling or reading in the School of Education. Offered as required.

Mr. Millon

Professor

ARTHUR ROY ECKARDT, PH.D., *Chairman*

Associate Professor

RAYMOND EUGENE FUSSLE, B.D.

15. Phenomenology (3)

Introduction to the field through study of selected data from different religious traditions, using successive methods of interpretation: historical, scientific, theological, and philosophical. First and second semesters.

16. Biblical Studies I (3)

Study of Old Testament writings, with emphasis on early religious traditions of the Hebrews; the history of Israel from the founding of the Kingdom through the post-exilic period; social, economic, and political influences on Jewish religion; the prophetic movement; the law; the Temple and its worship; and the importance of Jewish religion for Christianity and for mankind. First semester.

17. Biblical Studies II (3)

Study of New Testament writings, with emphasis on the four Gospels, the Acts of the Apostles, and the major Epistles. The life and teachings of Jesus and of St. Paul. The theological viewpoint of the primitive Church as reflected in the New Testament. Second semester.

101. Faiths of the Orient (3)

Study of the rise, development, and teachings of selected major religions of India, China, Japan, and Southeast Asia. First semester.

102. Faiths of the West (3)

Study of the rise, development, and teachings of the major religions of Europe and North America with some attention to Islam. Second semester.

151. The Jewish-Christian Dialogue (3)

Analysis of the confrontation of synagogue and church in history and the present with the aid of current materials on the subject. Stress upon moral issues such as antisemitism and upon doctrinal similarities and differences between Judaism and Christianity. Some consideration of religious and sociopolitical aspects of the re-establishment of the State of Israel. First or second semester.

211. Recent Theological Trends (3)

Study of major twentieth-century movements in Catholic, Protestant and Jewish thought in the United States and Europe. Among the developments included are liberalism versus orthodoxy, the demythologization of Scripture, the crisis of technology and secularization, theologies of "the death of God," and the ecumenical movement. First semester.

212. Theological Ethics (3)

Study of alternative points of view on the relating of theology and of religious anthropology to practical moral questions. Consideration of the positions of influential theologians and movements respecting marriage, race, politico-economic life, and international affairs. Particular attention to "the new morality" and "situation ethics." Second semester.

RESERVE OFFICERS' TRAINING PROGRAM

Students pursuing ROTC are eligible to be selected for deferment from induction under the Selective Service laws. The number of deferments which may be granted are limited by existing Department of Defense Directives.

Students in the Colleges of Arts and Science and of Business Administration may substitute Advanced Military or Aerospace Studies credits for six hours of electives.

Students in the College of Engineering may substitute advanced Military or Aerospace Studies credits for six hours of General Study (elective) courses.

A cash deposit of \$25 is required of all students at the time of registration. The deposit is refunded to the student upon his return of all issued property.

DEPARTMENT OF MILITARY SCIENCE

Professor

GATES BARNET STERN, B.A., *Chairman*

Associate Professor

ROLF BROOKS KREITZ, B.S.

HAROLD D. MATHENEY, B.S.

LEWIS JAMES MILLER, B.S.

Assistant Professor

JAMES M. LYLE, B.A.

Assistant

ROBERT DAVIS BOOTHE

ROBERT H. EBERT

ARTHUR J. PLANTE

The Army Reserve Officers' Training Corps was established at Lehigh University in September 1919. The courses are conducted under Department of Army regulations; the General Military Science Program is followed.

The general objective of this course of instruction is to develop young men through education, training, and enhancement of their inherent qualities of character for commissions as officers in the United States Army. This training is not duplicated in any other college course. The student learns to organize and lead others. He acquires qualities many college men miss — self-discipline, physical stamina and bearing — qualities that contribute to a success in any career. Instruction provides a basic military education common to all branches of the service.

Traditionally, Army ROTC has been a four-year program, consisting of a two-year Basic Course which is elective and a two-year Advanced Course which is also elective, but only students who have demonstrated a potential for becoming effective officers are selected by the Professor of Military Science and approved by the President of the University for participation. Students in the Advanced Course are paid \$40.00 per month (non-taxable) during the school year. A six-week Advanced Course summer training camp is attended normally between the junior and senior years. Pay for this camp is at the rate of \$147.30 per month. All uniforms, textbooks, and equipment needed by students for ROTC are furnished by the Army. Transportation to and from summer camp is paid by the Army.

Each student who successfully completes the ROTC Advanced Course is commissioned a Second Lieutenant in one of the components of the United States Army upon his

graduation from Lehigh. He will be required to serve on active duty for two years followed by four years in a reserve status. A student who accepts a Regular Army commission or who completes the Army Aviation Program after entering service must serve on active duty for not less than three years.

An ROTC graduate may delay his active military service for a period up to 48 months to pursue a full-time course of graduate-level instruction. Provided his field of study is one for which the Army has specific requirements, he is recommended by the PMS, and he is selected on a competitive basis by the Department of the Army. Time spent in a delay status does not lengthen the active duty service obligation for an officer who accepts a Reserve commission.

ARMY ROTC SCHOLARSHIP PROGRAM. The Army ROTC scholarship program is designed to offer financial assistance to outstanding young men in the four-year Army ROTC program who are interested in the Army as a career. Each scholarship provides for free tuition, textbooks and laboratory fees, in addition to pay of \$50.00 per month, for the period that the scholarship is in effect. During the six-week summer training period at the end of the junior year, this pay is increased to \$160.50 per month.

Scholarships may be awarded for either two or four years. Four-year scholarships are open to all students entering Army ROTC as freshmen. Applications must be made to the Army Headquarters serving the state of residence during the publicly announced period, usually between 1 December and 15 January, prior to the September of enrollment. Two-year scholarships are restricted to those students who have completed the first two years of ROTC and are selected for enrollment in the ROTC Advanced Course.

TWO-YEAR PROGRAM. Students who have been unable to take ROTC during their first two years of college may apply for the Advanced Course and are subject to the same selection process. However, they must complete a six-week basic summer camp prior to their junior year of college and acceptance into the ROTC program. This summer training takes the place of the Basic Course and qualifies the student for entry into the Advanced Course. Pay for the summer training is at the rate of \$95.70 per month. The Army furnishes or pays for transportation to and from the basic ROTC camp.

BASIC COURSE. During the freshman and sophomore years training is provided in basic military subjects, military history, weapons, equipment and leadership techniques. During the sophomore year the student cadet is given an opportunity to apply for the advanced program.

To enroll in the Basic Course, an applicant must be:

1. A citizen of the United States of America.
2. Between 14 and 23 years old.
3. Regularly enrolled as a student.
4. Screened and found acceptable by the Department of Military Science.

ADVANCED COURSE. Qualified students may apply for and be accepted into the Advanced Program, with a commission as Second Lieutenant in the United States Army as the objective. To be eligible for consideration and admission to the advanced program, a student regularly enrolled, must be a citizen of the United States between the ages of 14 and 25, of good moral character; he must have success-

fully completed the Basic Course or have credit in lieu through prior military experience, attendance at military schools, or completion of ROTC Basic Summer Camp; he must successfully complete the prescribed physical examination and officer qualification test. Prior to formal enrollment in the Advanced Course, a student who is selected for training is required to sign an agreement to complete the program of instruction during the remainder of his course at the University. He also agrees to accept appointment as an officer, if such appointment is offered, and to serve on active duty for the period prescribed. Once enrolled, the student receives training in subjects which will prepare him for his commission as an officer and subsequent service. Fundamentals of leadership techniques are stressed; military law, administration and logistics are covered, in addition to an understanding of tactics. Instruction is supplemented by student participation in operation of the ROTC program and in allied extra-curricular activities.

DMS PROGRAM. This is a competitive program which permits outstanding ROTC students to apply for a Regular Army commission immediately upon graduation. At the end of the junior year and prior to the Advanced course summer camp, approximately one-third of each junior ROTC class may be designated potential Distinguished Military Students. A student who maintains the same high standards throughout summer camp and his senior year may qualify for designation as a Distinguished Military Graduate and receive a Regular Army commission upon graduation.

FLIGHT TRAINING PROGRAM. Flight training is an extra-curricular activity conducted by an FAA approved flying school near the college. The instruction consists of 35 hours of ground training and more than 36 hours of flight instruction. Senior ROTC students who take flight training must agree to participate, if selected, in the Army Aviation Program upon entering active service.

TRANSFERS. Students transferring from other institutions may enter the ROTC program at the appropriate level and year, providing the institution from which transferred has a similar ROTC program for which the transferring student has received the necessary credits and the recommendation of his former Professor of Military Science. Students who have successfully completed the ROTC Basic Summer Camp, prior to admission to Lehigh, may enter the Advanced Course in their junior year.

Basic Course

13. Basic Military Science (1)

An introductory course designed to provide the student with an understanding of the Army, the ROTC program, and military obligations under present laws. Training during leadership laboratory periods, i.e., squad drill, rifle marksmanship, customs of the Army, and introduction to military courtesy and discipline, enable the students to individually evaluate the Army ROTC program. One recitation and two hours of leadership laboratory a week. Fall semester.*

14. Basic Military Science (1)

During this course the student gains an understanding of U.S. military policy, missions and responsibilities of the Army as a member of the National Defense Team. Emphasis is placed on the student's personal responsibilities as a citizen and leader in this Defense Team. One recitation and two hours of leadership laboratory a week. Spring semester.*

21. Basic Military Science (2)

The objective of this course is to provide the ROTC student with a sound foundation in the principles of the art of warfare as exemplified in American Military History. Emphasis is placed on analyzing the principles of war and military leadership. Students are given greater responsibility in practicing leadership during leadership laboratory. Two recitations and two hours of leadership laboratory per week. Spring semester.

22. Basic Military Science (2)

This course is designed to develop student proficiency in the use of maps and aerial photographs and to become familiar with small unit combat operations and military tactics. Leadership training is emphasized by assigning students to leadership positions to evaluate the student's potential for the advanced program. Two recitations and two hours of leadership laboratory per week. Fall semester.

Advanced Course

105. Advanced Military Science (1)

The student analyzes realistic leadership actions and solves leadership problems. The functions of the various branches of the Army are discussed with the objective of assisting the student in selecting the branch he desires as a commissioned officer. Tactical training of the individual soldier and physical fitness are stressed during the leadership laboratory periods. Two recitations and two hours of leadership laboratory per week. Fall semester.*

106. Advanced Military Science (2)

The student is provided opportunities for practical work in applying the principles, techniques, and methods of military instruction and of small unit tactics. A required field trip to a military installation allows the student to apply the tactical lessons previously learned by performing as a military commander under conditions similar to active duty. Three recitations and two hours of leadership laboratory per week. After completing M.S. 106 the student is ready to participate in the six-week ROTC summer encampment. Spring semester.

107. Advanced Military Science (2)

Course is designed to teach the value and basic concepts of military intelligence, administration, law, and develop an understanding of staff organization and functions. Students are appointed as cadet officers and given leadership assignments to assist in developing and training junior cadets. Three recitations and two hours of leadership laboratory per week. Fall semester.

108. Advanced Military Science (1)

Students study the basic concepts and fundamentals of supply, evacuation and troop movements. To prepare the future officer for active duty, an orientation of Army life is presented with a brief review of leadership responsibilities. Two recitations and two hours of leadership laboratory a week. Spring semester.*

**Students must take an approved three credit-hour course from the curricula of the Colleges of Arts and Science, Business and Economics, or Engineering which contributes to their potential military capabilities.*

DEPARTMENT OF AEROSPACE STUDIES**Professor**

STEPHEN D. ARMSTRONG, B.A., *Chairman*

Assistant Professors

DAVID H. PITTRAD, B.S.

RICHARD M. THODEN, JR., B.S.

EDWIN M. WAGNER, B.G.E.

Assistants

RICHARD EDWARD HOLLERAN

JAMES CHARLES LEE

JOSEPH J. VEILLEUX

The Lehigh Unit of the Air Force Reserve Officer Training Corps was established in October 1946. Its program is designed to prepare students for commissions in the United States Air Force upon successful completion of an undergraduate course. The Department of Aerospace Studies offers two programs for students to qualify for commission: one of four years and one of two years. Any student who has met or will meet the baccalaureate degree requirement at the end of his university education may apply for entrance into the four or two year program. He must complete his AFROTC training and university education and be commissioned by his 28th birthday.

FOUR-YEAR PROGRAM. The four year program consists of classroom and laboratory work during the four undergraduate years and one field training period of four weeks, usually between the junior and senior years, at a United States Air Force base.

During the first two years the program acquaints students with military and aerospace technological advances and current research and development activities. Leadership training is also begun. During the last two years, emphasis is placed on personal development. Students increase their leadership ability by assuming positions of responsibility in the Cadet Corps. To insure that they will keep abreast of the developments in the Air Force, students continue to receive information on technological changes.

While in an undergraduate status, Air Force ROTC students are furnished, free of charge, all text and reference books, uniforms, and equipment required for aerospace study. Under the provisions of the Reserve Officers Training Corps Revitalization Act of 1964, Air Force ROTC Cadets who are members of the four-year program are offered an opportunity to compete, on a nationwide basis, for full financial assistance grants which include tuition,

fees and books, plus a retainer of \$50 per month. Those fully enrolled cadets who do not obtain a financial assistance grant will receive \$50 monthly during their junior and senior years.

At the beginning of the junior year, or upon initiation of a financial assistance grant, each student is required to sign a formal agreement that he will complete the Professional Officer Course and accept a commission as a second lieutenant in the United States Air Force when he has been granted his degree. Also, the student is sworn into the Enlisted Reserve of the United States Air Force. The term of commitment after commissioning for any non-flying professional area is four years. If the student is physically qualified and desires to become a pilot or navigator, the required term of service is five years, after completion of flying training.

TWO-YEAR PROGRAM. The two-year program is for those students who are unable to complete the first two years of the four-year Air Force ROTC program. Such students may apply during their sophomore year for acceptance into the two-year program. In lieu of completing the freshman and sophomore years of the four-year program and the four-week summer training, these men will receive field training in a six-weeks' officer training course conducted on an Air Force base during the summer between the sophomore and junior years. Upon successful completion of the six-week intensive military and academic program, they will return to the campus to be enrolled in the Professional Officer Course to complete the same academic program required of the four-year students. These students receive \$50 a month in subsistence allowance.

FLIGHT INSTRUCTION PROGRAM. Senior cadets who are physically qualified may take flight instructions in their senior year at no cost to themselves. The FIP provides 36½ hours of flying time, 35 hours of instruction (20 hours dual and 15 hours solo) plus 1½ hours for a final flight progress check. Cadets who complete the 35 hours of instruction and pass the FAA written examination and the final flight check, may receive an FAA private pilot's license.

GENERAL INFORMATION ON BOTH PROGRAMS. Adjustment in the Aerospace program will be made to accommodate students enrolling in an honors or cooperative course. Students who are eligible for and desire graduate education immediately after completing their undergraduate work may request a delay in reporting for active duty until completing their graduate degree.

ELIGIBILITY REQUIREMENTS. To be eligible for the Air Force ROTC program a student must be:

1. A male citizen of the United States.
2. Physically qualified for commission in the United States Air Force in accordance with existing Air Force regulations.
3. Not under 14 years of age; and upon graduation not more than 28 years of age.
4. Planning to pursue work leading to at least a bachelor's degree.
5. Willing to sign a formal agreement and enlist in the Air Force Reserve at the beginning of the junior year, or upon initiation of a financial assistance grant, which

ROMANCE LANGUAGES

obliges him to remain in the ROTC program, to accept a commission, and to serve the required period in the Air Force upon graduation.

General Military Course

1. Aerospace Studies (1)

World Military Systems: An introductory course exploring the causes of present world conflicts, the role and relationship of military power toward conflict, the responsibilities of an Air Force Officer, the evolution of different political philosophies and the means that nations develop to pursue their objectives.

2. Aerospace Studies (1)

World Military Systems: A continuation of the study of military means that modern nations have developed. Emphasis is placed on the United States Department of Defense and the United States Air Force. Several of the major commands such as the Strategic Air Command are discussed at length.

11. Aerospace Studies (1)

World Military Systems: A broadened study of military forces which includes surveys of the United States Army, the United States Navy, and future trends and implications of land, sea, and aerospace warfare. This study is limited to the military forces of the United States.

12. Aerospace Studies (1)

World Military Systems: An analysis of major world powers to include Western Alliances such as NATO, SEATO, and CENTO; the Communist military forces of USSR, China, and the Soviet Satellites; and future trends toward war, peace, and world military alignments.

Professional Officer Course

111. Aerospace Studies—

Air Force Officer Development (3)

Development of the knowledge and skills required of the junior officer in the Air Force. This will include the nature of war, history of air power, and the mission, doctrine, and employment of the United States Air Force.

112. Aerospace Studies—

Air Force Officer Development (3)

Continuation of the development of knowledge and skills required of a junior Air Force officer. This will include the history and importance of national space effort, orbits and trajectories, space vehicle systems, ground supports systems, manned space flight, and operations in space.

113. Aerospace Studies—The Professional Officer (3)

Introduction to military professionalism. A study of the meaning of professional responsibilities of the professional officer, the foundations of the military profession, the military justice system, theories of leadership, discipline and human relations.

114. Aerospace Studies—The Professional Officer (3)

A military explanation of leadership and management. Includes principles and functions of management, Air Force personnel policies, channels of communication, problem solving, the command-staff team, the subordinate, performance standards, data processing, and Air Force controls.

Professor

JOHN ANDREWS VAN FERDE, PH.D., *Chairman*

Associate Professor

VICTOR MANUEL VALENZUELA, PH.D.

Instructors

ALLEN M. BARSTOW, M.A.

WALTER F. MARSHALL, M.A.

ALBERTO ROMERO, LICENTIATUS

JOHN T. H. TIMM, M.A.

FRENCH

1. Elementary French (3)

Basic conversational French illustrating essential grammatical principles. Emphasis on aural-oral learning with required laboratory practice. First semester.

2. Elementary French (3)

Continuation of Fr. 1, with the addition of simple vocabulary-building tests. Prerequisite: Fr. 1. Second semester.

11. Intermediate French (3)

Reading based on works of the nineteenth and twentieth century writers; formal review of French grammar; prose composition; outside reading. Prerequisite: One year of college French or two units of entrance French. First semester.

12. Intermediate French (3)

Continuation of Fr. 11. Prerequisite: Fr. 11. Second semester.

13. Types of French Literature (3)

Training in the ability to read and understand representative works from the Middle-Ages to the nineteenth century. Outside reading and reports. Conducted in French. Prerequisites: French 42 or 4 units of entrance French or consent of chairman of the department. First semester.

14. Types of French Literature (3)

Reading and discussion of representative works of the nineteenth and twentieth centuries. Outside reading and reports. Conducted in French. Prerequisites: French 13 or consent of chairman of department. Second semester.

23. Seventeenth Century French Literature (3)

A study of the main pre-classical and classical French writers of the seventeenth century. Lectures, discussion of texts, reports, and collateral reading. Conducted in French. Prerequisites: French 13 and 14, or 5 units of entrance French, or consent of chairman of the department. First semester.

24. Seventeenth Century French Literature (3)

Continuation of Fr. 23. Conducted in French. Prerequisite: Fr. 23, or consent of chairman of department. Second semester.

25. Eighteenth Century French Literature (3)

The literature of the Enlightenment and pre-romanticism. Lectures, discussion of texts, reports, and collateral readings. Conducted in French. Prerequisites: French 13, 14, or

5 units of entrance French, or consent of chairman of department.

26. Eighteenth Century French Literature (3)

Continuation of Fr. 25. Prerequisite: Fr. 25. or consent of chairman of department.

31. Nineteenth Century French Literature (3)

Main literary currents of the nineteenth century; romanticism and realism. Lectures, reports, collateral readings. Prerequisites: French 13 and 14, or 5 units of entrance French, or consent of chairman of department.

32. Nineteenth Century French Literature (3)

Continuation of Fr. 31. Prerequisite: Fr. 31, or consent of chairman of department. Second semester.

41. French Oral and Written Composition (3)

For students who wish a greater opportunity for practice in the oral and written use of French than can be provided in the literature courses. Prerequisites: French 12, or 3 units of entrance French, or consent of chairman of department. First semester.

42. French Oral and Written Composition (3)

Continuation of Fr. 41. Prerequisite: Fr. 41, or consent of chairman of department. Second semester.

For Advanced Undergraduates and Graduates

221. French Literature before the Seventeenth Century (3)

A general review of French literature from its beginning through the sixteenth century. First semester.

222. Contemporary French Literature (3)

Second semester.

223. Proseminar (3)

A study of the works of some author or group of authors, or of a period. First semester.

224. Proseminar (3)

Continuation of Fr. 223. Second semester.

301. French Classicism (3)

A study of the French classical theatre, novel, and criticism with emphasis on Corneille, Racine, Moliere, Madame de Lafayette, Malherbe, and Boileau. Conducted in French. First semester. Mr. Van Eerde

302. The Age of Enlightenment (3)

A study of the "philosophes" and "encyclopedistes" of the 18th century, with emphasis on Voltaire, Rousseau, Montesquieu, and Diderot. Conducted in French. Second semester. Mr. Van Eerde

303. History of the French Language (3)

A chronological history of the origins and development of the French language, from the beginnings to the present. Particular stages of the development of the language will be analyzed: Gallo-Romance, Old French, Middle French, Renaissance, Classicism, Romanticism, and Contemporary French. Vocabulary, pronunciation, and structure will be

treated. Conducted in English. Prerequisite: Fr. 13-14 or 41-42, or the equivalent, or consent of chairman of department. First semester. Mr. Barstow

304. Old French Literature (3)

Readings in French Literature of the Middle Ages, particularly representative works of the literary renaissance of the twelfth century: *chanson de geste*, lyric poetry and *roman d'aventure*. Longer treatment will be given to the Arthurian romances, especially the works of Chrestien de Troyes. Lectures, discussions, and reports. Some of the readings will be in the original Old French, some in modern French translation. Conducted in English. Prerequisite: Fr. 13-14 or 41-42, including a thorough reading knowledge of the language, or consent of chairman of department. Second semester. Mr. Barstow

305. Twentieth Century French Literature (3)

A study of the principal novelists of the 20th Century in France: Proust, Gide, Mauriac, Sartre, Camus, Robbe-Grillet, Beckett; with a consideration of the trends, philosophy, and movements they represent. Conducted in French. Prerequisite: Fr. 13-14 or 41-42 or consent of chairman of department. First semester. Mr. Marshall

306. Twentieth Century French Literature (3)

A study of the drama and poetry of 20th Century France with readings chosen to illustrate the principal dramatists and poets as well as literary movements. Conducted in French. Prerequisite: Fr. 13-14 or 41-42 or consent of chairman of department. Second semester. Mr. Marshall

307. Stendhal and Flaubert (3)

The major works of Stendhal and Flaubert with particular consideration to style, theme, and influence. Conducted in French. Prerequisite: Fr. 13-14 or 41-42 or consent of chairman of department. First semester. Mr. Marshall

308. Symbolism (3)

An intensive study of the symbolist school of poetry from Baudelaire through Mallarme and the end of the 19th Century. Conducted in French. Prerequisite: Fr. 13-14 or 41-42 or consent of chairman of department. Second semester. Mr. Marshall

ITALIAN

1. Elementary Italian (3)

Grammar; composition; rapid reading of easy modern prose. No previous study of Italian required. First semester.

2. Elementary Italian (3)

Continuation of Ital. 1. Prerequisite: Ital. 1. Second semester.

11. Intermediate Italian (3)

The age of Dante. Lectures in English on Dante and his contemporaries; readings in the *Divina Commedia*. Prerequisite: One year of college Italian or two units of entrance Italian. First semester.

12. Intermediate Italian (3)

The Romantic Period—lectures in English, and selected

Romance Languages: Portuguese, Spanish

readings from the works of Manzoni and Leopardi. Prerequisite: One year of college Italian or two units of entrance Italian. Second semester.

PORTUGUESE

1. Elementary Portuguese (3)

A study of Portuguese grammar and forms; practice in writing and speaking Portuguese. First semester.

2. Elementary Portuguese (3)

Continuation of Port. 1. Prerequisite: Port. 1. Second semester.

SPANISH

1. Elementary Spanish (3)

Basic conversational Spanish illustrating essential grammatical principles. Emphasis on aural-oral learning with required laboratory practice. First semester.

2. Elementary Spanish (3)

Continuation of Span. 1, with the addition of the use of simple vocabulary-building and reading texts. Prerequisite: Span. 1. Second semester.

11. Intermediate Spanish (3)

Reading of modern Spanish prose, with a view to acquiring exactness and speed in reading; rapid review of grammar, composition, and conversation. Prerequisite: One year of college Spanish or two units of entrance Spanish. First semester.

12. Intermediate Spanish (3)

Continuation of Span. 11. Prerequisite: Span. 11. Second semester.

13. Cultural Evolution of Spain (3)

The historical and cultural evolution of Spain from its beginning to the present. Reading of representative Spanish authors. A term paper in Spanish is required. Conducted in Spanish. Prerequisite: Span. 12 or four units of entrance Spanish, or consent of chairman of department. First semester.

14. Cultural Evolution of Latin-America (3)

Continuation of Span. 13. The historical and cultural evolution of Latin America. Reading of representative Latin-American authors. A term paper in Spanish is required. Conducted in Spanish. Prerequisite: Span. 13 or consent of chairman of department. Second semester.

21. Introduction to Spanish Fiction (3)

Readings and discussion of selected novels and short stories; outside reading and reports. Conducted in Spanish. Prerequisite: Span. 12 or four units of entrance Spanish, or consent of chairman of department. First semester.

22. Introduction to Spanish Drama (3)

Reading and discussion of selected plays; outside reading and reports. Prerequisite: Span. 21, or consent of chairman of department. Second semester.

31. Spanish Conversation and Composition (3)

For students who wish a greater opportunity for practice in the oral and written use of Spanish than can be provided

in the literature courses. Special attention given to the history and culture of Spain. Conducted in Spanish. Prerequisite: Two years of college Spanish or three units of entrance Spanish. First semester.

32. Spanish Conversation and Composition (3)

Continuation of Span. 31, with special attention given to Latin-America area studies. Conducted in Spanish. Prerequisite: Span. 31. Second semester.

For Advanced Undergraduates and Graduates

231. Spanish American Literature (3)

Reading and discussion of representative works of the literature of the Pre-Columbian, Conquest, and Colonial periods. Oral and written reports; term paper. Conducted in Spanish. Mr. Valenzuela

232. Spanish American Literature (3)

Reading and discussion of representative works of the literature of the nineteenth and twentieth centuries. Oral and written reports; term paper. Conducted in Spanish. Mr. Valenzuela

301. The Spanish Essay (3)

Reading and discussion of outstanding Spanish thinkers of the twentieth century, with emphasis on the works of Unamuno and Ortega y Gasset. Oral and written reports. Conducted in Spanish. First semester. Mr. Valenzuela

302. The Latin-American Essay (3)

Reading and discussion of distinguished Spanish-American essayists of the twentieth century with emphasis on the works of Rodo, Vasconcelos, Vaz Ferreira, and Francisco Romero. Oral and written reports. Conducted in Spanish. Second semester. Mr. Valenzuela

303. Cervantes (3)

Reading and critical study of the chief works of Miguel de Cervantes with special emphasis on *Don Quijote*. Collateral reading and reports. Given in Spanish. First semester. Mr. Valenzuela

304. Lope de Vega (3)

The development of the Spanish Drama of the Golden Age, including the important plays of Lope de Vega. Collateral reading and reports. Given in Spanish. Second semester.

305. Spanish Literature of the Middle Ages (3)

Reading and discussion of outstanding works such as: *El Cid*, *El Libro de Buen Amor*, *La Celestina*. Given in Spanish. First or second semester.

306. Latin America Literature since World War II (3)

Reading and discussion of representative works of contemporary Latin-American authors. Given in Spanish. First or second semester. Mr. Valenzuela

308. Spanish Literature since the Civil War (3)

Reading and discussion of representative contemporary Spanish authors such as Cela, Matute and Sender. Collateral reading and reports. Conducted in Spanish. Second semester. Mr. Timm

SOCIAL RELATIONS

Professor

ROBERT CLIFFORD WILLIAMSON, PH.D., *Chairman*

Assistant Professors

ROY CECIL HERRENKOHL, JR., PH.D.

ROBERT GRIFFITH JONES, PH.D.

Instructors

JAMES RATHBURN MCINTOSH, M.A.

ROBERT R. REEDER, M.A.

Teaching Assistants

WILLIAM S. CLEWELL, GEORGE ALBERT HUNT, JR., JOHN FRANCIS O'LOUGHLIN, JR.

3. Introduction to Social Relations (3)

An interdisciplinary study of man's evolution, culture, society and individuality. Social psychological, anthropological and sociological materials will be discussed to explore the contrasting definitions of man developed in contemporary social science. Not open to students who have had or are taking S.R. 11, 21 or 31. First semester.

4. Introduction to Social Relations (3)

A continuation of S.R. 3 with attention placed on man's participation in the social process and theories of social change. Cross-cultural investigations and research into contemporary issues in American society will be studied to examine how the individual is affected by and affects his social environment. Not open to students who have had or are taking S.R. 11, 21 or 31. Prerequisite: S.R. 3. Second semester.

11. Principles of Sociology (3)

An introduction to the field of sociology and its concepts and methods. Among the topics are the nature of the group, social organization and structure, socialization, stratification, social institutions, ethnic relations, social change. Not open to students who have had or are taking S.R. 3 or 4. First and second semester.

21. Social Psychology (3)

An introduction to the theories, methods of investigation, and research results of social psychology with emphasis on psychological processes in social behavior, social attitudes, group behavior and social interaction. Not open to students who have had or are taking S.R. 3 or 4. First and second semester.

31. Cultural Anthropology (3)

Examination of the scope, aims and methods of anthropology; the nature of culture; the cultural evolution of man; the range of culture phenomena emphasizing economic organization, kinship and social organization, political organization, and religion; and a brief introduction to the history of ethnological theory. Analysis of the characteristic features of the life, thought, and culture of selected primitive and peasant peoples throughout the world. Not open to students who have had or are taking S.R. 3 or 4. First and second semester.

65. Contemporary Social Problems (3)

An exploration of major problems facing contemporary

men, the social contexts giving rise to these problems, and the social consequences of alternative strategies for dealing with them. Selected problems such as mental health, crime, the population explosion, racial tensions, the modern city, and war will be studied in detail. Prerequisite: sophomore standing.

75. Minority Groups (3)

Ethnic minorities and intergroups relations. Consideration of the historical and social character of minority groups and an examination of theory and research focusing of intergroup cooperation and conflict. Prerequisite: sophomore standing.

Mr. Herrenkohl

For Advanced Undergraduates and Graduates

292. Research Methods (4)

Training in the methods of research used in the study of social relations. Study of selected problems and applications in research design, execution, analysis, and interpretation. Introduction to major techniques of research including laboratory experimentation, field study, and participant observation; questionnaire construction and interview procedure. Introduction to different levels of analysis. Prerequisite: six credit hours in Social Relations or consent of chairman of department. Second semester.

Mr. Herrenkohl

301. Experimental Social Psychology (3)

Training in design, execution and interpretation of experiments in social psychology. An opportunity for original research. Prerequisite: six credit hours in Social Relations or Psychology. First semester.

Mr. Jones

302. Seminar in Social Psychology (3)

Intensive consideration of selected topics in current theory and research in social psychology. The subject matter will vary from semester to semester. May be repeated for credit. Prerequisite: six credit hours or consent of chairman of department. Second semester.

Mr. Jones

303. Groups and Organizations (3)

Survey of theories and empirical research on interpersonal behavior in groups and organizations. Emphasis on such topics as: structure and process, group size, communication networks, leadership, power, decision making and effectiveness. Prerequisite: six credit hours in Social Relations or consent of chairman of department.

304. Human Communication (3)

Problems in understanding the processes and functions of communicative behavior. Review of technical, semantic and pragmatic problems, viz. information theory and cybernetics, issues in psycholinguistics, and effects of communication in groups and society.

305. Personality and Social Processes (3)

An examination of theory and research concerning the influence of individual personality and motivation on interpersonal perception and on participation in social situations. Six credit hours in Social Relations or consent of chairman of department.

Mr. Herrenkohl

331. Theories of Cultural Anthropology (3)

A systematic analysis of the development of anthropology

as a scientific discipline. Contemporary theory and practice in anthropological studies of society, culture and the individual are considered in historical perspective. Prerequisite: Six credit hours in Social Relations or consent of chairman of department. First semester. Staff

333. Primitive Political Systems (3)

A comparative analysis of systems of law, government, and politics among selected tribal and peasant societies. Analysis of the sources and functions of law and government in particular societies, examination of systems of social control, and the conflict of these cultural systems in the modern world. Attention to historical contemporary anthropological theory in this area. Prerequisite: Six credit hours in Social Relations or consent of chairman of department. Second semester. Staff

335. Cultural Dynamics (3)

Critical evaluation of approaches to the problems of culture change; analysis of invention and intergroup cultural borrowing; agents and conditions conducive to change; mechanics of culture growth; and application of techniques for inducing change. Attention to the impact of Western civilization upon traditional native societies; socio-cultural adjustments to the impact; and community disintegration and reintegration. Prerequisite: Six credit hours in Social Relations or consent of the chairman of the department. First semester. Mr. Reeder

336. Religion and Magic (3)

A comparative analysis of the origins, elements, forms and symbolism of religious beliefs and behavior; the role of religion in society with particular reference to nonliterate societies. Anthropological theories and methods of analysis of religion, both historical and contemporary, will be considered. Prerequisite: Six credit hours in Social Relations or consent of the chairman of the department. Second semester. Mr. Reeder

338. Folklore and Culture (3)

Traditional forms of expression (songs, tales, myths, proverbs, ritual, etc.) and their setting in non-literate and literate societies; the social and psychological functions of folklore, with particular emphasis on the concepts of myth, ritual, and superstition; the relationship between folklore and literature. Second semester. Staff

339. Seminar in Anthropology (3)

Intensive consideration of selected topics in contemporary or past research in cultural anthropology. The subject matter will vary from semester to semester. First or second semester. May be repeated for credit. Prerequisite: Six credit hours in Social Relations or consent of the chairman of the department. Mr. Reeder

364. The Family (3)

A sociological study of man's basic institution. Includes: an analysis of historical backgrounds, interaction within the family, relation to other groups and institutions, problems of family disorganization, legal aspects of marriage and divorce, family adjustment, the family in a changing society. Second semester. Mr. Williamson

366. Population Problems (3)

Quantitative and qualitative aspects of U.S. and world population. Includes: causes and effects of migrations, racial composition and race relations, population theories, legal aspects, social consequences of population trends, present trends and future predictions. Prerequisite: Six credit hours in Social Relations or consent of the chairman of the department. Second semester.

367. Latin American Social Institutions (3)

An introduction to the contemporary indigenous, mestizo and creole cultures of Latin America with analysis of specific communities. An investigation of family, education, religious, and recreational institutions with particular emphasis on intellectual developments. Attention to the problem of change and social planning. Prerequisite: One course in Social Relations or consent of chairman of department. First semester. Mr. Williamson

368. The Urban Community (3)

A study of urban communities in the world and in the United States. A history of the city, ecological and demographic patterns and growth, institutional organization, status systems, suburban development, resources and problems, future development and planning. Prerequisite: Six credit hours in Social Relations or consent of the chairman of the department. Second semester. Mr. McIntosh

369. Social Disorganization (3)

Social disorganization in contemporary society, with emphasis on the concepts of anomie and alienation. Evaluation of various theories of social disorganization. Prerequisite: Six credit hours in Social Relations or consent of chairman of department.

371. Special Topics in Social Relations (1-3)

An opportunity for advanced work through supervised reading and research. Prerequisite: Consent of chairman of department. First semester.

372. Special Topics in Social Relations (1-3)

Continuation of S.R. 371. Second semester.

373. Seminar in Sociology (3)

Intensive consideration of selected topics in contemporary theory or research in sociology. The subject matter will vary from semester to semester. Prerequisite: Six credit hours in Social Relations or consent of chairman of department. First or second semester. May be repeated for credit. Staff

374. Social Stratification (3)

Examination of concepts of stratification, such as social class, and of theories using these concepts. Consideration also of research findings which indicate the significance of stratification for society. Prerequisite: Six credit hours in Social Relations or consent of chairman of department. Mr. Herrenkohl

381. Development of Sociological Theory (3)

A critical and comparative study of the principal schools of social thought which have contributed to the development of sociological theory. The origins and development of sociology, major contributors, current trends. Prerequisite:

site: Six credit hours in Social Relations or consent of chairman of department. First or second semester.

Mr. McIntosh

384. Social Structure (3)

The theory of social structure considered as a basic key to the understanding of social phenomena, with attention to such concepts as interaction, position, role and role-set, status, institutionalization, equilibrium, norm, and culture. Selected propositions concerning structural relationships and processes will be examined. Prerequisite: Six credit hours in Social Relations or consent of chairman of department. Second semester.

Staff

394. The Individual, Society and Culture (3)

This course will explore the interdisciplinary implications of the materials and methods of social psychology, sociology, and anthropology. Prerequisite: Six credit hours in Social Relations or consent of chairman of department. Second semester.

For Graduates

402. Theory in Social Psychology (3)

A critical analysis of theoretical orientations in social psychology, their place and relevance to the scientific study of human interaction. Behavioristic, phenomenological and mathematical theories will be compared and evaluated.

Mr. Jones

411. Advanced Research Methods (3)

A basic course in research theory and methods. Consideration given the nature of theory, hypotheses testing, the definition of variables and methods of measurement.

Mr. Herrenkohl

412. Practicum in Research Methods (3)

Laboratory in the design and execution of research. Emphasis on the design of measurement instruments, the application of statistical techniques and the analysis and interpretation of data. The student will pursue an independent research project and write a research report based upon it. Prerequisite: S.R. 411. Second semester.

Mr. Herrenkohl

432. Culture Patterns and Personality (3)

The psychological implications of cultural variation, including the analysis of national character.

Mr. Williamson

435. Current Anthropological Theory (3)

An examination of the theoretical foci of anthropology and its relation to disciplines, e.g., ecology, linguistics, ethno-history, the cross-cultural study of cognition, etc.

Staff

464. Seminar on the Family (3)

Societal functions of marriage and the family and the relation of this institution to the social structure and demographic variables. Particular emphasis on the treatment of family disorganization.

Mr. Williamson

465. Organizational Behavior (3)

Theory and research concerning the development and

functioning of organizations. Structure, goals, authority and power, communication, role conflict in large organizations. Cross-institutional comparisons of industrial, research, governmental, medical, and academic organizations.

Staff

467. Latin American Social Structure (3)

Analysis of given Latin American societies with special attention to economic and political structures. Individual projects.

Mr. Williamson

468. Advanced Urban Sociology (3)

Selected problems in urban research, urban and community planning and redevelopment. Relation of the city and the region to economic development and government functions.

Mr. McIntosh

470. Contemporary Sociological Theory (3)

An examination of current developments in theoretical sociology. Functional theory and conflict theory as reflected in Parsons, Merton, Coser and Dahrendorf and others. A critique of current theoretical schools.

Mr. McIntosh

471. Special Topics (3)

Intensive study in an area of social relations, which is appropriate to the interests and needs of the staff and students.

Staff

472. Special Topics (3)

Continuation of S.R. 471.

Staff

DIVISION OF PHYSICAL EDUCATION AND ATHLETICS

Professor

WILLIAM BADIER LICKONBY, B.S., *Director*

Assistant Professors

WILLIAM THOMAS CHRISTIAN, M.A.
JOHN NELSON COVERT, B.S.
FREDERICK HOMER DUNLAP, B.A.
LEROY ARLAN HECKMAN, M.A.
GERALD GRANT LEEMAN, B.A.
JOHN STOHLER STECKBECK, M.S.

Instructors

THOMAS JEFFERSON GANNON, B.A.
FLETCHER A. JOHNSON, JR., B.S.
WALTER KING, B.A.
SAMPSON LEE SANDERS, B.ED.
STANLEY R. SCHULTZ, B.A.
JAMES WALTER SCIBLE III, B.S.
GARY DOUGLAS WALTERS, A.B.
JOHN CALVIN WHITEHEAD, B.S.

The Division consists of the Department of Intercollegiate Athletics and the Department of Physical Education and Intramural Sports. It has supervision over the entire field of intercollegiate athletics and physical education at the University. Its activities consist of intercollegiate athletics, intramural athletics, and required physical education, including corrective exercises.

Experience indicates that it is essential that the physical education program emphasizes the physical fitness and efficiency benefits to be derived from a well-rounded and athletic phase of the program. The purpose of the athletic, physical education, and intramural sports program is designed to:

- A. Raise and maintain the physical standards of the University.
- B. Develop and maintain a high level of all-around physical fitness so that the undergraduate student may more readily assimilate instruction.
- C. Encourage regular and healthful exercise by the development of skills, techniques, and attitudes.
- D. Foster an aggressive and cooperative team spirit, to increase the confidence of the individual, to develop sportsmanship, and to increase University pride through participation in vigorous competitive athletics.

Facilities for accomplishing these are afforded in Taylor Gymnasium, Grace Hall, the field house, the two playing levels of Taylor Field, and Sayre Park field, an area of seven acres located above the Look-Out on the top of South Mountain and only a short distance from the fraternity houses and residence halls, and Saucon Valley Fields located south of the campus and on the south side of South Mountain. These 410 acres have the following facilities: All-weather quarter mile track, nine all-weather tennis

courts, lacrosse and soccer fields, three football practice fields, Varsity House, two baseball diamonds, twelve to sixteen intramural fields, and a football field which is the site of a future stadium. Almost all of the outdoor intramural sports contests and all upperclass intramural activities are held in this area. A shuttle bus service is provided to and from this field.

DEPARTMENT OF INTERCOLLEGiate ATHLETICS

The Department of Intercollegiate Athletics offers opportunity to the undergraduate student body to participate in intercollegiate competition both at home and away with institutions which are Lehigh's natural rivals and also other institutions which are at some distance.

The intercollegiate program consists of varsity teams in football, cross country, soccer, wrestling, basketball, swimming, tennis, track, baseball, golf, lacrosse, fencing, and rifle. In addition, there are freshman teams in most of the above sports.

DEPARTMENT OF PHYSICAL EDUCATION AND INTRAMURAL SPORTS

The Department of Physical Education and Intramural Sports has supervision and control of the required recreational physical activities of the student body. The aim of the department is to insure the health and physical development of every student of the University.

Through its program in physical education and intramural sports the University endeavors to maintain among its students a high degree of physical fitness, to establish habits of regular and healthful exercise, to foster the development of such valuable by-products as self-confidence, good sportsmanship, and a spirit of cooperation, and to provide each student with ample opportunity for acquiring an adequate degree of skill in sports of the type in which participation can be continued after graduation.

Freshman students are required to register for and engage in some form of activity under departmental supervision. This requirement calls for three hours a week in the gymnasium or participation in an organized sport. Sophomore, junior, and senior students are encouraged to continue their physical activities and participation in intramural sports.

Prior to his arrival on campus, each new or transfer student must submit to the Health Service a Record of Physical Examination form filled in and signed by a physician, and a completed Health History form. All such forms are carefully checked by the Health Service and each student thereby classified for activities in the Department of Physical Education in accordance with his current health status.

All freshmen are required to take a physical efficiency test for the purpose of classification and development. All freshmen are required to take a swimming test during the first week of regularly scheduled classes. In the gymnasium, opportunity is offered in the following activities: physical development, recreational swimming, beginners' swimming, boxing, fencing, apparatus exercises, life-saving, controlled weight lifting, badminton, and sports fundamentals. All undergraduate students must swim 75 feet

before graduation. Students are encouraged to change their activities whenever it is thought best for their all-around development.

A comprehensive program in intramural sports is sponsored for the student body including fraternity, residence hall, interclass, town, and independent groups in touch football, tennis, soccer, badminton, handball, individual athletics, basketball, swimming, wrestling, track, softball, volleyball, and recreational games. Students are encouraged to participate in these sports, and awards are given for excellence in performance.

Individual exercises are prescribed for the correction of physical and functional defects. Students of this group are carefully examined and individually guided.

The University maintains a well-equipped Health Center for medical treatment. If a student is injured while engaged in any sport he must report as soon as possible to the first-aid room or to the University Health Service.

The following physical education courses are required of all physically qualified students:

1. Physical Education (0)

Freshman first semester. Three hours per week.

2. Physical Education (0)

Freshman second semester. Three hours per week.

UNDERGRADUATE SCHOLARSHIPS AND LOANS

GENERAL STATEMENT. Lehigh University is desirous of extending tuition aid to deserving and promising students who otherwise would not be able to attend the University, to the extent that funds are available for such assistance. During the academic year 1967-68 over 650 students were granted financial assistance of approximately \$830,000.

Scholarship aid is awarded on the basis of established financial need, exceptional academic achievement and promise, commendable participation in activities outside the classroom, and good citizenship. Scholarships are awarded on a yearly basis and for an entire scholastic year. Renewal of the scholarship is anticipated upon re-application in the spring of the year. However, continuation of an award assumes that the recipient will continue to show scholastic excellence and leadership activity commensurate with the promise evidenced when the scholarship was originally awarded. Continuing need and good citizenship are also requirements for continuation of awards.

Tuition Scholarship Loans are provided for students who are deserving and in need of aid, but for whom adequate free tuition scholarship aid is not available. The loan may be for a part or, in some instances, for the entire tuition fee, or may be used to supplement a partial free tuition scholarship. This plan enables many worthy and conscientious students to help finance their own way through college by deferment of the payment of part of their tuition. It is often better for a student to take out a partial tuition loan than to spend too many hours in outside work to support himself while in college.

Trustee Scholarships are awards covering the tuition charges in whole or part. These are provided by the Board of Trustees from general funds in order to supplement endowed tuition scholarships.

Leadership Awards, while still requiring evidences of genuine financial need, good scholarship, and good citizenship, place more emphasis on leadership attainments in non-academic activities. The available scholarships of this type include the Alumni Student Grants provided for good students

with both aptitude and achievement in athletics and the Leonard Hall Scholarships for students who have evidenced both capacity and deep interest for the Christian ministry, with particular interest in the ministry of the Episcopal Church. These various scholarships are restricted in terms of the particular qualifications and interests of the applicants as indicated in each instance.

Endowed and Supported Scholarships are provided by individuals and by corporations either through endowments or by annual contributions. These awards, described in the following pages, are granted to able and deserving students who otherwise would not be able to attend college.

ELIGIBILITY. Entering freshmen may apply for financial aid in accordance with instructions from the Office of Admission.

A student transferring from another four-year college, unless he has been graduated, is not eligible to apply for financial aid until he has completed one year of residence at Lehigh University. A student entering from a recognized junior college with full transferred credits (junior standing) may be a candidate for financial aid on his junior college record.

Students who are already enrolled at Lehigh and have been in residence for one college year or more are eligible to apply for financial aid.

APPLICATION. Candidates not previously enrolled in the University should write to the Office of Admission; candidates who have been enrolled in the University one academic year or longer should apply in person to the Office of Financial Aid. Closing dates for filing applications are:

1. Entering freshmen and junior college transfer students—January 15.
2. Resident students—March 15.

Later applications for financial aid can be given consideration only if funds are still available.

AWARDS. All awards are made by the faculty Committee on Undergraduate Financial Aid in accordance with policies and procedures established by that committee and announced through its Executive Secretary to students applying for financial aid.

TUITION LOANS ARE made on the basis of merit and need, at the discretion of the Committee on Undergraduate Financial Aid to the extent that loan funds are available.

No loan can be made to a student on scholastic or disciplinary probation. The maximum indebtedness to the University that any student may normally incur will generally not exceed one-half of his total tuition obligations up to and including the semester for which he is seeking tuition aid.

Each student qualifying for a tuition loan is asked to sign a note, endorsed by his parent(s) or guardian. Repayment schedules satisfactory to the University may be arranged through the Office of Financial Aid. Tuition loans will bear interest at the rate of four per cent from the date of the note, with the provision that the rate shall increase to six per cent in the case of any note which falls into default.

SHORT-TERM LOANS are emergency loans and must be repaid, according to schedule agreed upon, before the end of classes of the semester for which they are granted. Short-term loans bear interest at the rate of four per cent per year from the date of the note. A minimum interest charge of fifty cents is made for each short-term loan granted.

The maximum amount for which a short-term loan may be granted, whether for tuition or for other purposes, is sixty per cent of the student's total bill to the University for that semester.

Every student incurring indebtedness to the University is required to undertake to pay his debt in full as rapidly as possible. Prompt repayment of loans insures the availability of a continuing fund for other student needs as they arise.

ENDOWMENT OF SCHOLARSHIPS

Undergraduate or graduate scholarships named to honor an individual or corporation may be established in perpetuity by arrangement with the board of trustees of Lehigh University. The income from this donation will be paid to the holder of the scholarship to be applied toward the payment of University fees. The University does not, however, guarantee that this income will be forever sufficient to pay such fees in full.

DESCRIPTIONS OF ENDOWED SCHOLARSHIPS

The Annual Giving Scholarship Fund

Through the gifts of alumni, parents, friends, and companies to the 1959-60 Annual Giving Fund, this fund was

established to assist young men to obtain the advantages of higher education. The income from this fund is to be used to award scholarships on the basis of financial need, character and personality, high scholastic achievement, and leadership qualities, and without restriction as to college or curriculum.

Atlas-Reinhold Scholarship Fund

Through its president, Paul B. Reinhold, '13, the Atlas Equipment Corporation of Pittsburgh, Pennsylvania, has established this scholarship fund. The income from this fund is used to provide scholarships covering tuition in such amounts as student need indicates, on the basis of character, intelligence, and leadership qualities.

Robert J. Bartholomew Memorial Scholarship Fund

This fund was established by the late Mary A. Bartholomew in memory of her husband, Robert J. Bartholomew '95. The gift is to be used for the purpose of providing scholarships for needy and deserving students with preference given to those who are residents of Bath, Pennsylvania, or of Northampton County, Pennsylvania.

Frank Breckenridge Bell Memorial Scholarship Fund

This fund has been established by Mrs. Frank B. Bell as a memorial to Frank Breckenridge Bell, M.E. '98, Eng.D. (Hon.) '45 and trustee of Lehigh University from 1936 to 1949. The income arising from the fund is to be used for the purpose of awarding annually a scholarship for a student attending or about to attend Lehigh University. Primary consideration is to be given to the following factors: financial need, character and integrity, and capacity for creative or original thinking, preferably in the field of engineering.

The J. D. Berg Scholarship Fund

This fund was established by Mrs. J. D. Berg in memory of her husband, John Daniel Berg, M.E. '05, Eng.D. (Hon.) '47, who devoted many years to Lehigh University as alumnus and as trustee. An annual scholarship providing for tuition, fees, and an amount for books shall be awarded to a student who is in financial need and has prerequisites of character and personality, high scholastic achievement, and leadership qualities which merit the award. Preference shall be given to students residing in the West Pennsylvania district and who enroll in an engineering curriculum at Lehigh University.

Award of Bethlehem Fabricators, Inc.

Bethlehem Fabricators, Inc. established this scholarship fund in honor of the late Robert Parke Hutchinson, E.M. '04, and in recognition of his forty years of service to the company and devotion to his alma mater. It is hoped that these incentive scholarship awards from this fund will serve "to spread and implement his belief in the American tradition of private industrial development and his interest in the education of worthy young men to carry forward that tradition." This scholarship will be awarded annually to the engineering student about to enter his senior year who "has shown the most improvement during his sophomore and junior years," and under the rules of the Committee on Undergraduate Financial Aid.

The Bethlehem Fabricators' Scholarship Fund

This fund was established by Bethlehem Fabricators, Inc., to provide tuition scholarships for students who are

in need of assistance. Character and personality, high scholastic achievement, and leadership qualities shall be given consideration when these awards are made. Other qualifications being equal, preference shall be given to candidates applying from the counties of Lehigh or Northampton in Pennsylvania.

The Brodhead Scholarship

Albert Brodhead, '88, left practically his entire estate to establish a fund for general University purpose. Part of the income of this fund has been designated as the Brodhead Scholarship in memory of Albert Brodhead; his father, Charles Brodhead, an early trustee of Lehigh University; his mother, Camilla Brodhead; and his sister, Kate Brodhead Wilbur. The scholarship is awarded by the Committee on Undergraduate Financial Aid to an undergraduate in the Department of Electrical Engineering.

Eugene C. Brown Memorial Scholarship Fund

This fund was established by bequest of the late Blanche C. Brown in memory of her husband, Eugene C. Brown, E.E. '95. Awards from the income of this fund are made in accordance with regulations governing such awards.

The Harvey M. Burkey Scholarship Fund Endowed by the American Metals Company, Limited

This fund was established by the American Metals Company, Ltd., in honor of Harvey M. Burkey, Class of 1906, and in recognition of his outstanding career in serving the Company with exceptional devotion and ability for over forty-five years. The income from the fund is to be used to award scholarships to qualified students seeking a bachelor's degree in metallurgical or chemical engineering.

Class of '04 Scholarship Fund

Members of the Class of '04, on the occasion of their Golden Anniversary in June '54, established this scholarship fund as a memorial to the class. The income from the fund is to be used to award a senior scholarship on the basis of character, scholarship, qualifications indicating promise of future leadership, and extra-curricular activities. Financial need is not a requisite for the award.

The William W. Coleman Fund

William W. Coleman, Met. '95 established this fund in 1951. The income provides annual awards in general equal to the amount of tuition, for undergraduates, preferably seniors in metallurgical engineering, on the basis of financial need, high scholastic achievement, character, personality, and leadership qualities.

William Wheeler Coleman Memorial Scholarship

The Bucyrus-Erie Foundation, Incorporated has established a fund for this scholarship in memory of the late William Wheeler Coleman, Class of 1895, Chairman and President of Bucyrus-Erie Company for forty-six years. The income from the fund is used for the purpose of awarding a scholarship or scholarships to undergraduates in the College of Engineering. The awards, administered by the Committee on Undergraduate Financial Aid, are based upon financial need, character, personality, scholastic achievement, and leadership qualities. The number of awards each year depends on the income available from the fund.

The Stewart J. Cort Scholarship

A gift to establish scholarships was made by Stewart J. Cort, El. Met. '06, Eng.D. (Hon.) '48, president of the Alumni Association, 1937-1938, and a member of the Board of Trustees from 1942 until his death in 1958. The income from this fund is to be used for scholarships for students seeking degrees in one of the engineering departments with preference being given to students in metallurgical engineering who meet the normal qualifications as to need, scholarship, character, and leadership.

The William S. Cortright Memorial Scholarship

Mrs. William S. Cortright established in 1938 a fund, the income from which provides a scholarship annually in memory of her husband, who was graduated from Lehigh University in 1872. The award is designated for a student who is a resident of Bethlehem or the immediate vicinity and who is enrolled in the curriculum of mechanical engineering.

The George C. Coutant Scholarship Fund

This scholarship fund was established by a bequest from Hedwig A. Coutant in memory of her husband, George C. Coutant, M.E. '00, to provide scholarship for meritorious students in need of assistance.

The Eckley B. Coxe Scholarship Fund

Mrs. Eckley B. Coxe, the widow of a trustee who served Lehigh University from 1871 until his death in 1895, established this fund to aid needy and worthy students. The income from the fund is used for scholarships.

The John R. W. Davis Memorial Scholarship Fund

This fund was established by Mrs. John R. W. Davis of Seattle, Washington, in memory of her husband, John R. W. Davis, C.E. '91. The income is to provide for scholarships in civil engineering for meritorious students in need of financial assistance.

The Alban and Eleanor Eavenson Scholarship Fund

This fund was established by Alban Eavenson, Chem. '91, as an expression of his interest in helping young men obtain a Lehigh education. The income from the fund is to be used to award scholarships with preference to students enrolled in either the chemistry or chemical engineering curricula.

The Natt Morrill Emery Scholarship

Established in memory of the late Natt Morrill Emery vice-president and controller of Lehigh University, by an alumnus and former student of Dr. Emery's the Natt Morrill Emery Scholarship covers the full tuition fee. It will be awarded by Lehigh University every four years (or whenever it becomes vacant) to a graduate of the high schools of Richmond, Virginia, who during his scholastic career has exemplified in character and conduct the qualities of loyalty and ability which marked the services of Dr. Emery to Lehigh University.

Harold Farkas Memorial Fund

The Harold Farkas Memorial Committee established an endowment fund to be known as the Harold Farkas Memorial Fund. The income from this fund is to be used for awarding a scholarship or scholarships which shall be

accomplished by the regular agency of the University. Such award or awards shall be based upon financial need, character and personality, scholastic achievement and leadership qualities.

The John T. Fuller Memorial Fund

This fund was established by Esther Fuller Warwick in memory of her father, John T. Fuller '03. The income from the fund is to be used to provide scholarships in engineering which are to be awarded to deserving students from Pennsylvania.

Julian W. Gardy Memorial Scholarship Fund

This fund has been established as a memorial to the late Julian W. Gardy, '23. The income from the fund is used to award scholarships as determined by the Committee on Undergraduate Financial Aid on the basis of financial need, character and personality, scholastic achievement, and leadership qualities.

The Alfred R. Glancy Fund

The late General Alfred R. Glancy, M.E. '03, Eng.D. (Hon.) '43, established this fund in 1949. The income provides for undergraduate scholarship awards made by the Committee on Undergraduate Financial Aid, in addition to the Alfred Noble Robinson Award of \$1,000 annually to a selected faculty member in memory of General Glancy's grandfather.

The Morris Goldstein Scholarship Fund

An endowed scholarship has been established through the gifts of Morris Goldstein '34. The income of the fund is to be used for a scholarship to an undergraduate in the College of Business Administration.

The Granite City Steel Company Scholarship Fund

The Granite City Steel Company, Granite City, Illinois, established this fund in 1951. The income provides annual awards for undergraduates in the College of Engineering, on the basis of financial need, character and personality, scholastic achievement, and leadership qualities.

The Henry S. Haines Memorial Scholarship

Mrs. Henry S. Haines, of Savannah, Ga., established in 1889 a scholarship as a memorial to her son, Henry Stevens Haines, M.E. '87. By the terms of the bequest this scholarship is awarded to a student in the curriculum in mechanical engineering. The requirements governing the award of University scholarships apply likewise to this scholarship.

Lillie Robb Hall Memorial Scholarship

The bequest for this scholarship came from the estate of the late William R. Hall, C.E. '02. The scholarship is awarded annually for a student's senior year in Civil Engineering and is based on character, scholarship, qualifications indicating promise of future leadership, and record in extra-curricular activities.

James Clark Haydon Memorial Scholarship Fund

Mary Haydon Hansen bequeathed the residue of her estate to Lehigh University as a memorial to her father, James Clark Haydon. The gift is to be used for the purpose of providing scholarships for needy and deserving persons.

The Samuel P. Hess Memorial Scholarship Fund

Recognizing the value of Lehigh University's contribution toward the training and education of young men, the family of Samuel P. Hess '10, of Detroit, Michigan, has established this scholarship fund as a memorial. The income from the fund shall be used to make awards based upon financial need, character and personality, scholastic achievement, and leadership, and leadership qualities. Preference shall be given to a student residing in the metropolitan area of Detroit, Michigan. The awarding of the scholarship or scholarships shall be accomplished by the regular agency as determined by the Board of Trustees at Lehigh University.

Albert George Isaacs '04 Endowed Scholarship Fund

This fund has been established by Kenneth L. Isaacs, M.E. '25, as a memorial to his father, Albert George Isaacs, '04. The award covering tuition and an allowance for books and supplies will be made to a student selected by the Committee on Undergraduate Financial Aid under the established rules governing the award of University scholarships.

The Anna Carpenter Richards Isaacs Scholarship

This fund was established by Kenneth L. Isaacs, M.E. '25, as a memorial to his mother, Anna Carpenter Richards Isaacs. The income from this fund shall be used to provide scholarships on the basis of financial need, character and personality, high scholastic achievement, and leadership qualities, without restriction as to college or curriculum.

The Kenneth L. Isaacs '25 Scholarship

Kenneth L. Isaacs, M.E. '25, established a fund to assist worthy young men to obtain the advantages of a higher education. The income is to be used to award scholarships to worthy students on the basis of financial need, character and personality, high scholastic achievement, and leadership qualities, without restriction as to college or curriculum.

The Reese D. Isaacs Memorial Scholarship

Kenneth L. Isaacs, M.E. '25, established this fund as a memorial in honor of his grandfather, Reese D. Isaacs, and to assist worthy young men to obtain the advantages of a higher education. The income from this fund is used to award scholarships on the basis of financial need, character and personality, high scholastic achievement, and leadership qualities, and without restriction to college or curriculum.

The Bernard H. Jacobson Fund

This fund was established by Bernard H. Jacobson, El. Met. '17. The income is to be used to provide financial aid, for one or more students in the College of Engineering who shall show financial need, good character and personality, high scholastic achievement, and qualities of leadership.

The Henry Kemmerling Memorial Scholarships

These scholarships have been provided through the gifts of Henry Kemmerling, C.E. '91, M.S. '03. Preference in making the awards is to be given to graduates of the public senior high schools of Scranton, Pennsylvania. The scholarships are to cover the tuition fee of the holder thereof.

A scholarship award is to be renewed yearly to the initial

holder thereof until he graduates, provided he remains in school and maintains a grade at least equal to the average of his class during the preceding year.

The following qualifications only are to be the basis of the award of the scholarship: (a) a good character, (b) need of financial assistance, (c) high scholasticability. The awarding of these scholarships will be administered through the Committee on Undergraduate Financial Aid.

At the discretion of the Committee, each full scholarship may be divided into two or more partial scholarships so that two or more may benefit by any annual award.

The Jacob B. Krause Scholarship Foundation

The Jacob B. Krause Scholarship Foundation was established under the will of Jacob B. Krause, B.A. '98, for the purpose of assisting needy students in the College of Arts and Science. Scholarships are to be awarded only to male students who maintain good scholastic standing and are in need of financial help.

Lambert Scholarship Fund

This fund was established by Blanche B. Lambert under her will bequeathing one-third of her residuary estate to Lehigh University as a gift for endowment to be known as the Lambert Scholarship Fund in memory of her husband, Sylvanus E. Lambert, '89. The principal thereof and the net income therefrom is to be used by the University for loans and scholarships to needy students of character, ability, and promise at the University, and is to be administered by the Officials of the University currently in charge of administering scholarships and loans to students at the University, in a manner approved by the Board of Trustees of the University. Mrs. Lambert stated in her will, "Lehigh University offered the benefit of its teaching staff and equipment, tuition free, for four years to my now deceased husband; hence this bequest."

The J. Porter Langfitt Scholarships

The J. A. O'Shaughnessy Foundation, Incorporated, established a fund of \$50,000, the income from which is to be used to establish scholarships in honor of J. Porter Langfitt, B.A. '24, M.E. '25, president of the Alumni Association, 1954-1955, and an alumnus member of the Board of Trustees from 1956. The scholarships shall be awarded on the basis of financial need, character, personality, leadership qualities, and high scholastic achievement.

The Lehigh Alumni of Tau Delta Phi Scholarship Fund

This fund was established by the Lehigh Alumni of Tau Delta Phi Fraternity in recognition of the achievements of the University and to provide for the continued growth of its educational program. A prominent portion of this fund was contributed by the Dale Memorial Committee as a memorial to the honor of the brothers Herbert Dale, class of 1933, and Robert Tiefenthal, class of 1935. In recognition of the special opportunities offered by Lehigh University for the education and training of young men, the income from the fund is to be used to award scholarships based on financial need, character and personality, scholastic achievement, and leadership qualities. Preference shall be given to any applicant who is an undergraduate member of Tau Chapter of Tau Delta Phi.

The Lehigh Portland Cement Company Scholarship Fund

The Lehigh Portland Cement Company established this fund in 1952. The income from the fund is to be used for the purpose of awarding scholarships to undergraduate students on the basis of financial need, character and well adjusted personality, intelligence, and above average potential for leadership.

Arthur Lehr Memorial Scholarship Fund

The Arthur Lehr Memorial Scholarship Fund has been established under an agreement between Anne Lehr and Lehigh University. The awarding of the scholarship or scholarships shall be accomplished by the regular agency as determined by the Board of Trustees of Lehigh University. Such award or awards shall be based upon financial need, character and personality, scholastic achievement and leadership qualities.

Alvan Macauley Scholarship Fund

This fund was established by Mrs. Alvan Macauley in honor of her husband, Alvan Macauley '92, who was chairman of the board of the Packard Motor Car Company. The income from this fund is to be used to award scholarships to worthy students in need of financial assistance.

The Mart-Hammonton Scholarship

The late Leon T. Mart, M.E. '13, formerly president of the Marley Company of Kansas City, Missouri, established this scholarship fund in 1953. The income from the Mart-Hammonton Scholarship Fund is to support one continuous tuition scholarship in the College of Engineering at Lehigh University. Preference shall be given to graduates of Hammonton High School, Hammonton, New Jersey, or graduates of any of the public or private secondary schools of the greater Kansas City area — this shall include schools of Jackson County, Missouri, and Johnson County, Kansas. In the event that no suitable candidates from these areas are available the scholarship can be awarded at large.

Alexander and Clara Maysels Scholarship Fund

Dr. Alexander Maysels, of Bethlehem, established this fund as a memorial to his wife, Clara Maysels. The awarding of the scholarship or scholarships shall be accomplished by the regular agency as determined by the Board of Trustees of Lehigh University. The basis of award shall be financial need, character and personality, high scholastic achievement, and leadership qualities regardless of race, creed, or color.

R. L. McCann Scholarship

Raymond L. McCann, E.M. '17, has established a fund to assist young men with limited financial support to obtain an engineering education. The scholarship is to be awarded to a student seeking a degree in one of the engineering departments with preference being given to Metallurgical Engineering. The basis of the award shall be financial need, character, personality, leadership qualities, and scholastic attainment.

Herbert Weymouth McCord Memorial Scholarship

Mrs. Celia M. Couch, Mrs. Henry Eccles, and Frank P. McCord have established this scholarship fund, as a memorial to their brother Herbert Weymouth McCord, C.E. '27. The income from this fund is to be used to award an annual

scholarship to a senior student in the College of Engineering. The basis of the award shall be financial need, character and integrity, high scholastic achievement, and leadership qualities.

The Fred. Mercur Memorial Fund Scholarship

Friends of the late Frederick Mercur, of Wilkes-Barre, Pa., general manager of the Lehigh Valley Coal Company, desiring to establish a memorial of their friendship and esteem, and to perpetuate his memory, contributed and placed in the hands of the trustees of the University a fund called the Fred. Mercur Memorial Fund. The income from this fund is awarded to students of the University.

The Mansfield Merriman Scholarship Fund

This fund was established under the will of Bazena T. D. Merriman to provide a scholarship in civil engineering in memory of her husband. Dr. Merriman served as professor of civil engineering at Lehigh University from 1878 to 1907, during which time his textbooks were widely adopted by engineering schools in the country and translated into many foreign languages.

The Henry L. Moses Scholarship

Mrs. Henry L. Moses established this fund as a memorial to her husband to assist worthy and deserving students. The income from this fund is used to make awards to a student or students selected by the Committee on Undergraduate Financial Aid under the established rules governing the award of University scholarships.

The Theophil H. Mueller '18 Scholarship Fund

This fund was established by the late Theophil H. Mueller, a corporate trustee of the University. The income is to be used to assist in defraying the expenses of some worthy student or students who are in need of financial assistance, provided, however, that if it is possible and advisable the student or students selected to receive such financial assistance shall be of the Moravian faith and preferably from Bethlehem, Pennsylvania, or its environs.

Franklin C. Murphy Scholarship Fund

This fund was established under the will of Franklin C. Murphy, Bus. Ad. '32. The income from the fund is to be used to award scholarships to high school graduates who are legal residents of the State of Ohio. However, if there are no acceptable applicants from the State of Ohio, then the awards shall be made to any applicant under the regular requirements governing the award of other University scholarships.

The Ray Sands Nostrand Memorial Scholarship

The Ray Sands Nostrand Memorial Scholarship was established by the late Benjamin Nostrand, Jr., M.E. '78, in memory of his son, Ray Sands Nostrand '17. The income from this fund is awarded to students of the University. The requirements governing the awards of University scholarships apply likewise to this scholarship.

C. Henry and Emily Nancy Offerman Scholarship

This fund was established by the late Emily N. Offerman in 1959. The income from this fund shall be used to provide scholarships to worthy students of good moral character, maintaining satisfactory scholastic grades and who require

financial assistance to enable them to further their education.

John Howell Powell (M.E. '04) Scholarships

In 1954 Mr. Powell of the Borough of Latrobe, County of Westmoreland, Pennsylvania, set up a Deed of Trust with the Mellon National Bank and Trust Company of Pittsburgh, the principal of which is to continue in perpetuity for scholarships to be awarded by Lehigh University, with first preference to be given to applicants who are from the Borough of Latrobe or who are graduates of the Mining and Mechanical Institute, Freeland, Pennsylvania.

The Murtha P. Quinn Scholarship

Mr. Murtha P. Quinn, '78, left one-thirteenth of his residual estate to Lehigh University for the purpose of granting scholarship aid with preference given to students whose homes are in South Bethlehem.

Isadore Raiff Memorial Fund Scholarship

The fund was established by the Raylass Department Stores, New York City, in honor and in memory of their late President, Isadore Raiff. The income from the fund is to be used to award a scholarship to worthy students in the College of Business Administration. Preference will be given to candidates from the states of Georgia, New York, North Carolina, Tennessee, and Virginia.

The Victor C. Records L. U. '98 Delaware Scholarship Fund

The income from this fund, established by Victor C. Records, Class of 1898, is to be used for the benefit of students attending Lehigh University who are in need of financial assistance to enable them to carry on or complete their studies at the University and who by character and application are deemed worthy of such assistance. Preference shall be given to residents of the state of Delaware with particular attention being paid to the counties of Laurel, Sussex, Kent, and New Castle.

Elijah Richards Endowed Scholarship Fund

This fund was established by Kenneth L. Isaacs, M.E. '25, as a memorial to his grandfather, Elijah Richards. The awarding of the scholarship or scholarships shall be accomplished by the regular agency as determined by the Board of Trustees of Lehigh University. The basis of award for the Elijah Richards scholarship or scholarships shall be financial need, character and personality, high scholastic achievement, and leadership qualities. Preference shall be given to students from Luzerne or Lackawanna Counties, Pennsylvania.

The Benjamin DeWitt Riegel Scholarship

This fund was established by Mrs. Benjamin DeWitt Riegel as a memorial scholarship in honor of her late husband, M.E. '98. This award is available to undergraduates of any college or curriculum who qualify on the basis of financial need, character and personality, high scholastic achievement, and leadership ability.

The Rust Engineering Company Fund

The Rust Engineering Company established this fund in memory of two of its co-founders, E. M. Rust, and E. J. Lee Rust, for the purpose of awarding scholarships to students in the College of Engineering of Lehigh University on

the basis of financial need, character and well adjusted personality, intelligence, and above average potential for leadership.

Frederick C. Seeman, Jr., Scholarship Fund

This scholarship fund was established by a bequest from Aringdale D. Seeman of Baltimore, Maryland, in memory of his son, Frederick C. Seeman, Jr. '27, who was killed in an automobile accident in 1927. Income from the fund is to be used to award scholarships to worthy students from the state of Maryland who are in need of financial assistance.

Donald B. and Dorothy L. Stabler Scholarship Fund

This fund was established by Donald B. Stabler, C.E. '30, M.S. '32, to provide scholarships at Lehigh for needy prospective students or undergraduates, the recipients being determined by their character, motivation, and personal achievements. In recognition of the financial aid received under this program while a student at Lehigh, each recipient is asked to sign a statement of intent that, after his graduation from college and insofar as financially able, he will make contributions to this fund equivalent to the aid which he received. Thus a student of a later college generation may enjoy the same financial aid which made it possible for the original recipient to attend Lehigh.

The David R. Thomas Memorial Fund

This fund was established by Professor and Mrs. Harold P. Thomas after their son's death in a plane crash on South Mountain in June, 1950. Donations from friends and family have been included in the fund. The income is to be used for tuition scholarships for one or more students who have completed at least one year at Lehigh University and are in need of financial assistance to complete their education. The award or awards will be made to students who exemplify in their lives the high ideals which were characteristic of David up to his untimely death.

Helen A. and Nathaniel Thurlow Memorial Scholarship Fund

This fund was established under the will of Helen A. Thurlow, sister of Nathaniel Thurlow, '95. The income from the endowment is to be used for the awarding of scholarships by the regular agency of the University.

Sonia and Alfred D. Tiefenthal Memorial Scholarship Fund

This fund was established by Alfred D. Tiefenthal for the purpose of awarding from income a scholarship or scholarships to a student or students enrolled in the College of Business Administration. The awarding of the scholarship is to be accomplished by the regular agency of the University, and is to be based upon financial need, character and personality, scholastic achievement, and leadership qualities.

Treadwell Corporation Scholarship Fund

The Treadwell Corporation of Easton, Pennsylvania, has established at Lehigh University the Treadwell Corporation Scholarship Fund for annual tuition scholarships in such number and amounts as the income will support. The scholarships are for students in mechanical engineering, with preference given to candidates from Lehigh and Northampton counties in the state of Pennsylvania.

The Samuel Foster York Memorial Scholarship Fund

This fund was established by Warren W. York, B.S. '24, as a memorial to his father, Samuel Foster York. The income is to be applied towards tuition scholarships for needy and worthy graduates of Allentown, Pennsylvania, secondary schools who desire to pursue business administration courses at Lehigh University.

York-Shipley Scholarship Fund

This fund was established by York-Shipley Inc. of York Pa., through its president, S. H. Shipley, Ch.E. '32. The income is to be used to provide scholarships to worthy students in need of financial assistance enrolling in the College of Engineering, with preference being given to students from the County of York in Pennsylvania enrolling in the mechanical engineering curriculum.

The Luther Rees Zollinger Memorial Fund

The sister of Luther Rees Zollinger left the residue of her estate to Lehigh University to establish this memorial fund to provide tuition scholarships for worthy students who are in need of financial assistance.

DESCRIPTIONS OF SUPPORTED SCHOLARSHIPS

Air Force ROTC Financial Assistance Program

The Air Force ROTC financial assistance program is designed for outstanding young men participating in the four-year Air Force ROTC program and who are interested in the Air Force as a career. These are two-year awards restricted to those students who have completed the first two years of Air Force ROTC and are selected to participate in the advanced program.

Alcoa Foundation Scholarships

The Aluminum Company of America supports at Lehigh University several undergraduate scholarships. The University also receives a grant-in-aid to the amount of \$125 per student recipient. The awards are to be made by the Committee on Undergraduate Financial Aid under the established rules governing the award of University scholarships.

The Allied Chemical Foundation Scholarship

The Allied Chemical Corporation, through its Foundation, supports a scholarship at Lehigh University for a student in chemical engineering. In making the selection the Committee on Undergraduate Financial Aid places emphasis upon intellectual capability, scientific ability, breadth of interests, and leadership qualities.

Army ROTC Scholarship Program

The Army ROTC scholarship program is designed to offer financial assistance to outstanding young men in the four-year Army ROTC program who are interested in the Army as a career. Each scholarship provides for free tuition, textbooks and laboratory fees in addition to pay of \$50 per month for the period that the scholarship is in effect. During a six-week summer training period at the end of the junior year, this pay is increased to \$120.60 per month. The scholarships are provided under provisions of Public Law 88-647, The ROTC Vitalization Act of 1964.

Scholarships may be awarded for either two or four years. Four-year scholarships are open to all students enter-

ing Army ROTC as freshmen, while the two-year scholarships are restricted to those students who have completed the first two years of ROTC and are selected for enrollment in the ROTC Advanced Course.

Frank Breckenridge Bell Memorial Scholarship

The Edgewater Steel Charitable Trust has established an annual scholarship of \$1,000 in honor of Frank Breckenridge Bell, M.E. '98, Eng.D. '45, former chairman of the board of Edgewater Steel Company, and a trustee of Lehigh University from 1936-1949. The award is available to a student in any college or curriculum, on the basis of financial need, character and integrity, and capacity for creative or original thinking, preferably in the field of engineering.

Carpenter Steel Scholarships

The Carpenter Steel Company makes available two scholarships for entering freshmen who are sons of employees of the Company and plan to major in specialized fields of engineering and science. The amount of the award, as determined by an analysis of the Parents' Confidential Statement, ranges from \$250 to \$1,500 annually. Scholarships may be renewed on recommendation of the Committee on Undergraduate Financial Aid.

Chevron Oil Company Scholarship

The Chevron Oil Company has established a scholarship in the amount of \$500 for a senior in chemical engineering. A cost-of-education grant of \$500 is also made to the Department of Chemical Engineering in support of the scholarship. The award is made by the Committee on Undergraduate Financial Aid under the established rules governing the award of University scholarships.

Chevron Oil Company Scholarship

The California Company Division

The Chevron Oil Company has established a scholarship in the amount of \$500 for undergraduate study in the Department of Geological Sciences. The award is made by the Committee on Undergraduate Financial Aid under the established rules governing the award of University scholarships.

Henry Farmer Foundation

The Trustees of the Henry Farmer Foundation have established a scholarship fund in the amount of \$10,000 to be expended for scholarships to students in the pre-medical program of the University. The awards are made by the Committee on Undergraduate Financial Aid under the established rules governing the awards of University scholarships.

Fort Pitt Bridge Works Scholarship

The Fort Pitt Bridge Works Scholarship is to be awarded to a junior enrolled in the civil engineering curriculum who will major in the structural option. In recognition of the fact that tuition does not cover the full cost of education of the student, the company will make an unrestricted gift to the University of \$300 each year.

General Motors Scholarships

The General Motors Corporation in its program of aiding private colleges has made available to Lehigh University

several undergraduate scholarships. These scholarships which are renewable range up to \$2,000 annually depending upon "demonstrated need." In addition the University receives a grant-in-aid for each award.

Kennecott Copper Corporation Scholarship Program

The Kennecott Copper Corporation has established an annual undergraduate scholarship in the amount of \$1000 for a junior or senior whose program emphasizes Mineral Sciences at Lehigh University. The recipient is selected by the Committee on Undergraduate Financial Aid with the approval of Kennecott or a subsidiary company. Selection criteria include: proficiency in studies; enthusiasm, leadership, cooperativeness, initiative, ambition; good health and sturdy constitution; and financial need.

The Kift-Mullen Memorial Foundation Scholarship

The Kift-Mullen Memorial Foundation of Allentown, Pennsylvania, makes available to graduates of Allentown high schools four annual scholarships of \$200 to students of junior standing in various teacher training institutions, who are preparing to enter the secondary school teaching profession. The University Committee on Scholarships and Loans makes recommendations of qualified Lehigh University students to the Kift-Mullen Memorial Foundation, which passes such recommendations from various teacher training institutions on to a committee of the Allentown high schools' representatives who make the final selection.

The Lebovitz Fund Scholarship

Through the Lebovitz Fund, Samuel L. Lebovitz, E.M. '23, President of The Modern Transfer Company of Allentown, Pennsylvania, has established at Lehigh University a scholarship in the amount of \$1,000 a year which is awarded annually by the Committee on Undergraduate Financial Aid. This award is made on the basis of high intelligence, financial need, and the qualities that give promise of leadership.

Lehigh University Merit Scholarships

In cooperation with the National Merit Scholarship Corporation Lehigh University will annually award up to twenty four-year Merit Scholarships financed through the Annual Giving Program of the alumni. The National Merit Scholarship Corporation conducts the competition for these scholarships as well as all the others under its supervision. Final selection of Lehigh University Merit Scholars is limited to Merit Finalists who wish to attend Lehigh University and are qualified to do so. The individual stipend is based on the candidate's need as estimated by the National Merit Scholarship Corporation and is adjusted annually according to the financial status of his parents and his own ability to earn funds during vacation periods. Stipends range from \$100 to \$1,500 per year.

Lever Brothers Company Scholarship

The Lever Brothers Company has established two scholarships, one for a junior and the other for a senior in chemical engineering. A cost-of-education grant is also made to the Department of Chemical Engineering in support of the scholarships. The awards are made by the Committee on Undergraduate Financial Aid under the established rules governing the award of University scholarships.

Christian R. and Mary F. Lindback Foundation Scholarship

The Trustees of the Christian R. and Mary F. Lindback Foundation have established a scholarship fund in the amount of \$1,000 to be expended for scholarships to deserving students who are residents of one of the states of New Jersey, Pennsylvania, Delaware or Maryland, without regard to race or religious affiliation and who, "by reason of their scholastic attainment, character, personality, and all-around ability give great promise of benefiting therefrom and be useful and valuable citizens of their communities."

Pennsylvania Power & Light Company Scholarships

The Pennsylvania Power & Light Company in its program of aiding both public and private colleges within its 29-county service area has made available to Lehigh University two undergraduate scholarships, one of which is restricted to study in either electrical or mechanical engineering. Each scholarship is in the amount of \$1,450 annually and is renewable. In addition the University receives a grant-in-aid for each award. The candidate for such a scholarship should secure an appropriate form from his secondary school counselor.

Pitcairn-Crabbe Christian Education Scholarships

These scholarships have been provided by the Pitcairn-Crabbe Foundation for students with strong Christian motivation, pre-ministerial students, or those who plan to enter the fields of social work, religious education, or eleemosynary activities. Preference will be given to the sons of clergymen or educators.

Procter and Gamble Scholarship Program

A Scholarship Program established in 1955 by the Trustees of The Procter & Gamble Fund makes available annual scholarship awards for entering freshmen at designated colleges, including Lehigh University. The awards are renewable annually throughout the four years on the basis of successful undergraduate performance and continuing financial need.

The participating colleges administer the scholarships, select the recipients from all eligible candidates on the basis of the colleges' own standards of academic achievement and distribute the money on the basis of the recipient's financial need.

At Lehigh the award is made to an entering student in the field of science or engineering selected by the Committee on Undergraduate Financial Aid under the established rules governing the award of University scholarships.

The scholarships provide an amount equal to full tuition and fees plus an allowance for books and supplies. In addition, an unrestricted grant of \$600 for each recipient is made annually to the University to help meet the cost of educating the scholarship holder.

Residence Halls Scholarship Fund

The Residence Halls Council of Lehigh University has provided four scholarships in the amount of \$400 each to be awarded to a freshman, sophomore, junior and senior living in the Residence Halls of Lehigh University. The recipient of the scholarship must continue his residence throughout the term of the scholarship.

Schlumberger Collegiate Award

The Board of Managers of the Schlumberger Foundation

of Houston, Texas, has made available to Lehigh University an undergraduate scholarship in the amount of \$500, with a further matching grant of \$500 as a contribution to the University. The Foundation has designated this scholarship and matching grant as the "Schlumberger Collegiate Award." The basic requirements state that the student be of high academic standing in his junior or senior year in electrical or mechanical engineering, physics or geology, and that his program include at least twelve hours of study in electricity.

Milton Roy Sheen Memorial Scholarship

Through its president, Robert T. Sheen, B.S. '31, Ch.E. '36, the Milton Roy Company of Philadelphia, Pennsylvania, has established a scholarship as a memorial to the founder of the company, Milton Roy Sheen. The Milton Roy Sheen Memorial Scholarship provides an annual award of \$1,200. The scholarship is to be awarded to employees or sons of employees of the Milton Roy Company. If no candidates are available, the scholarship is to be awarded to either a junior or senior enrolled in the chemical engineering or mechanical engineering curricula.

The Alfred P. Sloan National Scholarships

The Alfred P. Sloan Foundation, Incorporated, has granted Lehigh University eight of its national scholarships. Normally each scholarship will be for an amount equal to tuition plus an allowance for other college expenses. However, the University may award a lesser or a greater amount depending upon the financial need of the recipient.

Recipients of this scholarship shall be preferably students pursuing studies in mathematics, the sciences, engineering, or business administration. They shall also meet the regular requirements of financial need, high academic achievement, good character, and promising leadership qualifications.

Special Awards

Recognizing the need of many worthy and able students for financial aid in addition to tuition scholarship, friends of Lehigh have made grants to the University for this purpose. From this fund one or two awards are made on an annual basis to students in the College of Engineering by the Committee on Undergraduate Financial Aid in accordance with its established policies.

The Stauffer Chemical Foundation Scholarship

The Stauffer Chemical Company, through its Foundation, has established a scholarship in the amount of \$1000 for a deserving senior in chemical engineering. An unrestricted grant of \$2000 is also made to the Department of Chemical Engineering in support of the scholarship. The award is made by the Committee on Undergraduate Financial Aid under the established rules governing the award of University scholarships.

Texaco Scholarships

Texaco, Inc., has provided undergraduate scholarships available to students who have successfully completed at least two years of college work in any of several fields which would prepare them for careers in the petroleum industry. The donor also grants to the University a cost-of-education supplement. The scholarships are restricted to citizens of the United States who have proven scholastic ability and who have demonstrated qualities of leadership as well as a

recognition of the values of higher education, and who give evidence of good health and financial need.

Union Bank and Trust Company Scholarships

The Union Bank and Trust Company of Bethlehem, Pennsylvania, has established four scholarships in the College of Business Administration. Each award is in the amount of \$1250 and provides for a grant-in-aid to the University of \$250.

UNIROYAL Foundation Scholarship

UNIROYAL Incorporated, through its Foundation, has established a scholarship for a student who has successfully completed at least two years of college, who has need of financial assistance, and who has demonstrated interest in a career in industry. Also, the recipient must be willing to assume a moral obligation to repay over a reasonable period of time at least 25% of the scholarship aid received as worked out with the institution. In addition the University receives a grant-in-aid for each award.

The Western Electric Fund Scholarships

The Western Electric Fund has established at Lehigh University three annual scholarships, to a maximum of \$975 each, two to be awarded to undergraduate students in the College of Engineering, and one to an undergraduate in either the College of Business Administration or the College of Arts and Science. The scholarships may be granted to an upperclassman or to a first or second year student if the University desires. The recipient shall be a United States citizen without regard to color, creed, or national origin.

DESCRIPTION OF LOAN FUNDS

National Defense Student Loan Program

Under the National Defense Education Act of 1958, since amended, the federal government has made available through the University loans to students who show themselves capable of maintaining good standing and who show financial need.

During undergraduate study, the maximum loan under the law is \$1,000 per academic year, with not more than \$5,000 total indebtedness.

The National Defense Student Loan Program is administered by the Committee on Undergraduate Financial Aid.

W. Appleton Aiken Memorial Loan Fund

The Residence Halls Council of Lehigh University has provided the sum of \$3,000 as an undergraduate loan fund. The administration of the loan fund is under the usual University agencies. Preference in the granting of all loans to be given to students residing in the residence halls of the University.

C. S. Albright Loan Fund

In memory of Carl Samuel Albright, E.E. '11, his family has provided the sum of \$2,500 as an undergraduate loan fund. The administration of the loan fund is by the Committee on Undergraduate Financial Aid, and is for the assistance of worthy students requiring financial aid.

The Eckley B. Coxe Loan Fund

Mrs. Eckley B. Coxe, the widow of a trustee who served

Lehigh University from 1871 until his death in 1895, established this fund in 1897 and continued to make contributions to it during her lifetime. The several gifts were invested, and the income from this principal has created a revolving loan fund in excess of \$170,000 which is administered for worthy and needy students by the Committee on Undergraduate Financial Aid.

John R. W. Davis Memorial Loan Fund

This fund was established by Mrs. John R. W. Davis of Seattle, Washington, in memory of her husband, John R. W. Davis, C.E. '91. The income from the fund is to be used to make loans to needy and worthy students in the various branches of engineering at Lehigh University. The loans are to be administered by the Committee on Undergraduate Financial Aid in accordance with the principles used in administering the other loan funds of the University.

The Frazier and Ringer Memorial Fund

The Frazier and Ringer Memorial Fund was established in 1906 by the late Robert H. Sayre in memory of Benjamin West Frazier, A.M., Sc.D., former professor of mineralogy and metallurgy, and Severin Ringer, U.J.D., former professor of modern languages and literature and of history, each of whom served Lehigh University for one-third of a century. The income from the fund and payments made by the former borrowers are available for loans to cover the medical and surgical care of worthy students.

The Kenneth Hankinson, Jr., Memorial Fund

Mr. and Mrs. Kenneth Hankinson established this fund in memory of their late son, Bus. '50. The principal from this fund shall be used to grant emergency loans to deserving students of Lehigh University. Administration of the fund is at the discretion of the Dean of Students of the University.

R. L. McCann Loan Fund

Mr. R. L. McCann, E.M. '17, established this endowment fund to provide income for loans to needy students of Lehigh University.

George F. Pettinos Memorial Fund

An endowment fund has been established by George F. Pettinos, Jr. in memory of George F. Pettinos, M.E. '87. The income earned on the principal of the fund shall be used "to grant loans to students for tuition and fees." Repayments of the principal and interest on loans to students are also to be used to grant similar loans to students.

The Edward W. Pratt Fund

Edward Williams Pratt, M.E. '90, bequeathed to Lehigh University the sum of \$1,000 to be used "as a revolving fund for loans to students" to be administered at the discretion of the Dean of Students.

The President's Fund

The President's Fund was established during the early years of the University for the help of deserving students. As payments are made by former beneficiaries they are immediately available for the assistance of students of the University.

The Frank Williams Fund

Frank Williams, B.S. '87, E.M. '88, bequeathed to the University the greater part of his estate as an endowment, the income of which is lent to deserving students.

United Student Aid Funds Loan Program

Lehigh University is one of more than 600 colleges and universities participating in this national nonprofit loan program for needy and deserving students. Full-time undergraduate students who have completed satisfactorily the freshman year may borrow up to \$1,000 per year and graduate students may borrow as much as \$2,000 per year, but no student may borrow more than \$4,000. Interest of 6% simple and payments of interest and principal begin the fifth month after graduation and may be anticipated. In case of dropouts, payments are due to begin at once. The financial aid officer recommends the loan, after consultation with the student, and the loan is then negotiated at the student's home town bank on the student's own signature.

GRADUATE SCHOLARSHIPS AND FELLOWSHIPS

Candidates for scholarships or fellowships must file an application with the Office of Admission, Lehigh University, Bethlehem, Pa. 18015, on or before February 1 preceding his enrollment. Each application must be supplemented by an official transcript of the candidate's college work, a statement concerning his practical experience, and any other evidence of his qualifications which he may choose to submit. Scores made on Graduate Record Examinations or other recognized examinations are desired. Each applicant must indicate the field of graduate study he wishes to undertake. Each applicant is automatically considered for all awards for which he is eligible. See page 83 for further information.

SCHOLARSHIP DESCRIPTIONS

The Daniel S. Whiteman Memorial Scholarship

The Reilly-Whiteman-Walton Company of Conshohocken, Pennsylvania, makes an annual grant to support this scholarship in memory of the late Daniel S. Whiteman, E.M. '17. It is awarded to a graduate student specializing in colloid chemistry or a related field.

Graduate Tuition Grants

The Board of Trustees has authorized the annual award to graduate students, on the basis of superior qualifications and of need, of twelve Graduate Tuition Grants. These Grants are awarded to accompany certain research fellowships and provide for the remission of graduate tuition.

FELLOWSHIP DESCRIPTIONS

RESEARCH FELLOWSHIPS AND SCHOLARSHIPS

The William C. Gotshall Scholarship

A bequest from the late William C. Gotshall provides funds for as many as six scholarships to be awarded annually to worthy graduate students in any branch of engineering offered at Lehigh University. Appointment is for one year, with an annual stipend of \$1800 or more, depending on the qualifications of the applicant, plus remission of tuition fees. No duties other than graduate study are required of the holders.

The Alumni Fund Fellowship

The Alumni Fund for 1960 established an endowment, the income from which is to provide a graduate fellowship in any of the departments offering graduate study.

**The C. Kemble Baldwin Research Fellowship
in Aeronautics**

A fund established by Mrs. C. Kemble Baldwin as a memorial to her husband, C. Kemble Baldwin, M.E., '95 provides for the appointment of a research fellow in any branch of science having a bearing on the field of aeronautics. One or occasionally two appointments are available each year.

**The Lawrence Calvin Brink Research Fellowship
in Civil Engineering**

A fund established by the late Mrs. L. C. Brink as a memorial to her husband, Lawrence Calvin Brink, C.E.,

'94, provides for the occasional appointment of a research fellow in civil engineering.

The Henry Marison Byllesby Memorial Research Fellowships

In 1926 Mrs. H. M. Byllesby, widow of Col. H. M. Byllesby, M.E., '78, President of the Byllesby Engineering and Manufacturing Corporation, provided an endowment fund for the establishment of the Henry Marison Byllesby Memorial Research Fellowships in Engineering. The time of the holders of these fellowships must be devoted to graduate study and research work on some problem in electrical, mechanical, or hydraulic engineering. Usually two awards are made each year.

The William L. Heim Research Fellowship in Chemistry

A research fellowship in chemistry was established by William L. Heim, B.S. in Chem., '02.

The Garrett Linderman Hoppes Research Fellowship in Civil Engineering

A fund established by the late Mrs. Maria B. Hoppes in memory of her son, the late Garrett Linderman Hoppes, C.E., '83, provides for the occasional appointment of a research fellow in civil engineering.

The Roy R. Hornor Research Fellowship in Metallurgy and Inorganic Chemistry

The income from a bequest by Roy R. Hornor, B.S., '99, provides for a research fellowship in either metallurgy or inorganic chemistry, the holder of which devotes his time to research under the direction of the faculty and to graduate study. While the fellowship generally will be granted alternately to students in the two departments concerned, the appointment may be determined by the qualifications of available candidates.

The Chester W. Kingsley Memorial Fellowship

This fund is a bequest by Mrs. C. W. Kingsley in memory of her husband for the education of young men of exceptional scientific ability. An annual stipend up to \$2200 plus tuition is available for graduate study in engineering or science.

The New Jersey Zinc Company Research Fellowship

The New Jersey Zinc Company provided funds in 1924 for a research fellowship to be known as the New Jersey Zinc Company Research Fellowship in any field in which the University offers a graduate major.

The James Ward Packard Research Fellowship

The income from a bequest made by James Ward Packard, M.E., '84, provides for a research fellowship in any field in which Lehigh University offers work for the doctorate.

The Charles W. Parkhurst Research Fellowship

A fund established by Mrs. C. W. Parkhurst as a memorial to her husband, Charles W. Parkhurst, E.E., '93, provides for the occasional appointment of a research fellow in any field in which the University offers a graduate major.

The Student Chemistry Foundation Fellowship

In the spring of 1927, members of the class of 1930 established the Student Chemistry Foundation in honor of

Harry Maas Ullmann, A.B., Ph.D., a member of the chemistry department from 1894 to 1938 and chairman of the department from 1912 until his retirement. Subsequent classes have contributed to this fund which now provides an annual research fellowship in chemistry or chemical engineering. Only Lehigh graduates are eligible for this fellowship.

The Katherine Comstock Thorne Fellowship in Biology

The late Gordon Comstock Thorne of the class of 1916 endowed, in memory of his mother, a fellowship in biology, to be known as the Katherine Comstock Thorne Fellowship.

ADDITIONAL FELLOWSHIPS

Certain fellowships are supported annually by various governmental agencies, foundations, learned societies and industrial organizations. Normally the fellow devotes full time to his academic program and receives a stipend plus tuition grant. Among those national fellowships available are the following:

National Aeronautics and Space Administration

Traineeships have been granted by NASA the past several years to Lehigh University for award to qualified graduate students in space-related fields of study. The appointment provides tuition plus \$2,800 and dependency allowance. Application is made on the standard University fellowship form.

National Defense Act, Title IV

Fellowships are granted by the U.S. Department of Health, Education, and Welfare for award by Lehigh University to graduate students in various fields of study. The fellowship provides tuition, plus \$2,000 to \$2,400, and dependency allowance. Summer grants are available to supplement the nine month appointment. The standard University fellowship form serves as application.

National Institutes of Health

A large program of fellowships for U.S. students in the medical sciences and areas of the biological, physical and behavioral sciences provides tuition plus \$2,400 to \$2,800 and dependency allowance. Application should be made to the Career Development Branch, Division of Research Grants, National Institutes of Health, Bethesda, Md. 20014.

National Science Foundation

Several fellowship grants are awarded annually to U.S. graduate students for study in the mathematical, physical, medical, biological, and engineering sciences, anthropology, economics, geography, the history and philosophy of science, linguistics, political science, psychology, and sociology. Awards provide tuition plus \$2,400 to \$2,800 and dependency allowance. Application should be made in the fall to NSF, Washington, D.C. 20550. Some cooperative grants are made by Lehigh University.

Woodrow Wilson National Fellowship Foundation

Fellowships are awarded to first-year graduate students primarily in the humanities and social sciences, pursuing teaching careers. Awards provide nine months' tuition plus \$1,800. Nomination must be made by a faculty member to the appropriate regional committee. For information,

contact the Woodrow Wilson Foundation, Box 642, Princeton, N.J.

INDUSTRIAL-FOUNDATION FELLOWSHIPS

Among those fellowships supported by foundations and industrial concerns are the following:

The Air Products and Chemicals Incorporated Fellowship in Chemical Engineering.

The Air Reduction Company Fellowship in Engineering.

The Allegheny-Ludlum Fellowship in Metallurgy.

Althouse Chemical Fellows in Chemistry.

American Society for Tool and Manufacturing Engineers Fellowship in Industry Engineering.

The Armstrong Cork Company Fellowship in Physics.

Azoplate Corporation Fellowship in Chemistry.

The Louis Calder Foundation Fellowship in Chemistry.

The California Oil Company Fellowship in Chemical Engineering.

The Carpenter Steel Company Fellowship in Mathematics, Science, or Engineering.

Thomas R. Caton Fellowship in Chemistry.

The Esso Foundation Fellowship in Chemical Engineering.

The George Gowen Hood Fellowship (supported by the Catherwood Foundation) in any field leading to the doctorate.

The Materials Research Fellowship in Materials Research.

The Ogden Corporation Fellowship in Management Science.

National Printing Ink Research Institute Fellowship in Chemistry.

Paint Research Institute Fellowship in Chemistry.

Stressteel Corporation in Metallurgy.

Texaco Fellowship in Chemical Engineering.

The Union Bank and Trust Company Fellowship in Business Administration.

The United States Public Health Service (Water Pollution) Fellowship in Biology.

The United States Steel Foundation Fellowship in Engineering.

PRIIZES AND AWARDS

Student prizes and awards are announced at commencement exercises on Founder's Day, the second Sunday in October, and on University Day in June.

William Appleton Aiken Award

This medal is awarded to the outstanding student in History 11 and 12 each year.

Alumni Prizes

Funds are provided by the Alumni Association for the annual award of four prizes of \$25 each. Two prizes are awarded to the highest ranking juniors in the College of Engineering, one to the highest ranking junior in the College of Arts and Science, and one to the highest ranking junior in the College of Business Administration.

Medal of the Philadelphia Chapter, American Institute of Chemists

This medal is awarded to the academically highest ranking senior majoring in chemistry or chemical engineering.

American Society for Testing Materials Student Membership Prize

The American Society for Testing Materials awards each year four student memberships to students who in their junior year have demonstrated interest and meritorious work in the engineering courses which are related to the American Society for Testing Materials.

Bethlehem Fabricators Award

This tuition award is made to the senior who has shown the most improvement in academic achievement over previous years.

The Robert W. Blake Memorial Prize

The Robert W. Blake Memorial Prize is awarded annually at the Founder's Day exercises to a freshman, upon his completion of one year of studies in the College of Arts and Science, who is recommended by the faculty of the College of Arts and Science as the most outstanding in high scholastic achievement and in promise of worthy leadership.

The John B. Carson Prize

An annual prize of \$50 was established by Mrs. Helen Carson Turner, of Philadelphia, Pennsylvania, in memory of her father, John B. Carson, whose son, James D. Carson, was a graduate of the civil engineering curriculum of Lehigh University in 1876. It is awarded to that senior in civil engineering who shows the most marked excellence in the professional courses of his curriculum.

The William H. Chandler Prizes in Chemistry

Four annual prizes of \$25 each, one in each class, for excellence in the chemistry and chemical engineering curricula were established by Mrs. Mary E. Chandler, of Bethlehem, Pennsylvania, widow of Dr. William H. Chandler who was professor of chemistry at Lehigh University from 1871 until his death in 1906.

The N. J. Stotz and D. E. Pickert Choral Cup

The Choral Cup provided by Norman J. Stotz, Jr. '53 and Donald E. Pickert '53, is awarded to the outstanding senior participating in the choral organizations of the Department of Music.

The R. K. Burr and J. D. Kirkpatrick Concert Cup

The Concert Cup provided by Richard K. Burr '53 and J. Donald Kirkpatrick '55, is awarded to the outstanding senior(s) participating in the instrumental organizations of the Department of Music.

The Cornelius Prize

The Cornelius Prize of \$25, established by William A. Cornelius, M.E. '89, and endowed by a bequest by his widow, Mrs. Eleanor R. W. Cornelius, will be awarded annually to the senior student in mechanical engineering who is judged to have profited most by his opportunities at Lehigh University. The award will be based 70 per cent on scholarship, 20 per cent on attainment in general culture, and 10 per cent on development in personality. To be eligible for the award, a student's scholastic standing must be in the top quarter of the class in the College of Engineering.

The Philip Francis du Pont Memorial Prize in Electrical Engineering

The Philip F. du Pont Memorial Prize Fund was established in 1929 by L. S. Horner, E.E. '98. The annual income of this fund is awarded each year in the way of prizes, two-thirds to the highest ranking senior and one-third to the second highest ranking senior in electrical engineering.

Fraternity Alumni Advisory Council Scholarship Improvement Award

This trophy is awarded to the Lehigh Fraternity chapter whose scholastic average for the year is most improved over the average for the previous year.

Malcolm J. Gordon, Jr. Physics Prize

An annual award of \$40.00 is made to the highest ranking sophomore majoring in physics with some extracurricular activity.

The Hamilton Humanities Award

The Hamilton Watch Company awards an engraved electric watch each year to the senior engineering student who has most successfully combined proficiency in his major field of study in engineering with achievements (either academic, extra-curricular, or both) in the social sciences or humanities.

The Bill Hardy Memorial Prize

An annual award of \$100 is given by Mr. and Mrs. C. Edson Hardy in memory of their son to the junior who most nearly reflects the qualities that typified Bill Hardy, who was outstanding in many activities, academic and otherwise.

Haskins and Sells Foundation Award

An annual award of \$500 is awarded to that accounting student in the College of Business Administration or the College of Arts and Science who after three years has demonstrated excellence in scholarship, professional potential, extra-curricular activities, and moral character.

The Harold J. Horn Prizes

The heirs of Harold J. Horn, E.E. '98, established a fund, the income of which is used in the award of a first and second prize of \$40 and \$20 respectively for the two highest ranking juniors in electrical engineering.

The Andrew Wilson Knecht III Memorial Award

This award is made each year to the member of the mechanical engineering class graduating in June who has exhibited the greatest potential for applying his technical training to practical application. The award is a specially designed medallion with hand engraving and enclosed in a leather folder and presentation case.

The McClain Award for Meritorious Painting

The McClain Award for Meritorious Painting, consisting of a trophy and a fifteen (\$15) dollar purchase prize, and provided by Mr. A. V. McClain, shall be presented the student of painting in the Department of Fine Arts studio classes who completes the most meritorious painting during the academic year.

The McClain Progress Award

The McClain Progress Award, consisting of a trophy and a fifteen (\$15) dollar purchase prize, and provided by Mr. A. V. McClain, shall be presented to that student whose progress in painting in the Department of Fine Arts studio classes during the year shall be most marked.

Merck Index Award

A copy of the *Merck Index* is awarded by Merck and Co., Inc. to a senior in chemistry who is an outstanding student, who has been active in student society affairs and who has promise of a successful career in chemistry in the judgment of the faculty of the Department of Chemistry.

The Elizabeth Major Nevius Award

The Elizabeth Major Nevius Award was established by Walter I. Nevius, E.E. '12, "in loving memory of his wife, who profoundly admired young men of diligence, intelligence, aggressiveness and sterling character." The award of \$500 shall be made annually to that senior enrolled in any five-year combination curriculum leading to two baccalaureate degrees who, upon completion of his first four years at Lehigh University and upon graduation with his class, shall be adjudged the most outstanding of the seniors completing work for their first baccalaureate degree and continuing to a second baccalaureate degree at Lehigh University, judged upon the basis of leadership, citizenship, and scholarship.

The Pendleton Award

This silver bowl is awarded yearly to the student who has produced the most effective contemporary painting.

The Pennsylvania Institute of Certified Public Accountants Prize

The Pennsylvania Institute of Certified Public Accountants awards each year an Accountants' Handbook to the senior in the College of Business Administration majoring in accounting who is outstanding in academic achievement and leadership.

Phi Sigma Kappa Scholarship Cup

A scholarship cup, to be awarded for one year to the fraternity in the interfraternity council having the highest scholastic average for the preceding year and to become the permanent property of the fraternity winning it for three successive years, was provided by an alumnus of the Nu Chapter of Phi Sigma Kappa social fraternity in 1923.

New cups, to be awarded on the same terms as the original, have been provided by the local chapter of Phi Sigma Kappa.

The Allen S. Quier Prize in Metallurgy

An annual prize of \$15 has been provided by the daughters of the late Allen S. Quier in memory of their father, to be awarded to the senior who was adjudged by the staff of the Department of Metallurgical Engineering to have made the most progress in his work in that curriculum. While high scholastic standing is a requisite, the prize is awarded on the basis of progressive achievement in scholastic work, rather than an average rating.

Bosey Reiter Leadership Cup

This award is given to the student whose leadership shall contribute primarily to the best interest of the University. Leadership is defined chiefly as moral character and shall combine intellectual ability and common sense. High scholarship and athletic achievements shall be included as cases of leadership, but neither is necessary or sufficient alone.

Robert Ridgeway Senior Prize

The Robert Ridgeway Senior Prize is awarded annually to the Engineering senior with the highest cumulative average.

The Senior Band Plaque

The Senior Plaque was established by the seniors on the executive committee of The Lehigh University Band to honor a member (s) of the senior class of the Band who has given outstanding performances in both marching and concert seasons for four years and who has not served in a major administrative capacity in the Band.

The T. Edgar Shields Cup

The Shields Cup was established by the late Dr. T. Edgar Shields, former director of music at Lehigh. It is awarded annually to the student who is considered most outstanding in over-all musical activities.

Sigma Xi Undergraduate Research Award

An award of \$50.00 and associate membership in the society is made each year to an undergraduate student by the Chapter Executive Committee from departmental nominations. The basis of the award is research potential and demonstrated achievement in research.

Bradley Stoughton Student Award

This award is given to an outstanding senior student in the Department of Metallurgy. It consists of a certificate and twenty-five dollars awarded annually.

Thornburg Mathematics Prize

The Thornburg Mathematics Prize is made possible through a bequest by the late W. P. Tunstall ('03) in honor of the late Professor Charles L. Thornburg. The prize, consisting of a credit slip in the amount of forty dollars to purchase books in the field of mathematics or allied disciplines at the Book Store, shall be awarded to the senior with the most outstanding record in an advanced course in mathematics.

Trustees' Scholarship Cup

The trustees of the University have provided a scholarship cup which is awarded for one year to the living group having the highest scholarship average for the preceding year. The trustees' scholarship cup becomes the permanent property of any living group winning it for three successive years.

University Service Award

This award is given annually to the senior who has been adjudged to have contributed most during his career at Lehigh University, to promote student body unity, campus cooperation for worthy objectives, and loyalty to the alma mater. It is expected that the student selected shall be of sound character and satisfactory scholarship.

William Whigham, Jr. Memorial Prize

This is awarded annually to the top ranking freshman in engineering, based on accumulative average of the first two semesters.

The Elisha P. Wilbur Prizes

A fund was established by the late E. P. Wilbur, trustee of Lehigh University from 1872 until 1910, for distribution in prizes as the faculty might determine. The income from this fund is used to provide two awards.

WILBUR MATHEMATICS PRIZES. A first and second prize of \$50 and \$25 respectively to be awarded annually to the two highest ranking freshman engineers in the first year of freshman engineering mathematics completed at Lehigh University, as recommended by the Department of Mathematics.

WILBUR SCHOLARSHIP PRIZE. This prize of \$200 is awarded annually to the sophomore with the best semester average for the sophomore year.

The Williams Prizes in English

The late Professor Edward H. Williams, Jr., an alumnus of the University of the Class of 1875, established prizes for excellence in English composition and public speaking. The freshman, sophomore, and junior prizes are awarded by the faculty on the recommendation of the Department of English.

FRESHMAN COMPOSITION PRIZES. A first prize of \$100, a second prize of \$75, and a third prize of \$50 are awarded annually for the three best compositions submitted by freshmen of regular standing as required work in their English courses.

SOPHOMORE COMPOSITION PRIZES. A first prize of \$100, a second prize of \$75, and a third prize of \$50 are awarded annually for the three best compositions submitted by sophomores of regular standing as required work in their English courses.

JUNIOR COMPOSITION PRIZES. A first prize of \$100, a second prize of \$75, and a third prize of \$50 are awarded for the three best essays submitted by juniors as part of the required work in their courses in English.

The Williams Prizes in Extempore Speaking

A first prize of \$100 and a second prize of \$50 are awarded annually to freshmen of regular standing who excel in a contest in extempore speaking.

A first prize of \$100, a second prize of \$75, and a third prize of \$50 are awarded annually to the winners in a contest in extempore speaking for sophomores, juniors, and seniors. Winners of first prizes are not eligible to compete in subsequent years.

The Williams Prizes in Intramural Debating

Sums totaling \$300 are awarded annually as prizes in intramural debating. Students engaged in this activity are organized under the direction of the Department of English into teams which compete in a series of debates. The sum of \$200 is divided equally between the two members of the first place team and the sum of \$100 is divided equally between the two members of the second place team. Winners of first place prizes are not eligible to compete in subsequent years.

The Williams Prize in Dramatics

A prize of \$100 is awarded annually to a Lehigh undergraduate whose interpretation of a role in a production of the Mustard and Cheese Dramatics Club is judged the most outstanding.

The Williams Prize in Interpretive Reporting

A prize of \$100 is awarded annually to a Lehigh undergraduate for meritorious reporting, published or unpublished, intended to interpret the meaning of events or developments which are significant in the life of the University.

The Williams Prize in Creative Writing

A prize of \$100 is awarded annually to the author of a meritorious short story, play, or poem submitted by a Lehigh undergraduate.

The Williams Prize in Varsity Debating

A prize of \$100 is awarded annually to a Lehigh undergraduate whose performance in intercollegiate debating is judged the most outstanding.

The Williams Senior Prizes

The Williams Senior Prizes are awarded by the faculty on the recommendation of the committee on Williams Prizes.

1. First prizes of \$200, second prizes of \$100, and third prizes of \$50 are awarded annually in each of the five fields of economics, English, philosophy, psychology, and history and government for dissertations submitted by regular members of the senior class on or before April 15.

2. The committee on Williams Prizes publishes, before the close of the academic year, a list of recommended subjects for dissertations; but a senior may submit a dissertation upon any other subject in the respective field if the subject has received the approval of the committee.

3. Each senior entering the competition shall submit to the committee his choice of subject and plan of work by November 15.

4. The awards are made by the faculty upon recommendation of the committee, but no award is made if in any case a dissertation does not meet the standards of merit established by the committee. This standard includes such points as excellence in thought, plan, development, argument, and composition.

The Theodore B. Wood Prize

A prize of \$50 is awarded, annually, under the terms of the will of the late Theodore Wood to the mechanical engineering student who has made the greatest scholastic improvement during the first two years of his college course.

Prizes Awarded by Student Organizations

ALPHA A. DIEFENDERFER AWARD. In recognition of Professor Emeritus A. A. Diefenderfer's long service as faculty adviser to the organization, the Lehigh University Chemical Society established this award for the highest ranking senior in analytical chemistry. Each winner is presented with an engraved certificate, and his name is inscribed on a plaque given by the Society and displayed in the Chemistry Building.

ALPHA EPSILON DELTA AWARD. Alpha Epsilon Delta places the name of the pre-medical biology freshman with the highest cumulative average on a plaque in the Department of Biology.

ALPHA KAPPA PSI KEY. The Alpha Sigma Chapter of Alpha Kappa Psi, a professional fraternity in commerce, awards annually the Alpha Kappa Psi Scholarship Key to the senior student pursuing a degree in the College of Business Administration, who has attained the highest scholastic average for three years of collegiate work at Lehigh University.

THE ALPHA PI MU PRIZE. The Alpha Pi Mu honorary fraternity in industrial engineering awards each year an industrial engineers' handbook to a high-ranking sophomore with demonstrated interest in the industrial engineering curriculum.

AMERICAN CHEMICAL SOCIETY AWARD. The Lehigh Valley Section of the American Chemical Society awards a membership in the American Chemical Society and a subscription to a journal of this society to the highest ranking junior in chemistry or chemical engineering.

AMERICAN SOCIETY OF CIVIL ENGINEERS PRIZE. The Lehigh Valley Section of the American Society of Civil Engineers offers a prize of a junior membership in the American Society of Civil Engineers to the outstanding senior in civil engineering holding membership in the student chapter.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS JUNIOR MEMBERSHIP PRIZE. The Anthracite-Lehigh Valley Section of the American Society of Mechanical Engineers awards annually a prize of the value of \$10 to an outstanding member of the Lehigh Student Branch of the ASME. This prize takes the form of junior membership for one year in the parent society.

ETA KAPPA NU PRIZE. The Eta Kappa Nu honorary fraternity in electrical engineering awards a handbook in electrical engineering to the highest ranking freshman in the curriculum in electrical engineering.

THE GOLD-HANSEN TROPHY. The Gold-Hansen Trophy, provided by Stephen R. Gold and Robert A. Hansen, both members of the Class of 1960, is awarded to a student of at least four semesters' standing with the Lehigh University Band who has shown outstanding merit in other ways than musical or marching performance.

PHI ETA SIGMA AWARD. The Lehigh chapter of this national freshman honor society for men offers an award to the residence halls section with the highest freshman aver-

age for the fall semester each year. The trophy is a gift from Professor Harold V. Anderson of the Department of Chemistry.

PI LAMBDA PHI JOURNALISM AWARD. This is awarded to an undergraduate for outstanding editorial or business achievement in the field of publications. The trophies are made available by the local chapter of Pi Lambda Phi Fraternity.

PI TAU SIGMA PRIZE. The Pi Tau Sigma honorary fraternity in mechanical engineering awards each year a mechanical engineers' handbook to the highest ranking sophomore in the curriculum in mechanical engineering.

WILLIAM H. SCHEMPF AWARD. This award is made annually to the freshman who has shown outstanding ability and interest beyond the requirements of a normal freshman bandsman. It is made in honor of a former head of the Music Department by the Beta Sigma Chapter of Theta Chi Fraternity.

TAU BETA PI PRIZE. The Tau Beta Pi honorary engineering fraternity awards each year a slide rule or other prize of equivalent value to the engineering sophomore having the highest scholastic average.

BUILDINGS AND GROUNDS

The University occupies thirty-two buildings, exclusive of fraternity residences, which are located on a tract of land covering 180 acres on the north side of South Mountain overlooking the city of Bethlehem. The University recently acquired additional land on the slope of South Mountain and in Saucon Valley south of Bethlehem, bringing the total acreage to almost 700.

Alumni Memorial Building

The Alumni Memorial Building, which is used as the administration building, was erected as a memorial to 1,921 Lehigh men who served in World War I and especially to the forty-six who gave their lives. The cost of construction was raised by subscription from about 1,700 alumni.

In the south wing of the building are the offices of the President, Provost, Vice-President—Administration, Treasurer, Dean of Students, Registrar, Buildings and Grounds, and the Accounting Office. The north wing contains the offices of the Bursar, Vice-President—Development, Admission, Development, Public Information, Publications, and the Alumni Association.

The lobby of the building contains art galleries in which exhibitions are presented throughout the academic year. There is one automatic elevator in the building.

A collection of boxwood trees and shrubs, donated by the late Robert Parke Hutchinson, Class of '04, landscapes the building and the nearby President's Home.

Arboretum

The Arboretum is a tract of about eleven acres adjoining Sayre Park. It was established by a friend of the University as a tree nursery for the purpose of furnishing illustrative specimens of American trees and of cultivating trees and shrubs for the beautifying of the park. All of the more important species of North American trees are to be found in the Sayre Park and the Arboretum. A tract of seven acres adjoining the Arboretum has been planted with a variety of trees as an exhibition of indigenous tree culture.

Chemistry Building

The Chemistry Building is a three-story, fire-proof sandstone edifice, 259 feet long and 44 feet wide, with a wing of 62 feet long and 42 feet wide, and with a three-story extension, 60 feet long and 37 feet wide. An additional three-story wing, 116 feet long by 52 feet wide, has been added to the east of the original building.

Laboratory space and equipment are provided for qualitative and quantitative analysis, inorganic chemistry, organic chemistry, sanitary chemistry, industrial biochemistry, colloid chemistry, X-ray analysis, gas analysis, the furnace assay of ores, industrial chemistry, and research in chemistry.

The trustees of the University named this building, exclusive of the newer east wing, the William H. Chandler Chemistry Laboratory in recognition of Dr. Chandler's thirty-five years' service as professor of chemistry, 1871-1906. The east wing was named the Harry M. Ullmann Chemistry Laboratory, in recognition of Dr. Ullmann's service as head of the Chemistry Department.

A special hydrogenation building annex has been erected on the outside southwest corner of the court adjacent to the stairway, for the prevention of spark explosions. Access is from the main lobby of the Chandler building.

Christmas-Saucon Hall

Christmas-Saucon Hall is a three-story brick and stucco building. It has historic interest as the first building of Lehigh University. Asa Packer bought it from the Moravians. It was originally a church.

Renovation of Christmas-Saucon Hall was completed in 1958. The remodeled facilities provide headquarters for the departments of English, Mathematics, and Philosophy.

The Office of Placement and Counseling occupies the east wing and the north center section of the first floor.

On the first floor west wing are the common room, statistics laboratory, waiting room, and mathematics department offices.

The second and third floors provide a lecture room, seminar and conference room, and classrooms for the departments housed in the building.

Coppee Hall

Coppee Hall, named for the University's first president, is a three-story stone and stucco building. It contains the recitation rooms and offices of the departments of Government, History, International Relations, Fine Arts, and Religion. There is one large lecture room for common use.

Eckley B. Coxe Laboratory

The Eckley B. Coxe Laboratory is a two-story sandstone building, 100 feet long and 75 feet wide, occupied by the Materials Research Center. The building was named in memory of Eckley B. Coxe, a pioneer and leader in mining engineering in this country. He was a close associate of the founder of the University and served as a trustee from its early days until his death in 1895. His widow established an endowment fund for this building.

The portion of the building occupied by the Materials Research Center includes the Electron Microscopy Laboratory and a Crystal Growing and Zone Processing Laboratory.

Drown Memorial Hall

Drown Memorial Hall was erected by friends and alumni as a memorial to the late Thomas Messinger Drown LL.D., fourth president of the University, who served from 1895 to 1904. The building now houses the offices, lecture rooms, classrooms, and laboratories of the College of Business Administration.

Education Building

The School of Education is headquartered in a two-story, three-unit building at 520-524 Brodhead Avenue, across from the west entrance to the campus. The building, formerly a private residence, has been remodeled to accommodate eighteen offices, a conference room, and a library. The department had been in a one-story, 76x30-foot wooden frame structure at the east end of Packer Hall since April, 1947. That building was razed November 18, 1964.

Fritz Engineering Laboratory

Fritz Engineering Laboratory, headquarters for the Department of Civil Engineering, was established on the campus in 1909 by the late John Fritz of Bethlehem, known as the father of the steel industry in the United States, who served as trustee of the University for 35 years.

The original building, which was designed and erected under the personal supervision of Mr. Fritz, has been used by the department for various research and industrial projects and for laboratory instruction in mechanics of materials and hydraulics.

In October 1955, a new addition to the laboratory was dedicated. It houses the world's largest universal hydraulic testing machine capable of applying a 5,000,000-lb. load to tension or compression members up to 40 feet in length and flexure specimens up to 120 feet long.

The new addition consists of a seven-story section 130 ft. by 70 ft., plus a four-story section 114 ft. by 24 ft. The new building is a steel structure with reinforced concrete flooring and yellow brick and granite exterior. Two large aluminum-framed solex glass windows permit a maximum amount of natural light to enter the 50 ft. by 130 ft. crane bay which houses the huge vertical testing machine and the Amsler repeated load equipment, another outstanding feature of the new addition. The repeated load bed is a heavily reinforced concrete structure measuring 70 ft. by 14 ft. in plan, and 6½ ft. deep. Carefully machined steel plates in the top surface are designed to transmit shear and direct forces under all types of repeated loads.

A floor-controlled 20-ton capacity crane, 70 feet above floor level, services the new south bay and the 5,000,000-lb. testing machine. A 10-ton crane services the original north bay with its 800,000-lb machine, 2,000,000 inch-pound torsion machine, and other machines of smaller capacity.

Research and student instructional laboratories in hydraulics, soil mechanics, concrete, structural models, and sanitary engineering, as well as a separate student laboratory for materials testing, are provided.

The concrete laboratory includes storage bins for aggregates, together with equipment for making and storing all types of plain, reinforced, and prestressed concrete specimens.

The hydraulics laboratory has three levels, with pumps, tanks, turbines, weirs, and other appropriate apparatus used both for student instruction and industrial tests. Space is available for model test of spillways, rivers, channels, etc.

The laboratory machine shop is completely equipped with lathes, millers, drill-presses, grinders, power saws, and miscellaneous tools and equipment. The welding shop provides facilities for both electric arc and gas welding.

Other facilities include photoelastic stress analysis equipment, a photographic darkroom, research library, staff offices, seminar rooms, and a conference room.

Eugene Gifford Grace Hall

Eugene Gifford Grace Hall, named for the donor, who served as president of the Board of Trustees from 1924 to 1956, is a stone structure 120 feet wide and 180 feet long used for sports and recreation. The building contains an athletic palestra, which also serves as an assembly hall for the University, with a seating capacity of 3,000. The second floor is a large drill floor which is available for the major University dances and receptions. In addition, there are classrooms for the Music Department, dressing rooms for athletic squads, and classrooms and offices for the departments of Aerospace and Military Science. Promenade terraces at the level of the dance floor on three sides of the building afford views over the Lehigh Valley and of south Bethlehem.

Health Services Building

The Health Center is located on University Avenue diagonally across from Taylor Hall. Built in 1955, it is a three-story building constructed of native stone with the main entrance on University Avenue.

The main floor contains a waiting lounge, record office, clinical laboratory, examining offices, dispensary, X-ray, observation rooms, and an ear and throat room. On the ground floor are the physiotherapy department, library and conference room, and administrative offices.

The second floor contains two physicians' apartments and several rooms which are used for storage and filing of inactive medical records.

Lamberton Hall

Lamberton Hall, named after Lehigh's second president, Robert A. Lamberton, was built in 1907. Originally built as a University Commons, it was renovated in 1958. It serves as the language headquarters of the College of Arts and Science, and provides rehearsal and practice facilities for Lehigh musical organizations.

The first floor contains a modern language laboratory and a large classroom as well as the headquarters for the Department of Romance Languages. The second floor provides classrooms for all language departments and offices for the department of German.

Two indoor rifle and pistol ranges used by the military department are located in a section of the ground level. The remainder of the ground floor is used as headquarters for Mustard and Cheese, Lehigh's student dramatic organization.

Linderman Library

Linderman Library is a five-story building of native stone, with limestone trim, in the collegiate Gothic style of architecture. It incorporates a part of the original library building, erected in 1877 by Asa Packer and named in memory of his daughter, Lucy Packer Linderman. The more modern section of the building was opened in 1929.

The main floor is occupied by the reading room, offices of the library staff, a portion of the book stack, and the large lobby, where the loan desk, reference department, and public card catalog are located. The upper floors contain seminar rooms, the Rare Book Room and the Honeyman Collection. The offices of the Institute of Research are located on the ground floor, east end; and the office of the Dean of the College of Arts and Science the ground floor, west end. The remainder of the building is devoted to book stacks, of which there are four floors.

The Ordnance Laboratory

The facilities of the departments of Aerospace and Military Science, located in Eugene Gifford Grace Hall, have been augmented by a temporary one-story frame structure, 60 feet long and 25 feet wide. This building contains Army and Air Force ROTC supply storage facilities and garage space.

James Ward Packard Laboratory of Electrical and Mechanical Engineering

The late James Ward Packard, who was graduated from Lehigh University in 1884 with the degree of mechanical engineer, and was the designer of the first Packard motor car and founder of the Packard Motor Car Company of Detroit, Michigan, and of the Packard Electric Company, of Warren, Ohio, donated \$1,200,000 for the erection and equipment of an electrical and mechanical engineering laboratory, which was completed in 1929.

This building, named for the donor, is a five-story steel-framed sandstone structure 225 feet long and 180 feet wide. The lobby is finished in Italian travertine. The halls throughout the building are wainscoted with Tennessee marble. An

auditorium on the first floor with a seating capacity of 622 is equipped with still and motion-picture apparatus.

The western half of the building contains the offices, classrooms, research rooms, and laboratories of the Department of Electrical Engineering. The eastern half of the building houses the departments of Mechanical and Industrial Engineering with classrooms, drawing rooms, offices, research rooms, shops, laboratories, instrument rooms, and a photographic dark room.

The laboratories of the Electrical Engineering Department include the dynamo laboratory, which is equipped with a variety of rotating machines, transformers, circuit components, and instruments; the transient laboratory, which includes a surge generator, artificial lines, and oscilloscopes; a high voltage laboratory; an A.C. network analyzer with six generators, sixteen load units, and sixteen transmission line sections; and an electronics laboratory equipped with sine wave and square wave generators, oscilloscopes, vacuum-tube voltmeters, and components for the experimental study of vacuum-tube and transistor circuits in the audio and R. F. range. A fifteen-amplifier analog computer is also available.

The main mechanical engineering laboratory contains a modern oil-fired steam boiler, turbo-generator sets with condensers and auxiliaries, dynamometer test stands for steam turbines and reciprocating engines, steam jet refrigeration equipment with a barometric condenser, along with various types of pumps and flow-measuring instrumentation. Equipment associated with the compression and flow of air includes two reciprocating compressors, an axial flow fan with adjustable blades on rotor and stator and dynamometer drive, ventilating fans and an air conditioning unit adaptable for extensive testing. The internal combustion engine laboratory features a supercharged variable compression engine of CFR type, completely instrumented for tests. Another variable compression CFR type engine may be adapted for either spark or compression ignition. Strain gage-type pick-ups are available for study of pressure variations. Dynamometer equipment is available for tests of engines of the automatic type. A diesel test stand has fuel-measuring facilities and a strain gage-type torque meter. An instrumentation laboratory provides means for studying the characteristics of the instruments associated with the measurements basic to mechanical engineering. For work in experimental stress analysis a 60,000 lb. universal testing machine is available along with strain gage equipment, oscilloscopes, and two polariscopes for photoelastic investigations. For vibration and balancing studies, the equipment includes vibration velocity meters, a displacement indicator, recording vibrometer, electromagnetic torque meter, and portable balancing equipment.

The manufacturing processes laboratory contains the most modern machine tools, including two 20-h.p. 16" engine lathes, a 20-h.p. turret lathe, two milling machines, large drill press, and auxiliary grinding equipment for the maintenance of cutting tools. This laboratory is fully equipped with machinability analog computer, profilometer, dynamometers and recorders, optical comparator, and other precision measuring equipment for laboratory and experimental work in metal machining.

The Computer Laboratory has a General Electric 225 solid-state computing and information processing facility as well as a Royal McBee LGP-30 digital computer, and is equipped with seminar facilities and a conference room

so as to permit maximum use of the computer for educational purposes. A CDC 6400 will be installed in September, 1968, replacing the GE 225.

Packer Memorial Church

Packer Memorial Church in which religious services are held, was the gift of the late Mrs. Mary Packer Cummings, daughter of the founder of the University. It was built in 1887. Occasional musical recitals and the annual Bach Festivals are held in this building which contains the Starkey Memorial Organ.

Physics Building

The Physics Building is a five-story sandstone structure, 240 feet long and 44 to 56 feet wide. In addition to offices, classrooms, and lecture rooms, there are laboratory rooms for undergraduate and graduate exercises, laboratories for research, a reading room, machine shop, glass-blowing shop, electronic shop, constant-temperature room, chemical preparation room, and dark rooms.

Henry Reese Price Hall

Henry Reese Price Hall, named in honor of Dr. Henry Reese Price, an alumnus of the University of the Class of 1870 and late president of the board of trustees, provides offices and seminar rooms for the departments of classical languages and social relations. It formerly furnished accommodations for 35 students and was remodeled to service as an academic office building in 1966.

Business Economics Center

The Business Economics Center is housed in the former Delta Chi house which is located to the west of the University Center building. The building is a three-story brick structure, 36 feet long by 34 feet wide. It contains departmental and staff offices, seminar, and library, and rooms for statistical machine calculations.

Psychology Laboratory Building

This two-story stone building, 70 feet by 20 feet in plan, temporarily houses the elementary and advanced instructional laboratories, together with student and staff shop facilities of the psychology department. Adjoining the building is a one-story annex, 25 feet long and 20 feet wide, which contains the machine shop.

Saucon Valley Fields

These facilities are located on a 550 acre tract in Saucon Valley, of which approximately 120 acres include the following: an all-weather track, lacrosse field, soccer field, nine green grass-tex composition tennis courts, freshman and varsity baseball fields, a freshman football field, varsity practice football field, one lighted field, eight intra-mural football fields and eight intra-mural softball fields. The fields were put into service during the 1963 fall season. The freshman baseball field is a generous gift of the Class of 1942.

Sayre Observatory

Sayre Observatory was the gift of the late Robert H. Sayre, one of the original trustees of the University.

The observatory contains three rooms on the first floor which house animal laboratories for research and teaching in the Psychology Department.

The land upon which the observatory stands, consisting of seven acres adjoining the original grant, was presented to the University by the late Charles Brodhead of Bethlehem.

Sayre Park

Development of the mountain-side on the University grounds was effected through the donation in 1909 of the sum of \$100,000 by the children of the late Robert H. Sayre, to be used in the development of Sayre Park as a memorial to their father, who was a trustee of the University from its foundation until his death in 1907.

Sayre Park Field

Approximately 8½ acres of intra-mural playing fields located on the top of South Mountain at the southeast corner of Sayre Park. The playing fields are completely enclosed by cyclone fence affording athletic activity to students near the fraternity houses. Area includes a one story block building with masonry veneer, 24' 2" X 16' 2" with toilet facilities and storage area, constructed in 1961. Students began using these facilities in 1962.

Service Building

The Service Building, headquarters of the Department of Buildings and Grounds, consists of one main building, a five-story brick structure 160 feet long by 40 feet wide and an annex, a one and one-half story brick structure 160 feet long by 40 feet wide. Located at Adams and Fourth Streets, it is two blocks from the University campus.

The main building is used chiefly for the storage of maintenance materials and supplies, lumber, building materials, plumbing and heating supplies, and electrical supplies. A freight elevator 20 feet by 10 feet is used to handle materials to the various levels. The annex houses the various maintenance shops, carpenter shop, tinsmith shop, paint shop, and cement mason's shop, along with the materials used by the trades.

Taylor Field

An athletic field more than nine acres in area is provided for the accommodation of students who participate in the various outdoor sports. The stadium, located on the lower level, provides football and baseball fields, surrounded by concrete stands having a seating capacity of 12,000. New steel stands were erected in 1953 above the south concrete stands providing 4,000 more seats for a total seating capacity of 16,000. A new press box, rest rooms, and concession booths under the steel stands were erected. On the upper level there is a practice field for football, baseball, lacrosse, and soccer; also a quarter-mile track and a 220-yard straight-away.

Taylor Gymnasium and Field House

In 1913, Charles L. Taylor, E.M. '76, donated to the University the funds for the erection of a gymnasium and field house.

These buildings were remodeled, re-equipped, and expanded as one of the major projects of the Lehigh Progress Fund.

Taylor Gymnasium, which adjoins the athletic field, is a building 222 feet long and 73 feet wide. It has been expanded by the addition of a new swimming pool measuring 75 by 42 feet, and a new gymnasium measuring 94 by 77 feet.

The new swimming pool ranges in depth from five to ten feet, and includes a large gallery for spectators, an observation room below the water line, and the latest filtration equipment.

Included in the renovation of the old buildings and in the new construction are locker facilities for 2,600 students a faculty locker room, coaches' locker room, five basketball courts, weight room, fencing room, golf practice room, wet and dry steam rooms, and a specially designed wrestling room. Also included are a well-equipped first aid room for physical education activities, corrective exercise gymnasium, trainer's room, and class meeting rooms.

Athletic, Physical Education, and business offices were incorporated in the new construction. Improved heating is furnished by electric blowers. Framed pictures of all athletics teams grace the halls of this floor and stair halls.

The former entrance way has been transformed into a trophy room measuring 26 by 55 feet as a repository for athletic prizes and awards. The third floor addition, known as the Samuel E. Berger Room, the gift of Mr. Samuel Erwin Berger, '89 has also been remodeled.

The University Center

The University Center unites the original exterior lines of Packer Hall (215 feet long, by 60 feet wide), eliminating most of the original structural wood construction, substituting steel girders, steel columns, and I beams, with a new three-story stone addition connected and running parallel with new-windowed, old Packer Hall, this addition being 185 feet long, by 53 feet wide.

The basement section of the east wing contains the offices and classroom of the Division of Journalism and the facilities of The Brown and White, The Epitome, and radio stations WLRN and WLVR.

In addition to executive and business offices for each of the publications and radio stations, the facilities include a large news room with twenty typewriters, a photographic darkroom, a teletype room, three modern, fully-equipped broadcasting studios, an engineering control room, an electronics workshop, and a library containing some ten thousand recordings and tapes.

To the west of the publications area is a large game room, a music practice room, and the headquarters of the Lehigh Radio Society (W3AEQ). The basement of the new section is taken up entirely by service areas for the dining services.

On the main floor, east end, of the center, are the information desk, the Student Activities Office, and the offices of the Chaplain and the Associate Dean of Students. The remainder of the floor is devoted to the dining services, including the main kitchen, cafeteria, two dining rooms, each of which will accommodate approximately two hundred and seventy-five people.

The second floor houses the central files of student organizations, and provides eight meeting rooms. The Snack Bar, student lounge, bookstore, hi-fi room, and the room for cards and chess are together on this floor, thus providing an ample, centrally-located area for recreation and relaxation. There is a balcony affording a fine view of Bethlehem north of the lounge. The building may be entered on the south side at the level of this floor.

The faculty lounge, card and writing room, and a private dining room are on the third floor, east, of Packer Hall, and in the center section is the faculty and guest dining room which retains some of the architectural features of the

room's initial use as the University Chapel. The third floor of the addition includes a completely equipped kitchen for service to the several dining areas on this floor, and two large multi-purpose rooms which can be used for dances, lectures, recitals, meetings, and banquets. Folding partitions permit one room to be divided into two smaller rooms and the other room into four. Both rooms are equipped with public address facilities and one has in addition projection equipment, a sound system, and a permanently installed screen for motion pictures. At the west end there is an additional meeting room which may also serve as a private dining room. There is a balcony north of one multi-purpose room, and in the tower of Packer Hall is a small, handsomely appointed, private dining room.

There is a fourth floor of Packer Hall at the east end only. The facilities here include two small meeting rooms, a large meeting room, and a small television lounge.

There are three automatic elevators in the building.

Varsity House

The Varsity House is a two-story locker building, 121 by 82 feet in size. It contains offices for coaches, a doctor, and a trainer, a room for game officials, locker and shower rooms for home and visiting teams, and rooms for the storage and issue of equipment. This building was dedicated in June, 1963 and is the first of the buildings in the Saucon Valley Fields which will house the athletic facilities in the future.

Whitaker Metallurgical and Chemical Engineering Laboratory

A metallurgical and chemical engineering laboratory, comprising a five-story laboratory and two-story classroom wing, opened in the fall of 1965. The laboratory is located on the north side of Packer Avenue, across from Fritz Laboratory.

Facilities of the laboratory include 90,000 square feet of floor space, a darkroom, metallographic room, specimen preparation room, electron microscope room, balance room, ion-microscope room, physical ceramics rooms, and physical properties measurement room.

Among the more than twenty separate areas for scientific and engineering investigation will be laboratories for high pressure research and reaction kinetics, nuclear studies, analog computation, process control, high temperature thermodynamics and kinetics, analytical studies, and fine structures and metallography.

The classroom wing includes an auditorium-lecture hall with a seating capacity of 225.

W. A. Wilbur Engineering Laboratory and Power House

The W. A. Wilbur Engineering Laboratory and Power House is a two-story sandstone building, 188 feet long and 44 feet wide.

The power plant contains four Babcock and Wilcox straight-tube cross-drum boilers, each rated at 300 boiler horse-power. Two boilers are equipped with Petro oil burners and are fully automatic-controlled. A third boiler has been equipped with a B. & W. oil burner, also fully automatic-controlled. The fourth boiler is a fully automatic Faber fuel oil burner. Four 15,000-gal. fuel oil storage tanks are installed at convenient locations for receiving oil supply.

The plant is designed and equipped to provide steam at 250 pounds pressure to the engineering laboratories, in

addition to heating the University buildings. It is so arranged that any boiler can be isolated for laboratory tests for long periods if necessary. From this plant a six-inch line carries steam to the Packard Laboratory at the pressure desired for the laboratory work. Modern safety appliances and measuring equipment have been incorporated.

Williams Hall

Williams Hall, the donation of the late Dr. Edward H. Williams, Jr., '75, was so named by the trustees of the University in recognition not only of this gift but also of Dr. Williams' long, continued, and important service to the University as professor of mining and geology.

Originally a three-story brick building, 186 feet long and 70 feet wide, Williams Hall was rebuilt as a four-story building after it had been severely damaged by fire in January, 1956. It contains the offices, classrooms, laboratories, department libraries, and special collections of the departments of Biology, Geology, and Psychology.

Williams Hall Annex contains some of the research facilities of the departments of Biology and Psychology. This concrete and brick structure is connected to Williams Hall by a bridge passage between the third floor of the annex and the second floor of Williams Hall.

The northern portion consists of a three-story section, 35 feet long and 25 feet wide, which houses animal quarters together with aquatic-biology, virology, and bacteriology laboratories of the biology department. The entire third floor is a green house.

The southern portion, a single-story section, 35 feet long and 21 feet wide, contains the bioelectric research laboratory of the Psychology Department. This laboratory has electrically shielded and sound proofed recording and instrument rooms, an operating and work room, photographic darkroom, and an electronics shop.

THE RESIDENCE HALLS

Eight residence halls are located on the campus. These modern structures provide living accommodations for approximately 1,400 students. They are located near the center of the campus within walking distance of the Student Health Services Building, the University Center, and the classroom buildings.

Centennial Houses

A complex of six residence halls in three three-story buildings. The Centennial Houses were occupied in September, 1965. The complex houses 264 upperclassmen. It is located just east of the Freshman Quadrangle, overlooking Taylor Stadium. Six former faculty members and administrators were honored by the naming of individual units in the Centennial Houses complex for them. The individual houses are: Charles G. Thornburg; Natt M. Emery; C. Maxwell McConn; E. Kenneth Smiley; Wray H. Congdon and H. M. Leavitt. Each unit provides the atmosphere of a small living group, accommodating 44 students in two-man sleeping and study rooms located on the second and third floors. The ground floor of each unit contains a large living room, a library, and recreation and game room areas for students living in the individual housing unit.

Dravo House

Dravo House, a five-story fireproof residence hall com-

pleted in 1948, provides accommodations for approximately 280 students. The building was made possible by the alumni and friends of the University through their contributions to the Progress Fund. It is named in memory of Francis R. Dravo and Ralph M. Dravo, former University trustees. Each of the four-wing structures which compose the building has its own lounge, and the center unit has a lounge and reception room for visiting friends. There are rooms for one, two, and three students.

Henry Sturgis Drinker House

Henry Sturgis Drinker House, named for the University's fifth president, was completed in 1940. It is a four-story fireproof residence hall with accommodations for 190 students. It has rooms for two and three students, and a spacious lounge.

McClintic-Marshall House

McClintic-Marshall House was completed in 1956, providing accommodations for 296 upperclass students. The building consists of three student living floors each with 48 double rooms, two section-president rooms, a lounge, and two special purpose rooms. The ground floor holds the office of the Director of Residence Halls, the House president's and Residence Halls Council president's suite, and a large recreation room.

Park House

Park House was formerly the Delta Tau Delta house. It is a three-story building with accommodations for sleeping and study.

Charles Russ Richards House

Charles Russ Richards House, named in honor of the sixth president of the University, was completed in 1938. It is a four-story fireproof residence hall accommodating a total of approximately 210. The building contains a spacious lounge.

Charles Lewis Taylor Hall

Charles Lewis Taylor Hall, the gift of Mr. Andrew Carnegie, is a three-story concrete residence hall with accommodations for approximately 170 students, the majority of whom are housed in three-room suites, three to each suite. The building was named Taylor Hall by Mr. Carnegie in honor of Charles L. Taylor, his former partner in business, a graduate of the University in the Class of 1876 and a trustee of the University. The building was completed in 1907.

ACADEMIC OBSERVANCES

BACCALAUREATE SUNDAY. Baccalaureate Services were held Sunday afternoon, June 11, 1967 in Eugene Gifford Grace Hall. The sermon was delivered by The Reverend Horton Davies, B.A., M.A., B.D., D.Phil., D.D., Henry W. Putnam Professor of Religion, Princeton University.

UNIVERSITY DAY. University Day was observed Monday, June 12, 1967. The 99th Commencement Exercises were held in Eugene Gifford Grace Hall. The address to the graduating class was delivered by Horton Guyford Stever, A.B., Ph.D., Sc.D., President, Carnegie Institute of Technology. Honorary degrees were conferred as follows: Thomas S. Gates, chairman of the board, Morgan Guaranty Trust Co.; Fritz Machlup, director of International Finance Section, Princeton University; Hugh Paul McFadden, senior partner, McFadden, Riskin and Williams; H. Guyford Stever, Doctor of Laws.

FOUNDER'S DAY. The 89th annual exercises in honor of the Hon. Asa Packer, founder of the University, were held Sunday afternoon, October 8, 1967 in Eugene Gifford Grace Hall. The address to the graduating class was delivered by James Brown Fisk, B.S., Ph.D., D.Sc., D.Eng., President, Bell Telephone Laboratories.

ALUMNI ASSOCIATION

The Lehigh University Alumni Association which has been in existence since 1876, was incorporated in 1917. The offices of the Association are located in the Alumni Memorial Building. Along with the regular alumni activities, the Association is also concerned with fund raising to help meet the needs of the University.

Over 20,000 Lehigh alumni throughout the country who maintain an active interest in the University are afforded opportunities for frequent social contact with Lehigh men of all classes through 45 alumni clubs established in areas of alumni concentration. Important outposts of the University, these clubs hold meetings and carry on activities that support the programs of the University in its cultural, social, financial, and recreation phases.

The following are the alumni clubs:

Allentown Lehigh Club
Bergen-Passaic Lehigh Club
Lehigh Home Club (Bethlehem, Pa.)

Central New York (Syracuse)
Central Ohio Lehigh Club
Central Pennsylvania Lehigh Club
Chicago Lehigh Club
Connecticut Lehigh Club
Delaware Lehigh Club
Delaware Valley Lehigh Club (Trenton, N.J.)
Detroit Lehigh Club
Fairfield County (Conn.) Lehigh Club
Lancaster County Lehigh Club
Maryland Lehigh Club
Mid-Hudson Valley, N.Y. Lehigh Club
Monmouth County (N.J.) Lehigh Club
New York Lehigh Club
Nittany Valley (Penn State) Lehigh Club
North Central Pennsylvania Lehigh Club
Northeastern Pennsylvania Lehigh Club
Northern California Lehigh Club
Northern New England (Boston) Lehigh Club
Northern New Jersey Lehigh Club
Northern New York Lehigh Club
Northern Ohio Lehigh Club
Northwest Indiana Lehigh Club
Ohio Valley (Cincinnati) Lehigh Club
Pacific Northwest Lehigh Club
Philadelphia Lehigh Club
Pittsburgh Lehigh Club
Rochester (N.Y.) Lehigh Club
Rocky Mountain Lehigh Club
St. Louis (Mo.) Lehigh Club
Southeastern Pennsylvania Lehigh Club
Southern New Jersey Lehigh Club
Southern Anthracite Lehigh Club
Southern California Lehigh Club
Southern New York (Binghamton) Lehigh Club
South Florida Lehigh Club
Twin City Lehigh Club
Washington, D. C. Lehigh Club
Watchung Lehigh Club
West Coast Florida Lehigh Club
Western New York Lehigh Club
York Lehigh Club
Youngstown Lehigh Club

The officers of the Alumni Association for 1967-68 are:

President, Malcolm Carrington, '39
Newark, N.J.
Senior Vice President, D. T. Stevenson, '37
Harrisburg, Pa.
Junior Vice President, Alfred G. Blake, '24
Edison, N. J.
Treasurer, John K. Conneen, '30, Bethlehem, Pa.
Archivist, James D. Mack, '38, Bethlehem, Pa.
Comptroller, Donald W. Schmoyer, '44,
Allentown, Pa.
Executive Secretary and Editor of the *Lehigh Alumni Bulletin*, Robert A. Harrier, '27, Pen Argyl, Pa.

Spring, 1967	Summer, 1967	Fall, 1967
Undergraduate Students 2964	Undergraduate Students 544	Undergraduate Students 3141
Graduate Students 1715	Graduate Students 1041	Graduate Students 1854
Total 4679	Total 1585	Total 4995

Students in Undergraduate Curricula Spring, 1967

Curriculum	Seniors	Juniors	Sophomores	Freshmen	G.C.D.	Total
Arts and Science	233	181	185	212	—	811
Arts and Engineering	45	14	22	42	—	123
Business Administration	175	160	133	111	—	579
Chemical Engineering	45	49	61	—	—	155
Chemistry	19	10	11	—	—	40
Civil Engineering	27	42	43	—	—	112
Electrical Engineering	85	67	82	—	—	234
Engineering Mechanics	8	11	7	—	—	26
Engineering Physics	9	13	7	—	—	29
Fundamental Science	2	2	1	—	—	5
Industrial Engineering	54	61	53	—	—	168
Mechanical Engineering	60	55	60	—	—	175
Metallurgy and M.S.	23	20	29	—	—	72
Unclassified Engineers	—	—	15	415	—	430
General College Division	—	—	—	—	5	5
Total	785	685	709	780	5	2964

Students in Undergraduate Curricula Fall, 1967

Curriculum	Seniors	Juniors	Sophomores	Freshmen	G.C.D.	Total
Arts and Science	193	219	249	201	—	862
Arts and Engineering	23	31	30	45	—	129
Business Administration	157	143	147	110	—	557
Chemical Engineering	51	57	52	—	—	160
Chemistry	16	9	14	1	—	40
Civil Engineering	50	35	51	—	—	136
Electrical Engineering	70	89	76	—	—	235
Engineering Mechanics	8	9	4	—	—	21
Engineering Physics	9	13	16	3	—	41
Fundamental Science	1	1	7	—	—	9
Industrial Engineering	63	48	55	1	—	167
Mechanical Engineering	54	65	69	2	—	190
Metallurgy and M.S.	24	33	39	—	—	96
Unclassified Engineers	—	1	20	468	—	489
General College Division	—	—	—	—	9	9
Total	719	753	829	831	9	3141

GEOGRAPHICAL DISTRIBUTION OF UNDERGRADUATE STUDENTS Fall, 1967

Alabama	3	New Hampshire	2	Canal Zone	1
California	12	New Jersey	618	El Salvador	1
Colorado	4	New Mexico	2	Germany	1
Connecticut	155	New York	526	Ghana	1
Delaware	26	North Carolina	2	Haiti	1
District of Columbia	16	Ohio	49	Hong Kong	1
Florida	15	Oregon	4	India	2
Georgia	2	Pennsylvania	1332	Italy	1
Hawaii	2	Rhode Island	8		
Illinois	23	South Carolina	1	Netherlands	1
Indiana	8	Tennessee	6	Nicaragua	1
Iowa	4	Texas	4	Nigeria	1
Kansas	1	Vermont	3	Pakistan	1
Kentucky	2	Virginia	36	Panama	4
Louisiana	3	Washington	2	Peru	3
Maine	3	West Virginia	6	Philippines	2
Maryland	132	Wisconsin	4	Portugal	2
Massachusetts	65	Argentina	1	Puerto Rico	2
Michigan	8	Bermuda	1	Switzerland	1
Minnesota	1	Bolivia	1	Thailand	1
Missouri	9	Brazil	2	United Kingdom	2
Nebraska	2	Canada	1	Venezuela	3
					1

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HENRY LEIDHEISER, PH.D.
Director (July 1968)

WILLIAM DWIGHT SCHAEFFER, PH.D.
Associate Director, Coatings

JACQUELINE MARIE FETSKO, M.S.
Assistant to the Director

FACULTY AND STAFF

ELSIE KELLERMAN, PH.D.
Research Associate

EUGENE M. ALLEN, PH.D.
GEORGE R. IRWIN, PH.D.
ROBERT WILLIAM COUGHLIN, PH.D.
FORTUNATO JOSEPH MICALE, PH.D.
R. DORESWAMY IYENGAR, PH.D.
GARY WAYNE POEHLIN, PH.D.
PAUL C. PARIS, PH.D.
ROBERT PEH-YING WEI, PH.D.

Computing Center

JOHN EDWIN SMITH, M.A.
Director

THEODORE J. WHITTLINGER
Administrative Assistant

Center for Business Economics

ELMER CLARK BRATT, PH.D., LL.D.
Director

Center for the Application of Mathematics

RONALD SAMUEL RIVLIN, SC.D.
Director

GERALD F. SMITH, PH.D.

MERLE W. TATE, ED.D.

ERIC VARLEY, PH.D.

ROBERT FEATHERSTONE BARNES, JR., PH.D.

WYMAN BEALL FOWLER, PH.D.

GREGORY T. MCALLISTER, PH.D.

MICHAEL P. MORTELL, PH.D.

MARTIN L. RICHTER, PH.D.

ERIC P. SALATHE, PH.D.

Fritz Engineering Laboratory

LYNN SIMPSON BEEDLE, PH.D.
Director

DAVID ALAN VANHORN, PH.D.

Chairman, Structural Concrete Division

Chairman, Department of Civil Engineering

LAMBERT TALL, PH.D.

Chairman, Structural Metals Division

WALTER H. GRAF, PH.D.

Chairman, Hydraulics and Sanitary Engineering

HSAI-YANG FANG, PH.D.

Chairman, Soil Mechanics Division

LE-WU LU, PH.D.

Chairman, Structural Models Division

ROGER GEORGE SLUTTER, PH.D.

Chairman, Operations

JOSEPH ARTHUR CORRADO, M.S.

Engineer of Tests

HUGH T. SUTHERLAND

Instruments Associate

BRUCE LAUB, B.S.

Laboratory Accountant

(The first date after the name indicates date of first appointment to continuous service on the faculty or staff; the second date, when the first fails to do so, indicates the date of appointment to present professional rank.)

HALLE ABRAMS (1967)

Instructor in Metallurgy and Materials Science
B.Ch.E., Brooklyn Polytechnic Institute, 1959; M.S., Lehigh, 1964; M.Ch.E., Newark College of Engineering, 1965.

JOHN RODGER ADAMS (1965, 1966)

Assistant Professor of Civil Engineering
B.S., Marquette University, 1959; M.S., Michigan State University 1961.; Ph.D. Michigan State University, 1966.

JOHN WILLIAM ADAMS (1965)

Associate Professor of Industrial Engineering
B.S., University of Nebraska, 1952; Ph.D., University of North Carolina, 1962.

CARL ELMER ALLEN (1930, 1964)

Professor Emeritus of Accounting
B.S., Illinois 1923; M.S., 1925; Ph.D., 1930; C.P.A., Pennsylvania, 1939.

EUGENE M. ALLEN (1967)

Research Professor in Chemistry
B.A., Columbia, 1938; M.S., Stevens Institute of Technology, 1944; Ph.D., Rutgers, 1952.

GOREN ALPSTEN (1967)

Postdoctoral Research Associate in Civil Engineering
Teknologie Licentiat—Royal, Institute of Technology, (Sweden) 1967.

DAVID C. AMIDON, JR., (1965)

Instructor in History
B.A., Juniata College, 1957; M.A., Pennsylvania State University, 1959.

EDWARD DELBERT AMSTUTZ (1938, 1960)

Professor of Organic Chemistry and Chairman of the Department of Chemistry
B.S., Wooster, 1930; M.S., Institute of Paper Chemistry, 1932; Ph.D., Cornell, 1936.

NORMAN CRAIG ANDERSON (1966)

Assistant Director of Development
B.S., Lehigh, 1960; M.S., Southern Illinois University, 1964

RAY LIVINGSTONE ARMSTRONG (1946, 1958)

Associate Professor of English
B.A., Williams, 1930; B.A., Oxford, 1932; M.A., 1936; Ph.D., Columbia, 1941.

STEPHEN D. ARMSTRONG (1966)

Professor of Aerospace Studies
B.A., University of North Dakota, 1965; Lt. Colonel, U.S. Air Force.

JAY RICHARD ARONSON (1965)

Assistant Professor of Economics
A.B., Clark University, 1959; M.A., Stanford University, 1961; Ph.D., Clark University, 1964.

LLOYD WILLIAM ASHBY (1966)

Associate Professor of Education
A.B., Hastings College, Nebraska, 1927; M.A., Columbia Teachers College, 1935; Ed.D., 1950.

Faculty and Staff

EDWARD F. ASSMUS, JR., (1966)

Associate Professor of Mathematics

A.B., Oberlin College, 1953; A.M., Harvard University, 1955; Ph.D., 1958.

BETZALEL AVITZUR (1964)

Associate Professor of Metallurgy and Materials Science

B.Sc. and Dip. Ing., Israel Institute of Technology, 1949; M.S., University of Michigan, 1956; Ph.D., 1960.

JOHN ROSS BAKER (1962)

Instructor in English

B.A., Rice University, 1952; M.A., 1954.

NICHOLAS W. BALABKINS (1957, 1966)

Professor of Economics

Dipl. rer. pol., Gottingen, 1949; M.A., Rutgers, 1953; Ph.D., 1956.

SAUL BENJAMIN BARBER (1956, 1965)

Professor and Chairman of the Department of Biology

B.S., Rhode Island State, 1941; Ph.D., Yale, 1954.

THOBURN VAIL BARKER (1953, 1962)

Associate Professor of Speech

B.A., Ohio Wesleyan, 1943; M.A., Columbia, 1951.

ROBERT FEATHERSTONE BARNES, JR. (1965)

Associate Professor of Philosophy

B.S., Massachusetts Institute of Technology, 1957; M.A., Dartmouth, 1959; Ph.D., University of California, 1965.

LUCILE LEWIS BARRETT (1944)

Assistant to Director of Public Information

A.B., Syracuse, 1939.

WILLIAM A. BARRETT (1966)

Assistant Professor of Electrical Engineering

B.S., University of Nebraska, 1952; M.S., 1953; Ph.D., University of Utah, 1957.

•DONALD DELYLE BARRY (1963, 1967)

Associate Professor of Government

A.B., Ohio University, 1956; M.A., Syracuse, 1959; Ph.D., 1963.

•On leave, 1967-68

ALLEN MERRIL BARSTOW (1967)

Instructor in Romance Languages

B.S., Lehigh, 1955; M.A., Pennsylvania, 1966.

*ALLEN JENNINGS BARTHOLD (1939)

Professor and Chairman of the Department of Romance Languages

B.A., Lehigh, 1921; Ph.D., Yale, 1931.

*Retired, July 1, 1967.

FRANK SWAN BEALE (1930, 1964)

Associate Professor Emeritus of Mathematics

B.S., Maine, 1921; M.S., 1923; Ph.D., Michigan, 1931.

JACOB LYNFORD BEAVER (1917, 1952)

Professor Emeritus of Electrical Engineering

E.E., Lehigh, 1904; M.S., 1921; Sc.D., Harvard, 1932.

LYNN SIMPSON BEEDLE (1947, 1957)

Professor of Civil Engineering; Director, Fritz Engineering Laboratory

B.S. in C.E., California, 1941; M.S., Lehigh, 1949; Ph.D., 1952.

FERDINAND PIERRE BEER (1947, 1957)

Professor and Chairman of the Department of Mechanics
B.S., Geneva (Switzerland), 1933; M.S., 1935; Ph.D., 1937; M.S., Paris (France), 1938.

JAMES BEGLEY (1967)

Instructor in Metallurgy and Materials Science
B.S., Lehigh, 1963.

PETER BEIDLER (1963, 1967)

Instructor in English
B.A., Earlham College, 1962; M.A., Lehigh, 1965.

RAYMOND BELL (1966)

Instructor in Education

Teaching Certificate, St. John's College, York, England, 1961; M.Ed., Temple, 1966.

RUSSELL EDWARD BENNER (1962)

Associate Professor of Mechanical Engineering
B.M.E., Cornell University, 1947; M.S. in M.E., Lehigh, 1951; Ph.D., 1959.

LOIS REED BENSON (1955, 1958)

Chief Nurse and Administrative Assistant, University Health Service
B.A., Michigan, 1932; R.N., Allentown Hospital, 1939.

EDWARD JOHN BENZ (1956, 1963)

Adjunct Professor of Medical Microbiology
B.S., Pittsburgh, 1944; M.D., 1946; M.S., Minnesota, 1952.

†CHARLES CLARENCE BIDWELL (1927, 1947)

Professor Emeritus of Physics
A.B., Rochester, 1904; Ph.D., Cornell, 1914.
†Deceased, April 12, 1967.

ROBERT DOMINICK BILLINGER (1923, 1965)

Associate Professor Emeritus of Chemistry
B.S. in Ch.E., Lehigh, 1921; M.S., 1925; Ph.D., Cincinnati, 1929.

HARTWIG R. F. BLUME (1967)

Research Associate in Physics
Dipl. Phys., University of Freiburg (Germany), 1962; Ph.D., 1967.

ROBERT DAVIS BOOTHE (1967)

Instructor in Military Science
Sergeant Major, U.S. Army.

GAROLD JOSEPH BORSE (1966)

Assistant Professor of Physics
B.S., University of Detroit, 1962; M.S., University of Virginia, 1964; Ph.D., 1966.

*WALKER LENERO BOYNTON (1964)

Assistant Professor of Military Science
B.S., Central State College, 1954; Captain, U.S.A.
*Resigned, August, 1967.

HENDERSON BAMPFIELD BRADDICK (1956, 1960)

Associate Professor of International Relations
A.B., University of Washington, 1942; LL.B., Harvard, 1949; Ph.D., University of Washington, 1957.

FRANCIS MARIO BRADY, JR. (1955, 1957)

Assistant Professor of Accounting
B.S., Drexel Institute of Technology, 1950; M.B.A., Lehigh, 1957. C.P.A., Pennsylvania, 1955;

JEFFREY BRATSPIES (1964)
Instructor in Metallurgy and Materials Science
 B.S., Lehigh, 1962; M.S., 1966.

ELMER CLARK BRATT (1929, 1965)
Professor of Economics, Associate Dean for Research, College of Business and Economics, Director, Center for Business Economics
 A.B., Nebraska, 1925; A.M., 1926; Ph.D., Wisconsin, 1935; LL.D. (Hon.), Nebraska, 1955.

CHARLES WILFRID BRENNAN (1955, 1964)
Dean of Students
 B.S., Alabama, 1934; M.B.A., 1953.

BRIAN GEORGE BROCKWAY (1963)
Associate Professor of Business Law, and Chairman Department of Finance, Marketing and Law
 B.S., Northwestern, 1957; LL.B., Georgetown, 1961; LL.M., 1963.

ARTHUR LIONEL BRODY (1957, 1963)
Associate Professor of Psychology
 B.A., George Washington, 1951; Ph.D., Indiana, 1956.

ADDISON C. BROSS (1967)
Assistant Professor of English
 B.A., Davidson College, 1959; M.A., Duke University, 1960; Ph.D., Louisiana State University, 1967.

*JOSEF MARIA BROZEK (1959, 1963)
Research Professor of Psychology
 Ph.D., Charles (Prague), 1937.

*On leave 1968-69

ARTHUR WILLIAM BRUNE (1952)
Assistant Professor of Civil Engineering
 B.S. in E.M., Missouri School of Mines, 1941; M.S. in E.M., 1946; Ph.D., Pennsylvania State, 1952; P.E., Pennsylvania, 1964.

STEPHEN D. BRYEN (1967)
Instructor in Government
 A.B., Rutgers, 1964; M.A., Tulane, 1966.

NATT BRYANT BURBANK (1964)
Professor of Education; Director, Division of Secondary Education, School of Education
 A.B., University of Vermont, 1925; M.A., Columbia, 1931; LL.D., Vermont, 1963.

JOHN JOSEPH BURBRIDGE, JR. (1962, 1964)
Instructor in Industrial Engineering
 B.S., Lehigh, 1962; M.S., 1964.

CLIFFORD BURKET (1966)
Associate Professor of Education
 B.S., Lock Haven State College, 1950; M.Ed., University of Pittsburgh, 1954; Ed.D., 1965.

ADOLPH S. BUTKYS (1965)
Assistant Professor of Economics
 B.S., Albright, 1956; M.B.A., Temple University, 1959; Ph.D., University of Pennsylvania, 1964.

JOSEPH S. BUTTERWECK (1967)
Lecturer and Consultant in Education
 B.S., University of Pennsylvania, 1922; M.A., 1924; Ph.D., Columbia, 1926.

ALLISON BUTTS (1957, 1961)
Professor Emeritus of Metallurgy and Materials Science
 A.B., Princeton, 1911; B.S., Massachusetts Institute of Technology, 1913.

*RICHARD D. BYRD (1966)
Assistant Professor of Mathematics
 B.A., Hendrix College, 1958; M.S., University of Arkansas, 1959; Ph.D., Tulane University, 1966.

*Resigned, August, 1967

CLARENCE BOWEN CAMPBELL (1955, 1966)
Dean of Residence
 B.A., Temple, 1937; M.A., Lehigh, 1947.

RONALD NORMAN CARON (1965)
Instructor in Metallurgy and Materials Science
 B.S., Lehigh, 1965.

*PETER J. CARRIL (1966)
Professor in Physical Education
 B.A., Lafayette College, 1952; M.A., Lehigh, 1959.

*Resigned, July, 1967.

JOHN MILLAR CARROLL (1965)
Associate Professor of Industrial Engineering
 B.S., Lehigh, 1950; M.A., Hofstra, 1955.

JOHN S. CARTWRIGHT (1962)
Professor of Education; Director, Division of Educational Administration, School of Education
 A.B., Cornell University, 1927; M.A., New York University, 1942; Sc.D., Muhlenberg, 1954.

*JOHN H. CARY (1963, 1965)
Professor of History
 B.S., University of Wisconsin, 1950; M.A., Pennsylvania State, 1951; Ph.D., University of Illinois, 1959.

*Resigned, July 1, 1967.

ALFRED JOSEPH CASTALDI (1964, 1966)
Associate Professor and Director, Division of Elementary Education
 B.S., University of Pennsylvania, 1951; M.S., 1956; Ed.D., 1964.

RANDALL M. CHAMBERS (1966)
Adjunct Associate Professor of Psychology
 B.A., Indiana, 1948; M.A., Missouri, 1951; Ph.D., Western Reserve, 1954.

*KEITH E. CHAVE (1959, 1964)
Professor of Geology, Associate Director of the Marine Science Center
 Ph.B., Chicago, 1948; M.S., 1951; Ph.D., 1952.

*Resigned, July, 1967.

JOHN MCILVAIN CHEEZUM, JR. (1964)
Assistant Director of Institute of Research
 A.B., University of Pennsylvania, 1964.

*ROBERT D. CHIODI (1964)
Assistant Professor of Physical Education and Varsity Assistant Football Coach
 B.S., University of Maryland, 1952; M.A., Lehigh, 1960.

*Resigned, July, 1967.

WAI-FAH CHEN (1966)
Assistant Professor of Civil Engineering
 B.S., Cheng-Kung University, 1959; M.S., Lehigh, 1963; Ph.D., Brown University, 1966.

Faculty and Staff

CHIANG-SHUEI CHENG (1965)

Instructor in Physics

B.S., National Taiwan University, 1958; M.S., National Tsing Hua University, 1960.

WILLIAM THOMAS CHRISTIAN (1947, 1949)

Assistant Professor of Physical Education, Varsity Swimming Coach, Varsity Soccer Coach, Freshman Baseball Coach

B.S. in Ed., New Jersey State Teachers (Trenton), 1939; M.A., Lehigh, 1960.

GLENN JAMES CHRISTENSEN (1939, 1962)

Provost and Vice-President

B.A., Wooster, 1935; Ph.D., Yale, 1939; LL.D., College of Notre Dame (Md.), 1966.

WILLIAM S. CLEWELL (1967)

Teaching Assistant in Social Relations

A.B., Lycoming College, 1963.

•CURTIS WILLIAM CLUMP (1955, 1960)

Professor of Chemical Engineering

B.S., Bucknell, 1947; M.S., 1949; Ph.D., Carnegie Institute of Technology, 1954.

•On leave 1968-69.

JOHN V. CODY (1967)

Instructor in Classical Languages

A.B., Loyola University (Chicago), 1964; A.M., Princeton, 1966.

ALVIN COHEN (1962, 1965)

Associate Professor of Economics

B.A., George Washington University, 1953; M.B.A., Columbia, 1955; Ph.D., University of Florida, 1962.

ROBERT CARLTON COLE (1964)

Assistant Director of Publications, and Associate Editor, Lehigh Alumni Bulletin

A.B., Marshall University, 1959; M.A., Wake Forest University, 1964.

FRANK THOMAS COLON (1965, 1967)

Associate Professor of Government

A.B., Geneva College, 1954; M.A., University of Pittsburgh, 1960; Ph.D., 1963.

GEORGE POWELL CONARD II (1952, 1960)

Professor of Metallurgy and Materials Science, Director of Magnetic Materials Laboratory

B.S., Brown, 1941; M.S., Stevens Institute of Technology, 1948; Sc.D., Massachusetts Institute of Technology, 1952.

†WRAY HOLLOWELL CONGDON (1934, 1961)

Dean Emeritus of Students

B.A., Syracuse, 1914; M.A., (Engl.), 1915; M.A., (Ed.), Michigan, 1922; Ph.D., 1929.

†Deceased, March 19, 1968.

SAMUEL IRVIN CONNOR (1961)

Director, Office of Public Information

B.A., Lehigh, 1949.

PERCY ELWOOD CORBETT (1964)

Adjunct Professor of International Relations

M.A., McGill University (Canada), 1915; B.A., Oxford (England), 1920; M.A., 1925; LL.D. (Hon.), Melbourne (Australia), 1938; D.C.L. (Hon.), McGill, 1961.

JOSEPH A. CORRADO (1963, 1967)

Research Assistant, Instructor and Engineer of Tests in Civil Engineering

B.S., University of Detroit, 1963; M.S., Lehigh, 1965.

ROBERT WILLIAM COUGHIN (1965, 1967)

Professor of Chemical Engineering

B.S., Fordham University, 1956; Ph.D., Cornell University, 1961. P.E., New Jersey, 1964.

JOHN NELSON COVERT (1967)

Assistant Professor of Physical Education, Varsity Cross Country and Track Coach

B.S.Ed., Buffalo State University, 1953.

RAYMOND GIBSON COWHERD (1946, 1963)

Professor of History

A.B., William Jewell, 1933; M.A., Pennsylvania, 1936; Ph.D., 1940.

CLOYD CRISWELL (1947, 1949)

Assistant Professor of English

B.S. in Ed., Pennsylvania State Teachers (Millersville), 1933; M.A., New York, 1937.

FRANK ROBERT CUNNINGHAM (1966)

Instructor in English

B.A., Villanova University, 1959; M.A., 1962.

CASSIUS WILD CURTIS (1946, 1948)

Professor of Physics

A.B., Williams, 1928; Ph.D., Princeton, 1936.

EDWARD HUTCHINS CUTLER (1930, 1947)

Associate Professor of Mathematics

A.B., Harvard, 1925; A.M., 1926; Ph.D., 1930.

•ROBERT BENJAMIN CUTLER (1954, 1962)

Professor of Music, Chairman of the Department of Music, University Organist

A.B., Bucknell, 1934; M.A., Columbia, 1935.

•On leave, 1967-68.

*JEROME DAEN (1958, 1962)

Associate Professor of Chemistry

B.Ch.E., City College of New York, 1950; Ph.D., Brooklyn Polytechnic Institute, 1955.

*Resigned, July, 1967.

*CALVIN C. DAETWYLER (1965)

Assistant Professor of Geology

B.S., Syracuse University, 1952.

*Resigned, July, 1967.

WALTER EMIL DAHLKE (1964)

Professor of Electrical Engineering

Diploma, University of Berlin; Ph.D., 1936; Ph.D., (habil), University of Jena, 1939.

JOHN HARTLEY DANIELS (1964)

Assistant Professor in Civil Engineering

B.S., University of Alberta (Canada), 1955; M.S., University of Illinois, 1959.

HENRY DAUM (1966)

Visiting Lecturer in Education

A.B., Rutgers, 1935; M.Ed., 1937; Ed.D., Columbia, 1937.

H. BARRETT DAVIS (1946, 1953)

Professor and Chairman of the Division of Speech

B.L.I., Emerson, 1929; Cert., American Academy of Dramatic Arts, 1930; M.A. (Hon.), Emerson, 1958.

EDNA SOPHIA DEANGELI (1963, 1965)
Assistant Professor of Classical Languages
 B.S., Temple, 1938; M.A., Pennsylvania, 1960; Ph.D., 1965

JACK ANGELO DEBELLIS (1964)
Assistant Professor of English
 A.B., University of Florida, 1957; A.M., University of California at Los Angeles, 1959; Ph.D., 1964.

**ALBERT WILLIAM DE NEUFVILLE (1948, 1957)
Associate Professor Emeritus of Mechanics
 Dipl. Ing., Berlin, 1922; M.S., Stevens Institute of Technology, 1948; Ph.D., Lehigh, 1952.
 **Retired, July, 1967.

JACOB DE ROY (1967)
Instructor in Economics
 A.B., Rutgers, 1963; A.M., 1965.

MARGARET LINN DENNIS (1953, 1954)
Reference Librarian
 A.B., Allegheny, 1939; B.S. in L.S., Syracuse, 1940.

HERBERT MAYNARD DIAMOND (1927, 1964)
Professor Emeritus of Economics
 B.A., Yale, 1914; Ph.D., 1917.

•ALFRED JAMES DIEFFENDERFER (1961, 1965)
Associate Professor of Chemistry
 B.S., Pittsburgh, 1957; Ph.D., Massachusetts Institute of Technology, 1961.
 •On leave 1968-69.

WILLIAM ALBERT DIGEL (1960, 1964)
Instructor in English
 B.A., Lehigh, 1959; M.A., 1963.

ERNEST NEVIN DILWORTH (1949, 1967)
Professor of English
 Ph.B., Kenyon, 1933; M.A., Pittsburgh, 1937; Ph.D., Columbia, 1948.

GEORGE ANSON DINSMORE (1955)
Associate Professor of Civil Engineering
 B.E., Yale, 1946; M.S., Colorado, 1955.

THOMAS L. DINSMORE (1965, 1967)
Administrator, Metallurgy and Materials Science
 B.S., University of Rochester, 1946; M.S., Princeton, 1948.

GEORGE DOURIS (1964)
Part-time Lecturer in Education
 B.A., Philadelphia Museum School of Art, 1953; M.F.A., Temple University, 1958.

JOSEPH ALBERT DOWLING (1958, 1967)
Professor and Chairman of the Department of History
 A.B., Lincoln Memorial, 1948; M.A., New York, 1951; Ph.D., 1958.

GEORGE CLARENCE DRISCOLL, JR. (1950, 1965)
Professor of Civil Engineering
 B.S. in C.E., Rutgers, 1950; M.S., Lehigh, 1952; Ph.D., 1958.

JAMES WELLONS DUFFY (1963)
Instructor in Physics
 B.A., Williams, 1962; M.S., Lehigh, 1964.

ROY HELVERSON DUNGAN (1966)
Part-time Lecturer in Education
 B.S., Millersville State College, 1941; Ed.M., Temple University, 1947; Ed.D., 1960.

AURIE NICHOLS DUNLAP (1948, 1957)
Associate Professor of International Relations
 A.B., Union (New York), 1929; A.M., Columbia, 1931; Ph.D., 1955.

FREDERICK HOMER DUNLAP (1965)
Assistant Professor of Physical Education, Varsity Head Football Coach
 B.A., Colgate, 1950.

FRANK ALOYSIUS DUNN (1967)
Visiting Assistant Professor in Management Science
 B.A., LaSalle College, 1958; M.A., University of Pennsylvania, 1961.

NIKOLAI EBERHARDT (1962)
Associate Professor of Electrical Engineering
 Dipl. Engr., University of Munich, 1957; Ph.D., 1962.

EVELYN STRAWN EBERMAN (1955, 1957)
Assistant to Dean of Residence
 B.A., Swarthmore, 1921.

ROBERT HERBERT EBERT (1966)
Instructor in Military Science
 Master Sergeant, U. S. Army.

ARTHUR ROY ECKHARDT (1951, 1956)
Professor of Religion, Chairman of the Department of Religion
 B.A., Brooklyn, 1942; B.D., Yale, 1944; Ph.D., Columbia, 1947.

ANDREW J. EDMISTON (1967)
Professor in Education
 A.B., West Virginia Wesleyan, 1951; M.S., University of Miami, 1953; Ph.D., Pennsylvania State, 1960.

DAVID G. EISENHAUER (1967)
Special Assistant, Office of the President
 B.A., Carnegie-Mellon, 1963; M.F.A., Princeton, 1967.

JONATHAN BRITTON ELKUS (1957, 1965)
Professor of Music
 B.A., California, 1953; M.A., Stanford, 1954.

GEORGE MARK ELLIS (1967)
Assistant Dean, College of Arts and Science, and Associate Professor
 A.B., Yale, 1943; A.M., Harvard, 1947; Ph.D., 1952.

•RAYMOND JAY EMRICH (1946, 1958)
Professor and Chairman of the Department of Physics
 A.B., Princeton, 1938; Ph.D., 1946.
 •On leave, Spring, 1968.

WILLIAM JOSEPH ENEY (1936, 1957)
Joseph T. Stuart Professor of Civil Engineering
 B.E., Johns Hopkins, 1927; M.S., Lehigh, 1938; P.E., Pennsylvania, 1939.

JAMES VANDEUSEN EPPES (1950)
Associate Professor of Mechanical Engineering
 B.A., Virginia, 1928; M.E., Cornell, 1931; M.S. in M.E., Lehigh, 1943.

FAZIL ERDOGAN (1952, 1963)
Professor of Mechanics
 Yuk. Muh., Technical University of Istanbul, 1948; Ph.D., Lehigh, 1955.

Faculty and Staff

HSAI-YANG FANG (1966)
Assistant Professor of Civil Engineering
B.S., Hangchow University, 1947; M.S., Purdue University, 1956; Ph.D., West Virginia University, 1966.

GEORGE DORMER FARNE (1927, 1945)
Assistant Professor Emeritus of Romance Languages
A.B., Columbia, 1926; M.A., 1927.

•DOUGLAS DAVID FEAVER (1956, 1966)
Professor of Classical Languages
B.A., Toronto, 1948; M.A., Johns Hopkins, 1949; Ph.D., 1951.

•On leave, 1967-68.

FRANK JOSEPH FEIGL (1967)
Assistant Professor of Physics
A.B., Notre Dame, 1958; Ph.D., University of Pittsburgh, 1965.

JACQUELINE MARIE FETSKO (1949, 1966)
Assistant to the Director, Center for Surface and Coatings Research
B.A., Pennsylvania, 1946; M.S., Lehigh, 1953.

*JEROME I. FISCHMAN (1962)
Assistant Professor of History
B.S., City College of New York, 1950; M.A., 1952; Ph.D., New York University, 1962.

*Resigned, July, 1968.

VELMER BERNEL FISH (1948, 1954)
Associate Professor of Chemistry
B.S., Iowa State, 1936; Ph.D., 1942.

JOHN WILLIAM FISHER (1961, 1966)
Associate Professor of Civil Engineering
B.S., Washington University, 1956; M.S., Lehigh, 1958; Ph.D., 1964, P.E., Illinois, 1960.

*ANNE STROWD FLANNERY (1960)
Associate Librarian
A.B., Duke, 1934; A.B. in L.S., Emory, 1942; M.A., Duke, 1945.

*Resigned, November, 1967.

THOMAS FLECK, JR. (1965)
Instructor in Education and Principal, Laboratory School.
B.S., West Chester State College, 1956; M.Ed., Temple University, 1960.

CATHERINE RILEY FLECKSTEINER (1945, 1965)
Serials Cataloger

DANIEL JOHN FLEMING (1967)
Instructor in Mathematics and Astronomy
A.B., Clark University, 1962; M.A., 1965.

ROBERT THOMAS FOLK (1961, 1966)
Professor of Physics
B.S. in E.E., Lehigh, 1953; B.S. in Phys., 1954; M.S., 1955; Ph.D., 1958.

ADELBERT FORD (1931, 1955)
Professor Emeritus of Psychology
A.B., Michigan, 1920; A.M., 1923; Ph.D., 1926.

ROBERT DARROW FOUCHAUX (1963)
Assistant Professor of Physics
B.A., B.S., Lehigh, 1956; M.S., University of Illinois, 1958; Ph.D., 1963.

ALAN SHIVERS FOUST (1952, 1965)
McCann Professor of Chemical Engineering
B.S., Texas, 1928; M.S., 1930; Ph.D., Michigan, 1938, P.E., Michigan, 1947.

WYMAN BEALL FOWLER, JR. (1966)
Associate Professor of Physics
B.S., Lehigh, 1959; Ph.D., University of Rochester, 1963.

JAMES RICHARD FRAKES (1958, 1967)
Professor of English
B.A., Pennsylvania State, 1948; M.A., Chicago, 1949; Ph.D., Pennsylvania, 1953.

PAUL JUSTUS FRANZ, JR. (1944, 1962)
Vice-President—Development
B.S. in Bus. Adm., Lehigh, 1944; M.A., 1955.

AUGUSTUS HENRY FRETZ (1918, 1948)
Associate Professor Emeritus of Geology
Ph.B., Lafayette, 1903; C.E., 1906; M.S., 1924.

GILBERT DARREL FRIEND (1966)
Assistant Professor of Mathematics
A.B., Bradley University, 1960; M.A., University of Maryland, 1964; Ph.D., 1966.

RAYMOND EUGENE FUESSLE (1953)
Chaplain of the University, Associate Professor of Religion
B.A., New York University, 1930; B.D., Virginia Episcopal Theological Seminary, 1933.

MERTON OTIS FULLER (1912, 1955)
Associate Professor Emeritus of Civil Engineering
C.E., Syracuse, 1910; M.S., Lehigh, 1934.

ROBERT TAYLOR GALLAGHER (1942, 1964)
Professor of Mining Engineering; Associate Dean, College of Engineering
B.S. in E.M., Pennsylvania State, 1927; M.A. in Geol., Missouri, 1938; D.E.M., Colorado School of Mines, 1941. P.E., Pennsylvania, 1945; New Jersey, 1955.

THOMAS JEFFERSON GANNON (1967)
Instructor in Physical Education, Assistant Varsity Football Coach
B.A., Moravian College, 1961.

DORIS GARB (1967)
Part-time Instructor in German
B.A., University of North Carolina, 1964.

GERALD GARB (1967)
Professor of Economics
B.S., University of Pennsylvania, 1948; M.A., University of California (Berkeley), 1951; Ph.D., 1957.

*ARTHUR PARCEL GARDNER (1958, 1966)
Associate Professor of German
A.B., Duke, 1944; A.M., Harvard, 1945; Ph.D., 1950.

*On leave, Spring Semester, 1968.

JACOB MYER GEIST (1959)
Lecturer in Chemical Engineering
B.S., Purdue, 1940; M.S., Pennsylvania State, 1942; Ph.D., Michigan, 1950.

BAHKAR KUMAR GHOSH (1961, 1963)
Associate Professor of Mathematics
B.Sc., Calcutta (India), 1955; Ph.D., London, 1959.

LEANOR RUTH GILBERT (1930, 1943)
Recorder

LAWRENCE HENRY GIPSON (1924, 1952)
Research Professor Emeritus of History
 A.B., Idaho, 1903; B.A., Oxford, 1907; M.A., 1915; Ph.D., Yale, 1918; Litt.D. (Hon.), Temple, 1947; L.H.D. (Hon.), Lehigh, 1951; LL.D. (Hon.), Idaho, 1953; L.H.D. (Hon.), Yale, 1955; L.H.D. (Hon.), Kenyon, 1961; LL.D. (Hon.), Moravian, 1962; LL.D. (Hon.), Wabash, 1963.

FREDERICK ROBERT GLADECK (1966)
Instructor in International Relations
 B.A., Lehigh, 1960; M.A., University of Pennsylvania, 1964.

ELMER WILLIAM GLICK (1949, 1952)
Treasurer
 B.A., Lehigh, 1933.

WILLIAM MONROE GLOSE III (1960)
Accountant
 B.S. in Bus. Adm., Lehigh, 1958.

LAWRENCE PETER GOLAN (1964)
Instructor in Mechanical Engineering
 B.S., West Virginia University, 1961; M.S., 1964.

RICHARD ALLYN GONCE (1965)
Assistant Professor in Economics
 B.B.A., University of Wisconsin, 1954; M.B.A., 1959.

RONALD L. GOUGHER (1965)
Instructor in German
 A.B., Muhlenberg, 1961; M.A., Lehigh, 1964.

ARTHUR FREEMAN GOULD (1947, 1953)
Professor and Chairman of the Department of Industrial Engineering
 S.B., Massachusetts Institute of Technology, 1938; M.S., Lehigh, 1949; P.E., Pennsylvania, 1949.

WALTER H. GRAF (1968)
Associate Professor in Civil Engineering
 Dipl. Ing., University of Vienna (Austria), 1959; Ph.D., University of California (Berkeley), 1963.

JAMES LARMOUR GRAHAM (1930, 1954)
Associate Professor Emeritus of Psychology
 B.A., Muskingum, 1911; B.D., Union Theological Seminary, 1922; M.A., Columbia, 1922; Ph.D., Peabody, 1927.

MARGARET C. GRANDOVIC (1962)
Part-time Lecturer in Education
 B.S., Temple, 1938; M.Ed., 1957.

THOMAS R. GRAVETTE (1965)
Associate Professor of Military Science
 B.S., John Carroll University, 1957.

MARGUERITE B. GRAVEZ (1957)
Instructor in Mathematics
 B.A., Hunter, 1950; M.A., Radcliffe, 1951.

DAVID MASON GREENE (1958, 1964)
Associate Professor of English
 B.A., San Diego State, 1951; M.A., California, 1952; Ph.D., 1958.

*ROGER GRISMORE (1962)
Associate Professor of Physics
 B.S., University of Michigan, 1947; M.S., 1948; Ph.D., 1957.
 *Resigned, July, 1967.

MIKELL PORTER GROOVER (1966)
Instructor in Industrial Engineering
 B.A., Lehigh, 1961; B.S., 1962; M.S., 1966.

ANDREW C. GROSS (1966)
Instructor in Economics
 B.Sc., Case Institute of Technology, 1957; M.B.A., Western Reserve University, 1962.

HOWARD DIETRICH GRUBER (1914, 1948)
Associate Professor Emeritus of Electrical Engineering
 E.E., Lehigh, 1909; M.S., 1923.

CHARLES GUDITUS (1964, 1965)
Assistant Professor of Education
 B.S., Penn State University, 1950; M.S., Bucknell University, 1952; Ed.D., Lehigh, 1965.

SAMUEL LINIAL GULDEN (1953, 1967)
Associate Professor of Mathematics
 B.S., City College of New York, 1949; M.A., Princeton, 1950.

CLARK W. HAHN (1967)
Assistant Accountant

WALTER CHARLES HAHN, JR. (1963, 1967)
Associate Professor of Metallurgy and Materials Science
 B.S., Met. Engr., Lafayette, 1952; M.S., Pennsylvania State, 1958; Ph.D., 1960.

JOHN MCVICKAR HAIGHT, JR. (1949, 1967)
Professor of History
 A.B., Princeton, 1940; M.A., Yale, 1947; Ph.D., Northwestern, 1953.

THEODORE HAILPERIN (1946, 1961)
Professor of Mathematics
 B.S., Michigan, 1939; Ph.D., Cornell, 1943.

†ROBERT J. HALL (1963, 1966)
Assistant Professor of Management
 B.B.A., State University of Iowa, 1960; M.A., 1961.
 †Deceased, December 6, 1967.

GEORGE DEWEY HARMON (1925, 1964)
Professor Emeritus of American History
 B.A., Duke, 1921; M.A., 1922; Ph.D., Pennsylvania, 1930.

ROBERT AUSTIN HARRIER (1951)
Executive Secretary, Alumni Association, and Editor, Lehigh Alumni Bulletin
 E.M., Lehigh, 1927.

ROBERT RICHARD HARSON (1966)
Assistant Professor of English
 B.A., Wagner College, 1963; M.A., Ohio University, 1964; Ph.D., 1966.

RONALD JOHN HARTRANFT (1966)
Assistant Professor of Mechanics
 B.S., Lehigh, 1963; M.S., 1964; Ph.D., 1966.

Faculty and Staff

ALBERT EDWARD HARTUNG (1947, 1961)
Associate Professor of English
B.A., Lehigh, 1947; M.A., 1949; Ph.D., 1957.

EMIL ANDREW HAVACH (1941, 1949)
Head Trainer
D. Surg. Chirop., Temple, 1936.

THOMAS MORRIS HAYNES (1952, 1961)
Associate Professor of Philosophy
A.B., Butler, 1941; M.A., Illinois, 1949; Ph.D., 1949.

LEROY ARLAN HECKMAN (1967)
Assistant Professor of Physical Education, Varsity Basketball Coach
B.S.Ed., Kutztown State College, 1949; M.A., Colorado State University, 1961.

STANLEY FREDERICK HEFFNER (1930, 1946)
Manager of the Supply Bureau

NED D. HEINDEL (1966)
Assistant Professor of Chemistry
B.S., Lebanon Valley College, 1959; M.S., University of Delaware, 1961; Ph.D., 1963.

SIDNEY SAMUEL HERMAN (1962, 1966)
Associate Professor of Biology
B.S., Georgetown University, 1953; M.S., Rhode Island, 1958; Ph.D., 1962.

ROY CECIL HERRENKOHL JR. (1966)
Assistant Professor of Social Psychology and Methodology
B.A., Washington & Lee University, 1954; Ph.D., New York University, 1966.

RICHARD WARREN HERTZBERG (1964, 1965)
Assistant Professor of Metallurgy and Materials Science
B.S., City College of New York, 1960; M.S., Massachusetts Institute of Technology, 1961; Ph.D., Lehigh, 1965.

ANNA PIRSCENOK HERZ (1966)
Associate Professor of Russian
B.S., University of Pennsylvania, 1949; M.A., 1950; M.A., Columbia, 1951; Ph.D., Pennsylvania, 1956.

RICHARD C. HESS (1966)
Instructor in Speech and Debate Coach
A.B., Fairmont State College, 1963; M.A., Temple University, 1965.

JAMES PAUL HICKERSON, JR. (1965)
Instructor in Metallurgy and Materials Science
B.S., University of Idaho, 1964.

MARY JOANNE HILL (1967)
Editorial Associate Institute of Research
B.S., Carnegie-Mellon, 1959; M.A., University of Pittsburgh, 1964.

DONALD JOHN HILLMAN (1960, 1964)
Professor and Chairman of the Department of Philosophy
B.A., Cambridge (England), 1955; M.A., 1959; M.Litt., 1962.

JOHN TERENCE HIRST (1968)
Assistant Professor of Civil Engineering
B.A.S., University of British Columbia, 1962; M.A.S., 1966; Ph.D., University of California (Berkeley), 1968.

LLOYD HITCHCOCK, JR. (1966)
Adjunct Assistant Professor of Psychology
A.B., Southwest Missouri State, 1954; M.S., Georgia, 1956; Ph.D., Purdue, 1961.

JAMES B. HOBBS (1966)
Associate Professor of Economics
A.B., Harvard, 1952; M.B.A., University of Kansas, 1957; D.B.A., Indiana University, 1962.

JOHN ANTHONY HOGAN (1965)
Assistant Professor Physical Education, Assistant Varsity Football Coach and Freshman Track Coach
B.S., University of Cincinnati, 1951.

ROBERT MARK HOLCOMBE (1963, 1966)
Associate Director of Development
B.S., Lehigh, 1958.

WILLIAM FOWLER HOLLABAUGH (1960, 1966)
Assistant Professor in Electrical Engineering
B.S. in E.E., Lehigh, 1959; M.S. in E.E., 1960; Ph.D., 1966.

RICHARD EDWARD HOLLERAN (1965)
Assistant in Aerospace Studies
Master Sergeant, U.S. Air Force

CARL SANFORD HOLZINGER (1959, 1964)
Assistant Professor of Electrical Engineering
B.S., Lehigh, 1956; M.S., 1957; Ph.D., 1963.

FRANK SCOTT HOOK (1952, 1965)
Professor of English
A.B., Missouri, 1942; M.A., 1947; Ph.D., Yale, 1952.

CHUAN-CHIH HSIUNG (1952, 1960)
Professor of Mathematics
B.S., National Chekiang (China), 1936; Ph.D., Michigan State, 1948.

TI HUANG (1967)
Associate Professor of Civil Engineering
B.S., Tangshan Engineering College, 1948; M.S., Michigan University, 1952; Ph.D., 1960.

GEORGE ALBERT HUNT, JR. (1967)
Teaching Assistant in Social Relations
A.B., Villanova University, 1967.

JON TERENCE INNES (1965)
Instructor in Economics
B.S., Pennsylvania State University, 1958.

GEORGE RANKIN IRWIN (1967)
Professor of Mechanics
A.B., Knox College, 1930; M.S., University of Illinois, 1933; Ph.D., 1937.

DORESWAMY R. IYENGAR (1967)
Research Associate Professor of Chemistry
B.S., University of Mysore (India) 1951; M.S., M.A., University of Madras (India), 1954; Ph.D., University of Miami, 1962.

DONALD M. JACKSON (1967)
Instructor in Industrial Engineering
B.S., Lehigh, 1964.

MELVIN ROBERT JACKSON (1965, 1967)
Instructor in Metallurgy and Materials Science
B.S., Lehigh, 1965.

THOMAS EDGAR JACKSON, (1937, 1946)
Associate Professor of Mechanical Engineering
 B.S. in M.E., Carnegie Institute of Technology, 1934; M.S., Lehigh, 1937; P.E., Pennsylvania, 1946.

EUSTACE ANTHONY JAMES (1962, 1966)
Assistant Professor of English
 A.B., Princeton, 1958; M.A., Pennsylvania, 1960; Ph.D., 1965.

MARTINUS M. JANSEN (1967)
Post-Doctoral Fellow in Chemistry
 Ph.D., Technological University, Eindhoven (The Netherlands), 1966.

GEORGE ROBERT JENKINS (1948, 1963)
Director of the Institute of Research, Professor of Geology
 B.A., Colorado, 1936; Ph.M., Wisconsin, 1938.

FRANCIS P. JENNINGS (1967)
Visiting Professor of History
 B.S., Temple University, 1939; M.A., 1951; Ph.D., University of Pennsylvania, 1965.

FINN BJORN JENSEN (1947, 1954)
Professor and Chairman of the Department of Economics
 A.B., Southern California, 1934; M.A., 1935; Ph.D., 1940.

DARLENE MARILYN JOHNSON (1965).
Instructor in Education
 B.A., Hood College, 1964; M.Ed., Lehigh, 1965

FLETCHER A. JOHNSON, JR. (1966)
Instructor in Physical Education
 B.S., Boston University, 1964.

ROBERT GRIFFITH JONES (1965)
Assistant Professor of Social Psychology
 A.B., Davidson College, 1958; B.D., Yale, 1961; Ph.D., Duke University, 1966.

LANE LOUIS JORGENSEN (1967)
Adjunct Instructor in Management Science
 B.S., Lehigh, 1964; M.S., 1965.

CAREY BONTHON JOYNT (1951, 1960)
Professor and Chairman of the Department of International Relations
 B.A., Western Ontario, 1945; M.A., 1948; Ph.D., Clark, 1951.

ARTURS KALNINS (1965, 1967)
Professor of Mechanics
 B.S., University of Michigan, 1955; M.S., 1956; Ph.D., 1960.

LAVEEN KANAL (1966)
Adjunct Professor in Electrical Engineering
 B.S., University of Washington, 1951; M.S., 1953; Ph.D., University of Pennsylvania, 1960.

GEORGE EUGENE KANE (1950, 1964)
Professor of Industrial Engineering
 B.S., Pennsylvania State, 1948; M.S., Lehigh, 1954; P.E., Pennsylvania, 1955.

ALVIN SHELDON KANOFSKY (1967)
Assistant Professor of Physics
 B.A., University of Pennsylvania, 1961; M.S., 1962; Ph.D., 1966.

JOHN J. KARAKASH (1946, 1966)
Distinguished Professor and Chairman of the Department of Electrical Engineering; Dean, College of Engineering
 B.S. in E.E., Duke, 1937; M.S., in E.E., Pennsylvania, 1938; P.E., Pennsylvania, 1948.

*CHETAN LALCHAND KARNA (1963, 1966)
Assistant Professor in Mechanics
 B.E., College of Engineering, Poona (India), 1953; M.S. in M.E., Lehigh, 1960; M.S. in Appl. Mech., 1960.

*Resigned, January, 1967

JOHN DANIEL KEEFE (1965)
Instructor in Economics
 B.S., Lehigh, 1948; M.A., Miami (Florida), 1955.

ELSIE L. KELLERMAN (1966)
Research Associate in Center for Surface and Coatings Research
 A.B., Mt. Holyoke College, 1959; Ph.D., University of Pennsylvania, 1963.

JOHN L. KEMMERER (1966)
Assistant Purchasing Agent

JUDITH KEMMERER (1965, 1967)
Instructor in Education
 B.A., Muhlenberg, 1963; M.Ed., Lehigh, 1966.

ROBERT PAUL KERFOOT (1962)
Instructor in Civil Engineering
 B.S., Iowa State University, 1962; M.S., Lehigh, 1964.

SAMIR ANTON KHABBAZ (1960, 1964)
Associate Professor of Mathematics
 B.A., Bethel College, 1954; M.A., Kansas, 1956; Ph.D., 1960.

JOHN WYCLIFFE KHOURI (1967)
Part-time Lecturer in Education
 B.A., Geneva College (Pa.), 1940; M.A., University of Pittsburgh, 1941; M.Ed., 1953; Ed.D., 1964.

JERRY PORTER KING (1962, 1965)
Associate Professor of Mathematics
 B.S. in E.E., University of Kentucky, 1958; M.S. in Math., 1959; Ph.D., 1962.

WALTER KING (1967)
Instructor in Physical Education
 B.A., Lehigh, 1963.

MURRAY ROBERT KIRCH (1965)
Instructor in Mathematics
 B.A., Temple University, 1962; M.S., Lehigh, 1964.

SIDNEY KLEINBERG (1965, 1968)
Instructor in Chemical Engineering
 B.Ch.E., City University of New York, 1956; M.S., Massachusetts Institute of Technology, 1957.

KAMIL KLIER (1967)
Visiting Research Professor in Chemistry
 B.S., Chemicco-Technological University (Prague), 1954.

*REINARD HEINRICH KNERR (1962)
Instructor in Electrical Engineering
 Dipl., Rheinisch-Westfälische Technische Hochschule, Aachen (Germany), 1960; Dipl. d'Ing., Ecole Nationale d'Electrotechnique et d'Hydraulique, Toulouse (France), 1962; M.S., Lehigh, 1964.

*Resigned, January, 1968

Faculty and Staff

STEPHEN CHIHCHI KO (1965, 1967)

Instructor in Civil Engineering

B.S., Taiwan Christian College, 1962; M.S., Lehigh, 1967.

ALFRED PAUL KOCH (1946, 1961)

Professor of Accounting

B.S., Pennsylvania State College (Bloomsburg), 1939; M.S., Bucknell, 1940; C.P.A., Pennsylvania, 1952.

CELAL NIZAMETTIN KOSTEM (1966)

Research Associate in Civil Engineering

B.S., Technical University of Istanbul, 1960; M.S., 1961; Ph.D., University of Arizona, 1966.

RALPH WAYNE KRAFT (1962, 1965)

Professor of Metallurgy and Materials Science

B.S. in Met.E., Lehigh, 1948; M.S. in Met.E., University of Michigan, 1956; Ph.D. in Met.E., 1958.

CHARLES STEPHEN KRAIJANZEL (1962, 1966)

Associate Professor of Chemistry

Sc.B. in Chem., Brown, 1957; M.S., University of Wisconsin, 1959; Ph.D., 1962.

RALPH M. KRAUS (1961)

Assistant Professor of Accounting

A.B., Bethany, 1951; M.Litt., Pittsburgh, 1954.

GEORGE KRAUSS, JR. (1963, 1966)

Associate Professor of Metallurgy and Materials Science

B.S., Lehigh, 1955; M.S., Massachusetts Institute of Technology, 1958; Sc.D., 1961.

ROLF BROOKS KREITZ (1966)

Associate Professor of Military Science

B.S., Lehigh, 1957. Major, U.S. Army.

THONER LAMONT KROPP (1958, 1962)

Executive Secretary, Committee on Undergraduate Financial Aid; Assistant Director of Admission

B.A., Lehigh, 1956; M.A., 1963.

LEON ELWOOD KROUSE (1951, 1963)

Associate Professor of Finance

B.A., Susquehanna, 1941; M.S., Bucknell, 1947; Ph.D., New York, 1958.

THOMAS CHARLES KUBELIUS (1948, 1957)

Associate Professor of Business Law

B.S., Illinois, 1945; LL.B., 1947.

GUNNAR KULLERUD (1962)

Adjunct Professor of Geochemistry

M.S.C., Technical University (Norway), 1946; Ph.D., University of Oslo (Norway), 1948; D.Sc., 1954.

ALBERT BARRY KUNZ (1962, 1966)

Instructor in Physics

B.S., Muhlenberg, 1962; M.S., Lehigh, 1964.

GARY BERNARD LAISON (1961)

Instructor in Mathematics

B.A., Pennsylvania, 1958; M.A., 1960.

LILYANE LANCHY (1968)

Part-time Instructor in Romance Languages

EUGENE M. LANDIS (1967)

Adjunct Professor of Biology

B.S., University of Pennsylvania, 1922; M.S., 1924; M.D., 1926; Ph.D., 1927; M.S., (Hon.), Yale, 1938.

JOHN DAVID LANDIS (1967)

Instructor in Industrial Engineering

B.S., Lehigh, 1965.

NICHOLAS ANTHONY LAPARA (1964)

Instructor in Philosophy

B.S., Lehigh, 1959; B.A., 1961; M.A., University of Pittsburgh, 1962.

ARTHUR IRVING LARKY (1954, 1964)

Professor of Electrical Engineering

B.S., Lehigh, 1952; M.S., Princeton, 1953; Ph.D., Stanford, 1957.

NANCY LARRICK (1964, 1967)

Adjunct Professor of Education

B.A. Goucher College, 1930; M.A., Columbia University, 1937; Ed.D., New York University, 1955.

VORIS V. LATSHAW (1931, 1947)

Associate Professor of Mathematics

B.A., Indiana, 1927; A.M., 1928; Ph.D., 1930.

BRUCE ALAN LAUB (1965)

Laboratory Accountant of Fritz Engineering Laboratory

B.S., Lehigh, 1961.

WILLIAM BADER LECKONBY (1946, 1962)

Professor of Physical Education, Director of the Division of Athletics and Physical Education

B.S., St. Lawrence, 1939.

LAWRENCE H. LEDER (1968)¹

Professor of History, Chairman of the Department of History

B.A., Long Island University, 1949; M.A., New York University, 1950; Ph.D., 1960

¹Effective July 1, 1968

JAMES CHARLES LEE (1966)

Assistant in Aerospace Studies

Staff Sergeant, U.S. Air Force

GERALD GRANT LEEMAN (1950)

Assistant Professor of Physical Education, Varsity Wrestling Coach, Freshman Soccer Coach

B.A., State College of Iowa, 1948.

DANIEL LEENOV (1963)

Associate Professor of Electrical Engineering

B.S. in Chem., George Washington University, 1943; M.S. in Phys., University of Chicago, 1948; Ph.D., 1951.

JOHN DOUGLAS LEITH (1945, 1964, 1966)

Dean Emeritus of Students, Assistant to Vice President Administration

A.B., North Dakota, 1920; A.M., Columbia, 1924.

WILLIAM C. LENNOX (1963)

Visiting Assistant Professor of Mechanics

B.A.Sc., University of Waterloo, 1962; M.Sc., 1963; Ph.D., Lehigh, 1966.

EDWARD K. LEVY (1967)

Assistant Professor of Civil Engineering and Mechanics

B.S., Massachusetts Institute of Technology, 1953; S.M., 1964; Sc.D., 1967.

ROBERT LEWIS LEIGHT (1963, 1966)

Visiting Lecturer in Education

B.S., Kutztown State College, 1959; M.A., Lehigh, 1961; M.Ed., 1964; Ed.D., 1966.

RICHARD C. LEWIS (1966)

Assistant Professor of Business Law

A.B., Dartmouth College, 1962; LL.B., University of Miami Law School, 1965; LL.M., New York University Law School, 1966.

WILLARD DEMING LEWIS (1964)

President

A.B., Harvard, 1935; B.A., Oxford (England), 1938; Ph.D., Harvard, 1941; M.A., Oxford, 1945; LL.D., Lafayette, 1965; L.H.D., Moravian, 1966.

JOSEPH FRANCIS LIBSCH (1946, 1960)

Alcoa Foundation Professor and Chairman of the Department of Metallurgy and Materials Science, Director of the Materials Research Center

B.S., M.S., Massachusetts Institute of Technology, 1940; Sc.D., 1941. P.E., Pennsylvania, 1947.

JOHN ORTH LIEBIG, JR. (1946, 1955)

Associate Professor of Civil Engineering

B.S., Lehigh, 1940; M.S., 1949. P.E., Pennsylvania, 1951.

JOHN RALPH LINDGREN (1965)

Assistant Professor of Philosophy

B.S., Northwestern University, 1959; M.A., Marquette University, 1961; Ph.D., 1963.

*JUSTIN THOMAS LLOYD (1964)

Assistant Professor of Mathematics

B.S., University of Arkansas, 1959; M.S., Tulane, 1962; Ph.D., 1964.

*Resigned, July, 1967.

*RALPH H. LONG, JR. (1963)

Professor and Chairman of the Department of Mechanical Engineering

B.S., Tufts College, 1943; M.Eng., Yale, 1948; D.Eng., 1952. P.E., Maryland, 1954.

*Resigned, August, 1967

*NARENDRA PAUL LOOMBA (1962, 1963)

Professor of Management and Chairman, Department of Management Science

B.Sc., University of Punjab, 1947; B.S. in E.E., B.S. in M.E., University of Nebraska, 1952; M.S. in E.E., Massachusetts Institute of Technology, 1954; Ph.D., Wisconsin, 1959.

*Resigned, July, 1967.

*LEONARD A. LOPEZ (1966)

Assistant Professor in Civil Engineering

B.S., Tufts University, 1962; M.S., University of Illinois, 1963; Ph.D., 1966.

*Resigned, July, 1967.

ROLAND WILLIAM LOVEJOY (1962)

Associate Professor of Chemistry

B.A., Reed College, 1955; Ph.D., Washington State University, 1960.

LE-WU LU (1957, 1966)

Associate Professor of Civil Engineering

B.S., National Taiwan, 1954; M.S., Iowa State, 1956; Ph.D., Lehigh, 1960.

ROBERT ALAN LUCAS (1958, 1964)

Assistant Professor of Mechanical Engineering

B.S. in M.E., Lehigh, 1957; M.S., 1959.

FENG-SHYANG LUH (1965)

Assistant Professor of Accounting

B.A., National Taiwan University, 1957; M.S., University of Illinois, 1961; Ph.D., Ohio State University, 1965.

WILLIAM L. LUYBEN (1967)

Associate Professor of Chemical Engineering

B.S., Penn State, 1955; M.B.A., Rutgers, 1958; M.S., 1962; Ph.D., University of Delaware, 1963.

JAMES MICHAEL LYLE (1967)

Assistant Professor of Military Science

B.A., College of William and Mary, 1962. Captain, U.S. Army.

RICHARD FRANKLIN LYNCH (1967)

Instructor in Metallurgy and Materials Science

B.S., Lehigh, 1965; M.S., 1967.

JAMES DECKER MACK (1946, 1950)

Librarian

B.A., Lehigh, 1938; M.A., 1949.

MIGUEL ANGEL MACIAS, JR. (1965)

Instructor in Civil Engineering

B.S., Instituto Technologico y de Estudios Superiores de Monterrey, 1957; M.S., Lehigh, 1961.

RONALD BENNETT MADISON (1964)

Instructor in Civil Engineering

B.S., Lehigh, 1954; M.S., University of Washington, 1956.

MARY ISABELLE MALONE (1966)

Secretary to the President

B.A., Rosary College, 1945.

RICHARD GRIFFITH MALSBERGER (1959, 1966)

Professor of Biology

B.A., Lehigh, 1948; M.S., 1949; Ph.D., 1958.

ARTHUR HOWARD MANN (1965)

Assistant Dean of Students

B.A., Wesleyan University, 1940; S.T.B., General Theological Seminary, 1944.

JOHN ALEXANDER MANSON (1966)

Associate Professor of Chemistry, and Director of the Polymer Laboratory, Materials Research Center

B.Sc., McMaster University (Ontario), 1949; M.Sc., 1950; Ph.D., 1956.

GEORGE D. MARSH, JR. (1965)

Assistant Professor of Psychology

B.A., Los Angeles State College, 1957; M.A., 1960; Ph.D., University of California (Berkeley), 1965.

WALTER FREDERICK MARSHALL (1967)

Instructor in Romance Languages

B.A., St. John's University, 1961; M.A., Pennsylvania State, 1963.

JAMESON NEIL MARVIN (1967)

Instructor in Music

B.A., University of California (Santa Barbara), 1964; M.A., Stanford University, 1965.

Faculty and Staff

*PAUL MARX (1963, 1966)
Assistant Professor of English
A.B., Michigan, 1953; M.F.A., Iowa, 1957.
*Resigned, July, 1967.

HAROLD DEAN MATHENEY (1966)
Associate Professor in Military Science
B.S., University of Dayton, 1950. Lt. Colonel, U.S. Army.

JAMES PATRICK MATHEWS (1947)
Physiotherapist, University Health Service

JOSEPH ABELE MAURER (1947, 1964)
Professor and Chairman of the Department of Classical Languages
B.A., Moravian, 1932; M.A., Lehigh, 1936; Ph.D., Pennsylvania, 1948.

GREGORY T. MCALLISTER (1965, 1966)
Associate Professor of Mathematics
B.S., St. Peter's College, 1956; Ph.D., University of California, 1962.

GEORGE E. MCCUSKEY (1965)
Assistant Professor of Astronomy
A.B., University of Pennsylvania, 1960; M.S., 1965; Ph.D., 1965.

†JAMES PATRICK MCCONLOGUE (1967)
Instructor in Physical Education, Assistant Varsity Football Coach
B.A., Moravian College, 1947.
†Deceased, October 28, 1967.

ETHEL MAY MCCORMICK (1964, 1966)
Assistant Professor of Education
B.S., Northwestern University, 1931; M.Ed., Penn State University, 1941; D.Sc.Ed., Cedar Crest College, 1963.

GEORGE WALTER MCCOY, JR. (1956)
Director, University Health Service
B.S., Pennsylvania, 1929; M.D., 1932.

LESLIE GUY MCCRACKEN, JR. (1956)
Associate Professor of Electrical Engineering
B.S. in E.E., Massachusetts Institute of Technology, 1945; M.S. in E.E., Lehigh, 1947; Ph.D., in E.E., Pennsylvania State, 1952. P.E., Pennsylvania, 1958.

JOSEPH BRENDAN MCFADDEN (1948, 1961)
Professor of Journalism, Chairman of the Division of Journalism
B.A., St. Joseph's (Canada), 1941; M.A., Syracuse, 1948.

JAMES WILLARD MCGEADY (1950, 1959)
Associate Director of Admission
B.A., Lehigh, 1950.

JAMES RATHBURN MCINTOSH (1966)
Instructor in Sociology
B.A., Colby College; M.A., New School for Social Research, 1963.

JAMES ALAN MCLENNAN, JR. (1948, 1962)
Professor of Physics
A.B., Harvard, 1948; M.S., Lehigh, 1950; Ph.D., 1952.

DONALD F. MCLEROY (1966)
Assistant Professor of Geology
B.S., University of New Mexico, 1960; M.S., 1962; Ph.D., Stanford, 1966.

NORMAN PAUL MELCHERT (1962, 1967)
Associate Professor of Philosophy
B.A., Wartburg College, 1955; B.D., Lutheran Theological Seminary, 1958; M.A., Pennsylvania, 1959; Ph.D., 1964.

JOSEPH ROBERT MERKEL (1962, 1965)
Professor of Biochemistry
B.S., Moravian, 1948; M.S., Purdue, 1950; Ph.D., University of Maryland, 1952.

FORTUNATO JOSEPH MICALE (1962, 1966)
Professor of Chemistry
B.A., St. Bonaventure, 1956; B.S., Niagara University, 1959; M.S., Purdue, 1961; Ph.D., Lehigh, 1965.

JOHN ANTHONY MIERZWA (1966)
Associate Professor of Education and Director, Division of Counselor Education
B.S., Ohio University, 1954; M.A., 1955; Ed.M., Harvard, 1958; Ed.D., 1961.

LARRY M. MILEY (1967)
Assistant Accountant
B.S., Penn State, 1964.

LEWIS JAMES MILLER (1967)
Associate Professor of Military Science
B.S., Penn State, 1960. Major, U.S. Army.

PAUL VAN REED MILLER (1966)
Assistant Professor of Education
B.A., Yale, 1946; M.A., University of Pennsylvania, 1948; Ph.D., 1965.

•THEODORE MILLON (1954, 1959)
Associate Professor of Psychology
B.S., City University of New York, 1949; M.A., 1950; Ph.D., Connecticut, 1953.
•On leave, 1967-68

ROBERT HUGH MILLS (1964)
Associate Professor and Chairman of the Department of Accounting
B.S., Colorado, 1949; M.S., 1955; Ph.D., Wisconsin, 1960. C.P.A. (Illinois), 1957.

ARCHIE ROSCOE MILLER (1922, 1961)
Professor Emeritus of Electrical Engineering
B.S. in E.E., Illinois, 1918; M.S., Lehigh, 1925.

PAUL THEODORE MILLER (1961)
Assistant Superintendent of Buildings and Grounds

SAMUEL HAROLD MISSIMER (1950, 1962)
Director of Admission
B.A., Lehigh, 1950.

ALBERT CHARLES MOLTER (1960)
Purchasing Agent
B.S., Norwich, 1928.

SUTTON MONRO (1959, 1964)
Professor of Industrial Engineering
B.S., Massachusetts Institute of Technology, 1942.

ROBERT PATTISON MORE (1916, 1956)
Dean Emeritus of the College of Arts and Science
B.A., Lehigh, 1910; M.A., Harvard, 1913.

CARL LELAND MOORE (1948, 1963)
Professor of Accounting
 A.B., Bucknell, 1943; M.A., Pittsburgh, 1948. C.P.A., Pennsylvania, 1952.

CHARLES M. MORRIS (1967)
Visiting Associate Professor of Psychology
 A.B., Bucknell, 1931; M.Ed., 1932; Ph.D., New York University, 1938.

MICHAEL P. MORTELL (1967)
Assistant Professor of Mechanics
 B.Sc., University College (Cork, Ireland), 1961; M.Sc., 1963; M.S., California Institute of Technology, 1964; Ph.D., 1967.

JOHN WAYNE MURPHY (1962, 1964)
Director of Publications, and Managing Editor, Lehigh Alumni Bulletin
 B.S., Marshall University, 1959; M.A., State University of Iowa, 1962.

PAUL BENTON MYERS, JR. (1962, 1965)
Associate Professor of Geology
 A.B., Colgate, 1955; M.S., Lehigh, 1957; Ph.D., 1960.

JAMES E. NANCARROW (1964, 1966)
Visiting Lecturer in Education
 B.S., Bucknell, 1916; M.A., 1924; M.A., Columbia, 1929; D.Ed., Pittsburgh, 1940.

PABLO H. R. NASHI (1967)
Instructor of Electrical Engineering
 B.Sc., University of Manchester (England), 1958; M.Sc., University of Surrey (London, England), 1966.

HARVEY ALEXANDER NEVILLE (1927, 1964)
President Emeritus
 A.B., Randolph-Macon, 1918; M.A., Princeton, 1920; Ph.D., 1921; LL.D. (Hon.), Randolph-Macon, 1952; L.H.D. (Hon.), Moravian, 1962; LL.D. (Hon.), Lafayette, 1962.

BENJAMIN EDWARD NEVIS (1960, 1965)
Assistant Professor of Mechanical Engineering
 B.S., Lehigh, 1955; M.S., 1960; Ph.D., 1965.

SAMUEL GILBERT NORD (1964)
Assistant Professor in Psychology, Director of the Bio-electric Laboratory
 B.A., University of Delaware, 1956; M.A., 1958; Ph.D., Brown, 1963.

ROBERT WARREN NUMBERS (1960)
Superintendent of Buildings and Grounds
 B.S. in C.E., Lehigh, 1950.

JOHN DONALD OAKLEY (1967)
Instructor in Metallurgy and Materials Science
 B.S., Lehigh, 1965; M.S., 1967.

COLIN O'CONNOR (1967)
Postdoctoral Research Associate in Civil Engineering
 B.E., University of Queensland, 1949; Ph.D., 1961.

JOHN J. O'CONNOR (1967)
Research Associate Professor of Philosophy
 B.A., Columbia, 1945; M.A., Cornell, 1947; Ph.D., Columbia, 1952.

WILLIAM EDWARD OHNESORGE (1965)
Associate Professor of Chemistry
 Sc.B., Brown University, 1953; Ph.D., Massachusetts Institute of Technology, 1956.

JOHN FRANCIS O'LOUGHLIN, JR. (1967)
Teaching Assistant in Social Relations
 B.A., Villanova University, 1966.

JAMES HAROLD OLSEN (1966, 1967)
Associate Librarian
 B.A., George Washington University, 1962; M.L.S., University of Maryland, 1966.

JOHN ONDRIA (1967)
Assistant Professor of Electrical Engineering
 B.S., Lehigh, 1960; M.S., 1963; Ph.D., 1967.

KENNETH EVERETT ORBEN (1963)
Assistant Superintendent of Buildings and Grounds
 B.S. in E.E., Pennsylvania State, 1947.

THOMAS RUSSELL ORTOLANO (1965)
Assistant Professor of Chemistry
 B.S., Loyola University of the South, 1960; Ph.D., Louisiana State University, 1964.

JOSEPH C. OSBORN (1946, 1961)
Associate Professor of Mechanics
 B.S.M.E., Purdue, 1933; M.S., Michigan, 1946. P.E., Michigan, 1955.

ALEXIS OSTAPENKO (1957, 1965)
Professor of Civil Engineering
 Dipl. Ing., Munich Institute of Technology (Germany), 1951; Sc.D. in C.E., Massachusetts Institute of Technology, 1957.

WILLIAM WALLACE OSWALT, JR. (1956)
Part-time Lecturer in Education
 A.B., Muhlenberg, 1949; Ed.M., Temple, 1950; Ed.D., 1962.

ERIC VAN TINE OTTERVIK (1966)
Assistant to the Vice President—Research, and Assistant Professor of English
 B.S., Carnegie Institute of Technology, 1959; M.A., University of Pittsburgh, 1961; Ph.D., 1966.

ALBERT DEAN OTTO (1965)
Assistant Professor of Mathematics
 B.A., University of Iowa, 1961; M.S., 1962; Ph.D., 1965.

HARRY MARTIN OVERLINE (1967)
Instructor of Education
 Ed.B., Temple University, 1963; M.Ed., 1965.

JERZY ANTONI OWCZAREK (1960, 1965)
Professor of Mechanical Engineering
 Dipl. Ing., Polish University College, London, 1950; Ph.D., University of London, 1954.

BRADFORD BRECKENRIDGE OWEN (1945, 1948)
Associate Professor of Biology
 B.A., Williams, 1934; M.A., 1936; Ph.D., Harvard, 1940.

TEKIN OZBEK (1967)
Research Associate in Mechanics
 M.S., University of Istanbul, 1951; Ph.D., 1966.

Faculty and Staff

ANTHONY PACKER (1946, 1950)

Assistant Professor of Physical Education, and Assistant to the Director in charge of Fields
B.S., St. Lawrence, 1938.

CHESTER ANTHONY PAGE, JR. (1966)

Assistant Executive Secretary Field Service, Alumni Association
B.S., Lehigh, 1956.

ROBERT ROUPEAN PANOS (1964)

Supervisor of Counseling and Testing
B.A., Queens College, 1956; M.S., Penn State, 1958.

PAUL C. PARIS (1955, 1965)

Professor of Mechanics
B.S. in Eng. Mech., Michigan, 1953; M.S., Lehigh, 1955; Ph.D., 1962.

BASIL WALDO PARKER (1940, 1954)

Professor of Biology
S.B., Massachusetts Institute of Technology, 1933; A.M., Harvard, 1935; Ph.D., Massachusetts Institute of Technology, 1939.

JAMES MARSHALL PARKS (1967)

Associate Professor of Geology and Director of Marine Science Center
A.B., University of Kansas, 1948; M.S., University of Wisconsin, 1949; Ph.D., 1951.

PRESTON PARR (1949, 1964)

Dean of Student Life
B.S., Lehigh, 1943; M.S., 1944.

RUTH B. PARR (1967)

Part-time Librarian Education
B.S., Simmons College, 1945.

*CHARLES EDWIN PATTERSON, JR. (1962, 1963)

Assistant Professor of Government
A.B., Emory, 1957; M.A., 1958; Ph.D., University of Illinois, 1962.

*Resigned, July, 1967.

FRANK WATERS PAUL (1964)

Instructor in Mechanical Engineering
B.S., Penn State, 1960; M.S., 1964.

ALAN WIGGINS PENSE (1957, 1966)

Associate Professor of Metallurgy and Materials Science
B.S., Cornell, 1957; M.S., Lehigh, 1959; Ph.D., 1962.

*ARMAND BENJAMIN PERLMAN

Assistant Professor of Mechanics
B.S., Lehigh, 1961; M.S., Stanford, 1962; Ph.D., Lehigh, 1965.

*Resigned, July, 1967.

JOHN T. PETRAKIS (1966)

Instructor in Finance
B.A., American University, 1953; M.A., 1958.

JOSEPH PETRONIO (1967)

Systems Analyst
B.S., King's College, 1960.

*RICHARD LITTLE PETTENGILL (1965)

Cataloger of Social Science Materials
B.A., Bowdoin College, 1964; M.S., Columbia, 1965.

*Resigned, July, 1968.

HOWARD CHARLES PIEPER (1967)

Associate Director, Health Center
B.S., State University of Iowa, 1926; M.D., 1932.

WARREN AIKEN PILLSBURY (1962, 1965)

Associate Professor of Economics
A.B., New Hampshire, 1953; Florida State University, 1958; Ph.D., University of Virginia, 1963.

ARTHUR EVERETT PITCHER (1938, 1960)

Distinguished Professor of Mathematics, Chairman of the Department of Mathematics and Astronomy
A.B., Western Reserve, 1932; A.M., Harvard, 1933; Ph.D., 1935; D.Sc. (Hon.), Western Reserve, 1957.

*DAVID H. PITTARD (1965)

Assistant Professor of Aerospace Studies
B.S., North Carolina State University, 1957. Captain, U.S. Air Force.

*Resigned, March 8, 1968.

ARTHUR J. PLANTE (1967)

Instructor in Military Science
Staff Sergeant, U.S. Army.

LUCILLE H. PLEISS (1961)

Nurse, University Health Service
R.N., St. Luke's Hospital School of Nursing, 1949.

JOHN POCZE (1960, 1968)

Instructor in Physical Education and Varsity Fencing Coach

GARY WAYNE POEHLIN (1965)

Assistant Professor of Chemical Engineering
B.S., Purdue University, 1958; Ph.D., 1966.

HAYDEN NELSON PRITCHARD (1964)

Assistant Professor of Biology
A.B., Princeton, 1955; M.S., Lehigh, 1960; Ph.D., 1963.

DAVID ALEXANDER PROVEN (1967)

Instructor in Education
B.S., West Chester State College, 1951; M.A., Lehigh, 1967.

LUIS PUJOL (1964)

Instructor in Mechanical Engineering
B.M.E., Villanova University, 1962; M.S., Marquette University, 1964.

WILLIAM LEROY QUAY (1963)

Assistant Dean of Student Life
A.B., Muhlenberg, 1965; University of Pennsylvania, 1957.

FRANCIS JOSEPH QUIRK (1950, 1953)

Professor and Chairman of the Department of Fine Arts; Curator Permanent Collection; Director of Exhibitions
Dipl. Rhode Island School of Design, 1929.

SHELDEN HENRY RADIN (1963)

Assistant Professor of Physics
B.S., Worcester Polytechnic Institute, 1958; M.S., Yale, 1959; Ph.D., 1963.

BEEGAMUDRE RAKOSH-DAS (1967)

Instructor in Electrical Engineering
B.Sc., Engineering, Banaras, 1949; A.I.I.Sc., Bangalore, 1952.

LINDA K. RAMBLER (1966)
Cataloger in Humanities
 B.S., Millersville State College, 1961; M.S.L.S., Western Reserve University, 1964.

HARRY B. RAMSEY (1963)
Assistant Executive Secretary, Alumni Association
 B.A., Lehigh, 1950.

ROBERT JOHN RAVERA (1964)
Assistant Professor of Mechanics
 B.S., Pratt, 1960; M.S., Lehigh, 1962.

HENRY WILLIAM RAY (1966)
Visiting Lecturer in Education
 B.S., Kent State University, 1947; M.A., Columbia, 1951; Ed.D., 1955.

GERHARD RAYNA (1955, 1965)
Assistant Professor of Mathematics
 A.B., Harvard, 1952; M.A., Princeton, 1953; Ph.D., 1965.

GEORGE EMIL RAYNOR (1931, 1964)
Professor Emeritus of Mathematics
 B.S., Washington, 1918; M.A., Princeton, 1920; Ph.D., 1923.

GEORGIA EMILY RAYNOR (1961, 1964)
Head Cataloger
 A.B., Chatham, 1945; M.A., Lehigh, 1954; M.S. in L.S., Columbia, 1954.

RICHARD JAMES REDD (1958, 1964)
Associate Professor of Fine Arts
 B.Ed., Toledo, 1953; M.F.A., Iowa, 1958.

ESTOY REDDIN (1964, 1967)
Associate Professor of Education
 B.S., University of Pennsylvania, 1932; M.S., 1956; Ed.D., 1964.

ROBERT R. REEDER (1967)
Visiting Instructor in Cultural Anthropology
 B.A., Pennsylvania State, 1958; M.S., 1960; M.A., University of Colorado, 1967.

EDWARD FRANKLIN REIS
Part-time Lecturer in Electrical Engineering
 B.S., Lafayette College, 1956; M.S., Lehigh, 1958.

JOSEPH H. RENO (1947, 1961)
Part-time Physician, University Health Service
 M.D., Temple, 1941.

FREDERICK EUGENE RESSLER (1952, 1964)
Associate Registrar
 B.A., Lehigh, 1952.

RODNEY EARL RESSLER (1947, 1964)
Assistant Registrar

JOSEPH BENSON REYNOLDS (1907, 1948)
Professor Emeritus of Mathematics and Theoretical Mechanics
 B.A., Lehigh, 1907; M.A., 1910; Ph.D., Moravian, 1919.

RICHARD C. RICHARDSON (1967)
Adjunct Professor of Education
 B.S., Castleton State College, 1954; M.A., Michigan State University, 1958; Ph.D., University of Texas, 1963.

ROBERT O. RICHARDSON (1967)
Instructor in English
 B.A., Hamilton College, 1961; M.A., Cornell University, 1962.

WALLACE JAMES RICHARDSON (1952, 1959)
Professor of Industrial Engineering
 B.S., U.S. Naval Academy, 1941; M.S. in I.E., Purdue, 1948. P.E., Delaware, 1956.

PETER JULES RICCHETTA (1965, 1966)
Assistant Professor of Mathematics
 B.S., Yale, 1957; Ph.D., 1966.

MARTIN L. RICHTER (1965)
Assistant Professor of Psychology
 B.A., Rutgers, 1960; Ph.D., University of Indiana, 1965.

MARY GRUBER RILEY (1953, 1965)
Assistant Reference Librarian
 B.A., Pennsylvania State, 1952; M.S. in L.S., Drexel Institute of Technology, 1953.

EDGAR HEISLER RILEY (1926, 1958)
Associate Professor Emeritus of English
 A.B., Cornell, 1915; Ph.D., 1925.

ALICE DUFFY RINEHART (1964)
Instructor in Education and Coordinator of Educational Placement
 B.A., Smith, 1947; M.A., Lehigh, 1965.

RONALD SAMUEL RIVLIN (1967)
Professor of Mathematics and Mechanics; Director, Center for Application of Mathematics
 B.A., Cambridge (England), 1937; M.A., 1939; Sc.D., 1952.

KAROL LYNN ROBERTS (1968)
Part-time Instructor in Fine Arts
 B.S., Moore College of Art, 1965; M.F.A., Pratt Institute, 1967.

RICHARD ROBERTS (1964)
Assistant Professor of Mechanical Engineering
 B.S., Drexel, 1961; M.S., Lehigh, 1962; Ph.D., 1964.

JOEL C. W. ROGERS (1966, 1968)
Assistant Professor of Mathematics
 B.S., Massachusetts Institute of Technology, 1958.

ALBERTO ROMERO (1967)
Instructor in Romance Languages
 Bach., University of St. Thomas (Bogota), 1953; Licentiatus, University of St. Thomas (Rome), 1961.

EDWARD ROSENBAUM (1966)
Associate Professor of Economics
 B.A., Wayne State University, 1950; M.S., University of Wisconsin, 1951; Ph.D., 1954.

JOHN EDWARD ROTH
Part-time Lecturer in Electrical Engineering
 B.S., Bucknell, 1952; M.S., Lehigh, 1963.

HERBERT RUBENSTEIN (1967)
Professor of Philosophy
 B.A., University of Pennsylvania, 1942; M.A., 1943; Ph.D., Columbia, 1949.

Faculty and Staff

WILLIAM HENRY RUCKLE (1963)

Assistant Professor of Mathematics

A.B., Lincoln University, 1960; M.S., Florida State University, 1962; Ph.D., 1963.

ROBERT BENJAMIN RUNK (1966)

Assistant Professor of Metallurgy and Materials Science

B.S., Rutgers University, 1961; Ph.D., Alfred University, 1966.

JOHN DONALD RYAN (1952, 1962)

Professor of Geology, Chairman of the Department of Geological Sciences

B.A., Lehigh, 1943; M.S., 1948; Ph.D., Johns Hopkins, 1952.

PERCY LEE SADLER (1946, 1962)

Professor Emeritus in Physical Education

Brig. Gen., Inf., U.S.A. (Ret.)

JAMES S. SAEGER (1967)

Instructor of History

B.A., Ohio State University, 1960; M.A., 1963.

ERIC PAUL SALATHE (1967)

Assistant Professor of Mechanics

Sc.B., Brown, 1960; M.S., Princeton, 1962; Ph.D., Brown, 1965.

NORMAN HAROLD SAM (1962, 1964)

Associate Professor of Education, Director of Summer Sessions

B.S., Pittsburgh, 1951; M.Ed., 1955; Ed.D., 1962.

SAMPSON LEE SANDERS (1965)

Instructor in Physical Education, Assistant Varsity Football Coach and Head Varsity Track Coach

B.Ed., University of Buffalo, 1960.

RAYMOND BURKETT SAWYER (1946, 1964)

Associate Professor Emeritus of Physics

Ph.B., Ripon, 1921; M.S., Wisconsin, 1925; Ph.D., Chicago, 1930.

WILLIAM DWIGHT SCHAEFFER (1956, 1966)

Associate Director, Center for Surface and Coatings Research

B.S., Lehigh, 1943; M.S., 1947; Ph.D., 1967.

STEPHEN ALAN SCHAFER (1966)

Part-time Lecturer in Education

B.A., University of Delaware, 1949; M.H.L., Hebrew Union College, 1955.

JONATHAN BURKE SEVERS (1927, 1951)

Distinguished Professor of English, Chairman of the Department of English

A.B., Rutgers, 1925; A.M., Princeton, 1927; Ph.D., Yale, 1935; F.R.S.A., 1962.

MARGARET MELCHIOR SEYLAR (1966)

Part-time Lecturer in Education

B.S., Kutztown State College, 1945; M.A., Lehigh, 1956,

MURRAY SCHECHTER (1963, 1964)

Assistant Professor of Mathematics

A.B., Brooklyn College, 1957; M.A., New York University, 1959; Ph.D., 1964.

WILLIAM EDWARD SCHIESSER (1960, 1963)

Professor of Chemical Engineering

B.S., Lehigh, 1955; M.A., Princeton, 1958; Ph.D., 1960.

DONALD WALTER SCHMOYER (1946, 1962)

Assistant Treasurer

B.S. in Bus. Adm., Lehigh, 1944.

THOMAS JOSEPH MORTON SCHOPF (1967)

Assistant Professor of Geology

A.B., Oberlin College, 1960; Ph.D., Ohio State University, 1964.

STANLEY ROBERT SCHULTZ (1966)

Instructor in Physical Education, Varsity Baseball Coach

B.A., Trenton State College, 1964.

ERNEST BERNHARD SCHULZ (1927, 1965)

Professor Emeritus of Political Science

B.S., Michigan, 1920; M.A., 1921; Ph.D., 1927.

ELI SCHWARTZ (1954, 1962)

Professor of Economics

B.S., Denver, 1943; M.A., Connecticut, 1948; Ph.D., Brown, 1952.

JAMES WALTER SCIBLE III (1967)

Instructor in Physical Education, Varsity Lacrosse Coach and Freshman Football Coach

B.S., Shepherd (W. Va.) College, 1963.

CHARLES AUGUSTUS SEIDLE (1948, 1962)

Vice-President—Administration

B.A., Pittsburgh, 1931; M.A., Columbia, 1936; Ed.D., 1948.

EDITH AMANDA SEIFERT (1923, 1960)

Bursar

WILLIAM GERALD SHADE (1966, 1967)

Assistant Professor of History

A.B., Brown, 1961; M.A., 1962; Ph.D., Wayne State, 1966.

RUSSELL ALLEN SHAFFER (1964, 1967)

Associate Professor of Physics

B.S., Drexel Institute of Technology, 1956; Ph.D., Johns Hopkins, 1962.

CHING SHENG SHEN (1964)

Assistant Professor of Economics

B.A., Yen-Ching University, 1941; M.A., Boston University, 1951; Ph.D., University of North Carolina, 1957.

SHUANG YUAN SHIEH (1965)

Assistant Professor of Physics

B.S., National Taiwan University, 1957; Ph.D., University of Maryland, 1965.

*ROGER LONIS SHERMAN (1965)

Instructor in Physical Education, Assistant Varsity Football Coach and Varsity Lacrosse Coach

B.A., Muskingham College, 1961.

*Resigned, July, 1967.

†PAUL EDWARD SHORT (1938, 1946)

Assistant Professor of Physical Education, Assistant Director and Business Manager of Athletics

B.S. in Bus. Adm., Lehigh, 1934.

†Deceased, November 17, 1967.

ROBERT PETER SHURTLEFF (1963, 1964)
Assistant Dean of Residence
 B.A., Lehigh, 1955; M.Ed., 1964.

WILLIAM JOSEPH SIBLEY (1964)
Counselor in Placement and Counseling
 B.S. in Ed., East Stroudsburg State College, 1955; M.Ed., Lehigh, 1964.

GEORGE C. M. SIH (1958, 1965)
Professor of Mechanics
 B.S. in M.E., Portland, 1953; M.S. in M.E., New York, 1957; Ph.D., Lehigh, 1960.

DALE RODEKOHР SIMPSON (1960, 1966)
Professor of Geology, Chairman of the Comprehensive Honors Program
 B.S., Pennsylvania State, 1956; M.S., California Institute of Technology, 1958; Ph.D., 1960.

JAMES WILLIAM SIMPSON (1967)
Instructor in Metallurgy and Materials Science
 B.S., Lehigh, 1967.

HERBERT BANCROFT SKERRY (1967)
Assistant Professor of Mathematics
 A.B., Harvard, 1954; M.S., University of Wisconsin, 1958; Ph.D., Michigan State, 1967.

ROGER GEORGE SLUTTER (1961, 1966)
Assistant Professor of Civil Engineering; Engineer of Tests, Fritz Engineering Laboratory
 B.S. in C.E., Lehigh, 1953; M.S. in C.E., 1956.

EARL KENNETH SMILEY (1934, 1964)
Vice-President Emeritus
 A.B., Bowdoin, 1921; M.A., Lehigh, 1935; L.H.D. (Hon.), Moravian, 1947; LL.D. (Hon.), Waynesburg, 1952.

*GEORGE LEONARD SMITH, JR. (1959)
Instructor in Industrial Engineering
 B.S., Pennsylvania State, 1957; M.S., Lehigh, 1959; P.E., Pennsylvania, 1964.
 *Resigned, July 1, 1967

GERALD F. SMITH (1965)
Professor of Mechanics
 B.S., University of Buffalo, 1952; Ph.D., Brown, 1956.

JOHN EDWIN SMITH (1967)
Director of Computing Laboratory
 B.A., Wesleyan, 1950; M.A., 1952; B.S., Canisius, 1958.

MARGARET M. SMITH (1968)
Science Cataloger
 A.B., Oberlin, 1940; M.L.S., Drexel Institute of Technology, 1966.

WESLEY RICHARD SMITH (1958, 1962)
Associate Professor of Physics
 B.S. in E.P., Lehigh, 1950; M.S., 1951; Ph.D., Princeton, 1957.

WILLIAM ADAMS SMITH, JR. (1955, 1962)
Associate Professor of Industrial Engineering
 B.S., U.S. Naval Academy, 1951; M.S., Lehigh, 1957; Ph.D., New York University, 1966. P.E., Pennsylvania, 1959.

OLE M. SMOLANSKY (1963, 1966)
Associate Professor of International Relations
 A.B., New York University, 1953; A.M., Columbia, 1955; Ph.D., 1959.

JUDSON GRAY SMULL (1919, 1950)
Associate Professor Emeritus of Chemistry
 B.S. in Chem., Lehigh, 1906; M.S., 1921.

MAX DONALD SNIDER (1946, 1967)
Associate Professor of Marketing, Assistant Dean of the College of Business and Economics
 B.S., Illinois, 1936; M.S., 1937; M.B.A., Stanford, 1941.

ANDREW KAGEY SNYDER (1967)
Assistant Professor of Mathematics
 B.A., Swarthmore, 1959; M.A., University of Colorado, 1961; Ph.D., Lehigh, 1965.

WILLIAM J. SNYDER (1967)
Postdoctoral Fellow in Chemical Engineering
 B.S., Penn State, 1963; M.S., 1965; Ph.D., 1967.

MICHAEL PETER SOLTYS (1965)
Assistant Director of Placement
 B.S., East Stroudsburg State College, 1955; M.A., Lehigh, 1959.

ERWIN ALFRED SOMMER (1967)
Research Associate in Mechanics
 Dipl. Phys., University of Gottingen (Germany), 1962; Dr. Rer. Nat., University of Freiburg (Germany), 1966.

RICHARD N. SOPKO (1961)
Photographer—Draftsman in Civil Engineering

WILBER DEVILLA BERNHART SPATZ (1946, 1954)
Associate Professor of Physics
 B.S., Lafayette, 1930; M.S., Purdue, 1934; Ph.D., New York, 1943.

LESLIE H. SPERLING (1967)
Assistant Professor in Chemical Engineering
 B.S., University of Florida, 1954; M.A., Duke University, 1957; Ph.D., 1959.

FRANCIS X. SPLANE (1966)
Instructor in Economics
 B.A., University of Delaware, 1963; M.A., 1966.

ROBERT STEACY SPRAGUE (1957, 1966)
Professor of Chemistry
 B.S., Washington and Jefferson, 1943; Ph.D., Illinois, 1949.

RICHARD MOORE SPRIGGS (1964, 1967)
Professor of Metallurgy and Materials Science; Associate Director, Materials Research Center
 B.S., Penn State University, 1952; M.S., University of Illinois, 1956; Ph.D., 1958.

WILLIAM BUTLER STAFFORD (1967)
Assistant Professor of Education
 A.B., Ohio University, 1954; M.A., 1955; Ed.D., Indiana University, 1965.

WILLIAM EDWARD STANFORD (1967)
Assistant Director of Admission
 B.A., Drew University, 1962.

Faculty and Staff

JOHN STOHLER STECKBECK (1962)
Assistant Professor of Physical Education, Assistant Director of Physical Education and Intramurals
B.S. in Phys. Ed., West Chester State, 1936; M.S. in Phys. Ed., Pennsylvania, 1951.

FRED P. STEIN (1963, 1966)
Associate Professor of Chemical Engineering
B.S., Lehigh, 1956; M.S.E., University of Michigan, 1957; Ph.D., 1960.

GILBERT ALLAN STENGLE (1960, 1965)
Associate Professor of Mathematics
B.E.P., Cornell, 1954; M.S., Wisconsin, 1957; Ph.D., 1961.

ALAN HUGH STENNING (1965)
Professor and Acting Chairman of Mechanical Engineering
B.Sc., Glasgow University, 1950; M.S., Massachusetts Institute of Technology, 1951; Sc.D., 1955.

GATES BARNET STERN (1965)
Professor of Military Science
B.A., Lehigh, 1936. Colonel, U.S. Army

INDRIKIS STERNS (1967)
Visiting Professor of History
B.A., University of Pennsylvania, 1964; M.A., 1965.

JOHN A. STOOPS (1959, 1966)
Professor and Dean of the School of Education
B.S., California State College, 1948; M.S., University of Pennsylvania, 1949; Ed.D., 1960.

ROBERT DANIEL STOUT (1939, 1960)
Professor of Metallurgy and Materials Science, Dean of the Graduate School
B.S., Pennsylvania State, 1935; M.S., Lehigh, 1941; Ph.D., 1944; D.Sc., Albright, 1967. P.E., Pennsylvania, 1946.

CARL FERDINAND STRAUCH (1934, 1953)
Professor of English
A.B., Muhlenberg, 1930; M.A., Lehigh, 1934; Ph.D., Yale, 1946.

MILTON CALEB STUART (1926, 1952)
Professor Emeritus of Mechanical Engineering
B.S. in M.E., Pennsylvania, 1909; M.E., 1924.

JAMES EDWARD STURM (1956, 1962)
Associate Professor of Chemistry
B.A., St. John's (Minnesota), 1951; Ph.D., Notre Dame, 1957.

BALAKRISHNAN SUBRAMANIAN (1964)
Instructor in Mathematics
B.Sc., Andhra University, 1950; M.Sc., 1958.

ROBERT JOSEPH SULLIVAN (1962)
Associate Professor of Journalism
B.A., Syracuse, 1947; M.A., 1951.

RUTH Y. SUPER (1960)
Assistant to the Dean, Graduate School

ALFRED KRISS SUSSKIND (1968)
Professor of Electrical Engineering, Chairman of the Department of Electrical Engineering¹
B.B.E., B.S., Brooklyn Polytechnic Institute, 1948; S.M., E.E., Massachusetts Institute of Technology, 1950.

*WILLIAM HUMPHREY SUTCLIFFE (1964)
Research Associate Professor of Biology and Director of Marine Science Center
B.A., Emory, 1945; M.A., Duke, 1947; Ph.D., 1950.
*Resigned, July, 1967.

HUGH T. SUTHERLAND (1967)
Instrument Associate in Civil Engineering

ARTHUR SWEETZUR (1967)
Associate Director, Health Center
B.S., Muhlenberg, 1942; M.D., Jefferson Medical College, 1945.

*JOHN FRANCIS SZWED (1965)
Assistant Professor of Cultural Anthropology
B.S., Marietta College, 1958; B.S., Ohio State University, 1959; M.A., 1960; Ph.D., 1965.
*Resigned, July, 1967.

DONALD LEE TALHELM (1960)
Instructor in Electrical Engineering
B.S. in E.E., Lehigh, 1959; M.S. in E.E., 1960.

LAMBERT TALL (1955, 1966)
Associate Professor of Civil Engineering
B.E., Sydney (Australia), 1954; M.S., Lehigh, 1957; Ph.D., 1961.

STEPHEN KENNETH TARBY (1961, 1967)
Associate Professor of Metallurgy and Materials Science
B.S., Carnegie Institute of Technology, 1956; M.S., 1958; Ph.D., 1962.

MERLE W. TATE (1965)
Professor of Education
A.B., Central Wesleyan, 1926; M.A., University of Montana, 1943; Ed.M., Harvard University, 1946; Ed.D., 1947.

RICHARD NORMAN TAUBER (1966)
Assistant Professor of Metallurgy and Materials Science
B. Met. E., New York University, College of Engineering, 1961; M.S., 1964; Ph.D., 1966.

DOUGLAS HENLEY TAYLOR (1964, 1965)
Assistant Professor of Mathematics
B.S., University of Cincinnati, 1959; M.S., University of Illinois, 1961; Ph.D., 1965.

*IVAN JACKSON TAYLOR (1953)
Instruments Associate in Civil Engineering
*Resigned, July, 1967.

*ROBERT SAXTON TAYLOR (1950, 1963)
Associate Professor and Chairman, Division of Information Sciences; Associate Librarian
B.A., Cornell, 1940; M.S. in L.S., Columbia, 1950; M.A., Lehigh, 1954.
*Resigned, July, 1967.

ROBERT SAYRE TAYLOR, JR.
Legal Counsel
B.A., Lehigh, 1925; LL.B., Pennsylvania, 1928.

EVERETT ANDERSON TEAL (1945)
Director of Placement and Counseling
B.S., Ball State Teachers, 1932; M.A., Columbia, 1941.

BLOSSOM WEISS TEPPER (1964)
Assistant Professor in Education
B.A., Brooklyn College, 1942; M.Ed., Lehigh, 1962.

¹Effective May 1, 1968.

THEODORE ALFRED TERRY (1951, 1955)

Assistant Professor of Mechanical Engineering

B.S., Drexel Institute of Technology, 1950; M.S., Lehigh, 1951; Ph.D., 1963; P.E., Pennsylvania, 1957.

RICHARD M. THODEN, JR. (1965)

Assistant Professor of Aerospace Studies

B.S., St. Joseph's College, 1954. Major, U.S. Air Force.

HAROLD PRESCOTT THOMAS (1932, 1962)

Professor Emeritus of Education

B.S., Colgate, 1920; Ed.M., Harvard, 1925; Ed.D., 1932.

JOHN THOMAS HANLEY TIMM (1967)

Instructor in Romance Languages

B.A., Wisconsin State University (Oshkosh), 1963; M.A., Marquette University, 1967.

•CHARLES LEON TIPTON (1964)

Associate Professor of History

B.A., University of Southern California, 1958; M.A., 1961; Ph.D., 1964.

•On leave, 1967-68.

FRANCIS JOHN TREMBLEY (1928, 1949)

Professor of Ecology

B.S., Hobart, 1928; M.S., Lehigh, 1931; Ph.D., Pennsylvania, 1934; D.Sc., Hobart, 1964.

DORIS MAE TRANSUE (1964)

Nurse, University Health Service

R.N., St. Luke's Hospital, 1947.

**JOHN SCHRADER TREMPER (1939, 1955)

Associate Professor Emeritus of German

A.B., Colgate, 1928; M.A., Cornell, 1932; Ph.D., 1938.

**Retired, January, 1968.

†ROCCO JOHN TRESOLINI (1949, 1958)

Professor of Political Science, Chairman of the Department of Government

A.B., Hartwick, 1942; M.A., Syracuse, 1947; Ph.D., 1949.

†Deceased, June 27, 1967.

SEYMOUR TRESTER (1966)

Assistant Professor of Physics

B.S., Brooklyn College, 1957; M.A., Columbia University, 1960; Ph.D., New York University, 1964.

LOUIS REED TRIPP (1964)

Dean of the College of Business and Economics, Frank L. Magee Professor of Business Administration

B.A., Union College, 1934; Ph.D., Yale, 1942.

KENNETH MANGOLD TRUMBORE (1946)

Assistant Manager of the Supply Bureau

B.A., Moravian, 1940.

WENDELL PIGGOTT TRUMBULL (1957, 1958)

Professor of Accounting

B.S., Illinois, 1937; M.A., Michigan, 1941; Ph.D., 1954. C.P.A., Mississippi, 1949.

DAVID TRUTT (1965)

Assistant Professor of Mathematics

B.S., Lafayette, 1959; M.S., Brown, 1962; Ph.D., Purdue University, 1964.

EFFRAIM TURBAN (1966)

Assistant Professor of Management Science

B.S., Technion-Israel Institute of Technology, 1953; M.B.A., University of Berkeley (California), 1962; Ph.D., 1966.

JOHN HARMS UBBEN (1960, 1967)

Associate Professor and Chairman, Department of German

A.B., Central College (Iowa), 1936; M.A., Kentucky, 1937; Ph.D., Chicago, 1942.

S. HERBERT UNTERBERGER (1965)

Adjunct Professor in Economics

B.S., University of Pennsylvania, 1934; M.A., 1935; Ph.D., 1960.

DEAN UPDIKE (1965)

Assistant Professor of Mechanics

B.S., Princeton, 1957; M.S., New York University, 1960; Ph.D., Brown, 1964.

*JOHN M. VALENTIC (1966)

Instructor in Physical Education, Freshman Wrestling Coach

B.E., University of Buffalo, 1963

*Resigned, June 1, 1968.

•VICTOR MANUEL VALENZUELA (1957)

Associate Professor of Romance Languages

B.A., San Francisco State, 1951; M.A., Columbia, 1952; Ph.D., 1965.

•On leave, 1968-69.

**RALPH NEWCOMB VAN ARNAM (1928, 1961)

Associate Professor Emeritus of Mathematics and Astronomy

E.E., Cornell, 1926; M.S., 1927.

**Retired, July, 1968.

JOHN ANDREWS VAN EERDE (1960, 1963)

Professor and Chairman, Department of Romance Languages

A.B., Harvard, 1938; M.A., 1939; Ph.D., Johns Hopkins, 1953.

DAVID ALAN VANHORN (1962, 1967)

Professor and Chairman of Civil Engineering

B.S., Iowa State University, 1951; M.S., 1956; Ph.D., 1959. P.E., Iowa, 1957.

WESLEY JOHNSON VAN SCIVER (1962, 1965)

Professor of Physics

B.S., Massachusetts Institute of Technology, 1940; Ph.D., Stanford, 1954.

ERIC VARLEY (1967)

Professor of Mechanics

B.Sc., University of Manchester (England), 1955; M.Sc., 1957; Ph.D., Brown, 1961.

JOSEPH JEROME VEILLEUX (1966)

Assistant in Aerospace Studies

Technical Sergeant, U.S. Air Force

THOMAS JOSEPH VERBONITZ (1967)

Assistant for Systems Planning

B.S., Lehigh, 1958; M.B.A., 1960.

Faculty and Staff

CHARLES JOSEPH VERSACCI (1958, 1965)

Assistant Professor of Education and Supervisor of Reading and Study Clinic

A.B., Lafayette College, 1954; M.A., Lehigh, 1959; Ed.D., Temple University, 1966.

JOHN F. VICKREY (1961)

Assistant Professor of English

Ph.B., Chicago, 1949; A.M., 1952; Ph.D., Indiana, 1960.

EDWIN M. WAGENER (1966)

Assistant Professor of Aerospace Studies

B.G.E., University of Omaha, 1965. Major, U.S. Air Force

JAMES HAROLD WAGNER (1949, 1951)

Registrar

B.A., Gettysburg, 1947; M.A., Pennsylvania, 1950.

JOHN E. WALKER (1967)

Associate Professor of Economics

B.S., Clemson, 1958; Ph.D., University of Virginia, 1963.

GARY DOUGLASS WALTERS (1967)

Instructor in Physical Education, Freshman Basketball Coach

A.B., Princeton, 1967.

ELVIN GALEN WARFEL (1966)

Assistant Professor of Education

B.S., Shippensburg State College, 1950; M.Ed., Pennsylvania State, 1958; Ed.D., Columbia, 1967.

JOHN LOREN WASHBURN (1965)

Assistant Professor of Government

A.B., Park College, 1962; M.A., Duke, 1965.

ROBERT PEH-YING WEI (1966)

Research Associate Professor of Mechanics

B.S., Princeton, 1953; M.S., 1954; Ph.D., 1960.

ANDREW R. WEINTRAUB (1966)

Assistant Professor of Economics

B.A., Rutgers University, 1961; M.A., 1964; Ph.D., 1966.

LEONARD ANDREW WENZEL (1951, 1962)

Professor of Chemical Engineering, Chairman of the Department of Chemical Engineering

B.S., Pennsylvania State, 1943; M.S., Michigan, 1948; Ph.D., 1950. P.E., Pennsylvania, 1958.

*KARL LEROY WERKHEISER (1950, 1962)

Accountant

B.S., Rider, 1950.

*Resigned, January, 1967.

DONALD BIGHAM WHEELER, JR. (1947, 1957).

Associate Professor of Physics

B.S. in Engr. Phys., Lehigh, 1938; Ph.D., California Institute of Technology, 1947.

HOWARD R. WHITCOMB (1967)

Instructor in Government

A.B., Brown, 1961; M.A., Lehigh, 1963.

LAWRENCE WHITCOMB (1930, 1965)

Associate Professor Emeritus of Geology

Ph.B., Brown, 1922; A.M., Princeton, 1928; Ph.D., 1930

JOHN CALVIN WHITEHEAD (1967)

Instructor in Physical Education, Assistant Varsity Football Coach

B.S., East Stroudsburg State College, 1950.

GARY E. WHITEHOUSE (1965)

Assistant Professor of Industrial Engineering

B.S., Lehigh, 1960; M.S., 1962; Ph.D., Arizona State University, 1966. P.E., Pennsylvania, 1966.

THEODORE J. WHITTLINGER (1967)

Administrative Assistant, Computing Center

JOSEPH HARDY WHRITENOUR (1965)

Assistant Director of Public Information

ALBERT WILANSKY (1948, 1957)

Professor of Mathematics

B.A., Dalhousie (Canada), 1941; B.S., 1942; Ph.D., Brown, 1947.

BRADFORD WILLARD (1939, 1959)

Professor Emeritus of Geology

B.A., Lehigh, 1921; A.M., Harvard, 1922; Ph.D., 1923.

*ROBERT CLIFFORD WILLIAMSON (1963, 1964)

Professor of Sociology, Chairman of the Department of Social Relations

B.A., University of California (Los Angeles), 1938; M.A., 1940; Ph.D., University of Southern California, 1951.

*On leave, Fall Semester, 1967-68.

JOHN DUDLEY WOOD (1960, 1965)

Associate Professor of Metallurgy and Materials Science

B.S., Case Institute of Technology, 1953; M.S., Lehigh, 1959; Ph.D., 1962.

STANLEY WORDEN (1967)

Social Science Cataloger

A.B., University of Delaware, 1959; M.L.S., Pratt Institute, 1962.

FRANCIS JOSEPH WUEST (1961, 1965)

Professor and Chairman of the Department of Psychology

B.A., LaSalle College, 1951; M.A., Fordham, 1953; Ph.D., Brown, 1961.

WILLARD ROSS YATES (1955, 1963)

Professor and Acting Chairman, Department of Government; Dean of the College of Arts and Science

B.A., Oregon, 1948; M.A., 1949; Ph.D., Yale, 1956.

BUNG-TSENG YEN (1957, 1964)

Assistant Professor of Civil Engineering

B.S., National Taiwan, 1955; M.S., Lehigh, 1959; Ph.D., 1963.

THOMAS EDWIN YOUNG (1958, 1966)

Professor of Chemistry

B.S., Lehigh, 1949; M.S., 1950; Ph.D., Illinois, 1952.

DANIEL ZEROKA (1967)

Assistant Professor of Chemistry

B.S., Wilkes College, 1963; Ph.D., University of Pennsylvania, 1966.

BARBARA LYNNE ZABOR (1965)

Acquisitions Librarian

A.B., University of Michigan, 1963; A.M.L.S., 1965.

ALBERT CHARLES ZETTLEMOYER (1941, 1966)

Vice-President—Research; Distinguished Professor of Chemistry; Director, Center for Surface and Coatings Research

B.S. in Ch.E., Lehigh, 1936; M.S., 1938; Ph.D., Massachusetts Institute of Technology, 1941; D.Sc., Clarkson, 1965.

CHARLES KELLER ZUG (1961)

Advisor on Bequests, Trusts, and Insurance

B.S. in I.E., Lehigh, 1927; B.S. in E.E., 1927.

Graduate, Teaching and Research Assistants

MAHMOUD FAHMY G. ABD-EL-BARY (1964)

Teaching Assistant in Chemical Engineering

B.S., Alexandria (Egypt) University, 1960; S.M., Massachusetts Institute of Technology, 1964.

PETER JOHN ACHORN (1964)

Research Assistant in Chemistry

B.S., Bates College, 1961; M.S., Lehigh, 1966.

JOSEPH DOMENIC ADAMS (1967)

Teaching Assistant in English

B.A., Franklin & Marshall, 1952; M.Ed., Shippensburg State, 1966.

WILBERT CHARLTON ADAMS, JR. (1967)

Teaching Assistant in Electrical Engineering

B.S., Lehigh, 1966; M.S., 1968.

ZIYA AKTAS (1966)

Research Assistant in Civil Engineering

B.S., Middle East Technical University (Turkey), 1962; M.S., 1963.

STEPHEN RAY ALPERT (1967)

Graduate Assistant in Mathematics

B.S., Worcester Polytechnic Institute, 1967.

ANTHONY FRANCIS AMICO (1967)

Graduate Assistant in Information Sciences

B.S., University of Massachusetts, 1964.

CARL ANDERSON (1967)

Research Assistant in Chemical Engineering

B.S., Lehigh, 1963.

RONALD RAY ANDERSON (1966)

Graduate Assistant in Information Sciences

B.S., Iowa State University, 1963.

PETER HARWOOD ANSELMO (1966)

Graduate Assistant in Counseling & Testing

B.S., Lehigh, 1966.

CHARLES ARTHUR APPLE (1967)

Research Assistant in Metallurgy and Materials Science

B.S., Florida State University, 1967.

JEANNE EVELYN ARGOT (1967)

Research Assistant in Biology

B.S., Moravian College, 1965; M.A., Lehigh, 1967.

KEMAL ARIN (1967)

Research Assistant in Mechanics

M.S., Technical University of Istanbul, 1963.

JAMES OLIVER ARMACOST III (1966)

Research Assistant in Civil Engineering

B.E., Vanderbilt University, 1966.

ERIK W. ASLAKSEN (1967)

Graduate Assistant in Physics

Dipl. Ing. in Electronics, Eidgenossische Technische Hochschule, 1962.

BOAZ AVITZUR (1965)

Research Assistant in Metallurgy and Materials Science

B.Sc., Israeli Institute of Technology, 1953; B.S., University of Michigan, 1961; M.S., 1963.

RICHARD O. BANAGAN (1967)

Graduate Assistant in Mathematics

B.S., Upsala College, 1967.

FELIX BARDA (1967)

Teaching Assistant in Civil Engineering

B.E., University of New South Wales, 1967.

PATRICIA M. BARE (1967)

Graduate Assistant in Education

B.S., West Chester State, 1941.

ROBERT L. BATEMAN, JR. (1965)

Graduate Assistant in Physics

A.B., Ursinus College, 1965.

MARK KEITH BAUMAN (1967)

Graduate Assistant in History

B.A., Wilkes College, 1967.

DONALD RICHARDSON BECK (1962)

Research Assistant in Physics

B.S., Dickinson College, 1962; M.S., Lehigh, 1964.

JOHN ANDREW BERSETH (1967)

Graduate Assistant in Electrical Engineering

B.S., Lehigh, 1967.

VAHRAM BIRICIKOGLU (1966)

Research Assistant in Mechanics

Dipl. Ing., Istanbul State University, 1962; M.S., Lehigh, 1964.

STEPHEN L. BORST (1967)

Graduate Assistant in Physics

B.A., Johns Hopkins, 1965; M.S., Lehigh, 1967.

JEFFREY CRAIG BOSSERMAN (1967)

Graduate Assistant in Mathematics

B.S., Shippensburg State College, 1967.

SIHAM CHUCRI BRAIDI (1966)

Graduate Assistant in Mathematics

B.S., American University of Beirut, 1964; M.S., 1966.

JOHN ANTHONY BRESLIN (1964)

Research Assistant in Physics

B.S., St. Joseph's College, 1964; M.S., Lehigh, 1966.

LAURENCE MICHAEL BRICKMAN (1966)

Teaching Assistant in Biology

B.A., Lehigh, 1966.

WALTER BRYANT (1967)

Teaching Assistant in Chemistry

B.S., Pennsylvania Military Colleges, 1964; M.S., University of Pittsburgh, 1966.

JOSEPH OTSIEKU BRYDEN (1967)

Research Assistant in Chemical Engineering

B.Sc., Edinburgh University, 1965.

BARBARA JOAN BYRD (1966)

Graduate Assistant in Physics

B.S., Dickinson College, 1966.

EDUARDO CALABRESE (1966)

Research Assistant in Physics

Dottore Infisica, University of Messina (Italy), 1966.

LAUREN DUNCAN CARPENTER (1965)

Research Assistant in Civil Engineering

B.S., Ohio University, 1963; M.S., 1965.

MIN-CHUN CHAO (1967)

Research Assistant in Psychology

B.S., National Taiwan University, 1967.

Faculty and Staff: Assistants

ROBERT NORMAN CHAPPELLE, JR. (1967)
Graduate Assistant in Industrial Engineering
B.S., Lehigh, 1967.

TONY ER-PING CHEN (1967)
Research Assistant in Mechanics
B.S., Taiwan Provincial Chung-Hsing University, 1966.

CHINGMIIN CHERN (1966)
Research Assistant in Civil Engineering
B.S., National Taiwan University, 1961; M.S., North Dakota State University, 1966.

ESTEBAN CHORNET (1966)
Research Assistant in Chemical Engineering
Ingeniero Industrial, Barcelona, 1966.

TIN HO CHU (1966)
Teaching Assistant in Chemistry
B.S., Chung Chi (Hong Kong), 1964.

HAROLD E. CLARKE (1967)
Assistant Lecturer in Physics

THOMAS S. COOK (1967)
Teaching Assistant in Mechanics
B.S., Lehigh, 1963; M.S., Penn State, 1965.

PAUL BRUCE CORKUM (1965)
Graduate Assistant in Physics
B.S., Acadia University, 1965.

ELIZABETH ANN COTE (1966)
Graduate Assistant in English
B.A., Maine, 1964; M.A., Lehigh, 1967.

RICHARD SAMUEL COWAN, JR. (1966)
Teaching Assistant in Economics
B.A., Washington & Jefferson, 1964; M.B.A., Penn State, 1966.

GERARD EUGENE COZZOLINO (1967)
Graduate Assistant in Mathematics
B.A., Middlebury College, 1959.

MATTHEW CREAGER (1965)
Research Assistant in Mechanical Engineering
B.E., The Cooper Union, 1965.

JAMES W. DAVIS (1967)
Teaching Assistant in Chemistry
B.S., University of Scranton, 1967.

LAWRENCE JOHN DAVIS III (1967)
Research Assistant in Chemical Engineering
B.S., Lehigh, 1966.

DAVID JOHN DEANGELO (1967)
Teaching Assistant in Economics
B.S., Lehigh, 1966.

REYDANTE M. DEBORJA (1966)
Research Assistant in Chemical Engineering
B.S., University of Philippines, 1959; M.S., 1963.

PAUL S. DELO, JR. (1967)
Graduate Assistant in Education
A.B., Pittsburgh, 1958; M.Ed., Duquesne University, 1965.

SURESH KALYANJI DESAI (1967)
Research Assistant in Civil Engineering
B.S., Ponna University (India), 1950.

JEAN PAUL DETHOMAS (1967)
Graduate Assistant in Electrical Engineering
Ingenieur I.N.S.A., Institut National des Sciences Appliquées (Lyon), 1967.

THOMAS G. DIGGES, JR. (1965)
Research Assistant in Metallurgy and Materials Science
B.A., University of Virginia, 1956; B.S., M.S., University of Tennessee, 1963.

JAMES RICHARD DIMITRI (1966)
Research Assistant in Civil Engineering
B.S., University of Missouri, 1966.

PETER STEFAN DOBREFF (1967)
Research Assistant in Mechanics
B.S., Lehigh, 1966; M.S., Stanford, 1967.

RICHARD ALBERT DOERING (1966)
Teaching Assistant in Biology
B.S., Lehigh, 1966.

HOWARD V. DONOHOE (1967)
Graduate Assistant in Geology
B.A., Lehigh, 1966.

DOUGLAS SCHAEFFER DRUMHELLER (1967)
Research Assistant in Mechanics
B.S., University of Southern California, 1964; M.S., 1965.

GEORGE DUDASCIK (1966)
Graduate Assistant in Physics
B.S., Wilkes College, 1966.

JAMES SHACKELFORD DUGAN (1967)
Graduate Assistant in Residence Halls
B.A., Lehigh, 1965.

WILLIAM PAUL DUNKEL (1967)
Teaching Assistant in History
A.B., Muhlenberg College, 1967.

BRUCE CHARLES COULL (1965)
Research Assistant in Marine Biology
B.S., Moravian, 1964; M.S., Lehigh, 1966.

ABRAHAM BAGOT EASTWOOD III (1966)
Research Assistant in Biology
B.S., Muhlenberg College, 1965.

JOSEPH PAUL ECKHARDT (1966)
Teaching Assistant in History
B.A., Clarion State College, 1966.

GEORGE TYLER EMBLEY (1967)
Teaching Assistant in Mechanics
B.S., Lehigh, 1967.

SHU-JIN FANG (1966)
Research Assistant in Civil Engineering
B.S., National Taiwan University, 1965.

CATHERINE FERRY (1967)
Teaching Assistant in Chemistry
B.A., Cedar Crest College, 1967.

DAVID FINK (1965)
Teaching Assistant in Chemistry
B.S., Brooklyn College, 1964.

WILLIAM FIVES (1967)
Teaching Assistant in Chemistry
B.S., Mount St. Mary's College (Md.), 1967.

MARCO PAOLA FONTANA (1964)
Research Assistant in Physics
 D.Ph., University of Florence, 1964.

KARL HEINZ FRANK (1967)
Research Assistant in Civil Engineering
 B.S., University of California (Davis), 1966.

DONALD C. FREDERICKSON (1967)
Research Assistant in Civil Engineering
 B.S., Lafayette, 1967.

THOMAS S. FREUND (1966)
Graduate Assistant in Marine Science
 B.S., Lehigh, 1965.

JOSE HUMBERTO FUEYO (1963)
Research Assistant in Metallurgy and Materials Science
 B.S., Merrimack College, 1963.

ANTHONY J. GALANTY (1967)
Research Assistant in Chemical Engineering
 B.S., Pennsylvania State University, 1956; M.S., Newark College of Engineering, 1964.

DANIEL JAMES GALLAGHER (1967)
Graduate Assistant in Psychology
 B.A., Randolph-Macon, 1967.

THOMAS EUGENE GALLAGHER (1966, 1967)
Research Assistant and Assistant Engineer of Tests in Civil Engineering
 B.S., Duke University, 1966.

PETER GANSSMANN (1967)
Graduate Assistant in German

JOHN GBUR (1966)
Graduate Assistant in Physics
 B.S., Wilkes College, 1966.

JOSEPH GORDON GELLINGS (1967)
Research Assistant in Psychology
 B.A., Lehigh, 1965; B.S., 1966.

VINCENT JOSEPH GENTILCORE (1967)
Research Assistant in Metallurgy and Materials Science
 B.S., Lafayette, 1967.

CHARLES INGRAM GIBSON (1966)
Research Assistant in Biology
 B.A., Lehigh, 1964.

MAX W. GIGER (1967)
Research Assistant in Civil Engineering
 Dipl. Tech., Technikum Winterthur (Switzerland), 1965.

GEORGE E. GLAHN (1967)
Teaching Assistant in Civil Engineering
 B.S., University of Virginia, 1967.

HANS RUENIGER GNERLICH (1967)
Graduate Assistant in Electrical Engineering
 Dipl. Ing., Technical University (Karlsruhe), 1967.

IRWIN STANLEY GOLDBERG (1963)
Graduate Assistant in Physics
 B.S. in E.E., Drexel Institute of Technology, 1963; M.S. Lehigh, 1965.

RONALD CHARLES GOWER (1967)
Teaching Assistant in Metallurgy and Materials Science
 B.S., Lehigh, 1967.

JAMES SPROAT GREEN V (1966)
Research Assistant in Philosophy
 B.A., Lehigh, 1966; M.A., 1968.

CHARLES EDWARD GRIFFITHS (1967)
Research Assistant in Economics
 B.S., Lehigh, 1967.

HORACE GROFF (1967)
Teaching Assistant in Chemistry
 A.B., Bluffton College, 1967.

WILLIAM ANTHONY GUDELUNAS, JR. (1967)
Graduate Assistant in History
 B.A., West Chester State College, 1967; M.A., Lehigh, 1968.

ERVENE FRANCES GULLEY (1967)
Teaching Assistant in English
 A.B., Bucknell, 1965.

JAMES GUYKER (1965)
Graduate Assistant in Mathematics
 B.S., Grove City College, 1965.

DANA M. GYURICSEK (1966)
Teaching Assistant in Chemistry
 B.S., Fordham, 1965.

HOWARD CHARLES HAGENDORF (1967)
Research Assistant in Mechanics
 B.S., Penn State, 1965; M.S., 1967.

GEORGE SAMSON HALL (1966)
Research Assistant in Metallurgy and Materials Science
 B.S., University of Missouri, 1961.

COLEMAN R. HAMEL (1965)
Teaching Assistant in Chemistry
 B.Ch.E., Clarkson College of Technology, 1957; M.S., Bucknell University, 1963.

JOHN E. HARRY (1967)
Graduate Assistant in Economics
 B.S., Lehigh, 1967.

JOSEPH MICHAEL HARTH (1966)
Graduate Assistant in Mechanical Engineering
 B.S., Newark College of Engineering, 1965.

GOUTAM R. HATTIANGADI (1967)
Research Assistant in Chemical Engineering
 B.S., University of London, 1966.

ROBERT CHARLES HEISER (1966)
Research Assistant in Philosophy
 B.A., Lehigh, 1966.

WALTER RICHTER HENKEL (1965)
Teaching Assistant in Mechanics
 B.S., Lehigh, 1965.

GAIL CHADWELL HERZ (1967)
Graduate Assistant in Mathematics
 B.S., University of Nevada, 1964.

W. RALPH HILTON (1964)
Teaching Assistant in Philosophy
 B.A., Lehigh, 1963; M.A., 1966.

JOHN CAMPION HIRSH (1967)
Graduate Assistant in English
 B.A., Boston College, 1964; M.A., Lehigh, 1966.

Faculty and Staff: Assistants

MANFRED A. HIRT (1967)
Research Assistant in Civil Engineering
Dipl. Bauingenieur, Swiss Federal Institute of Technology, 1965.

PETER NAI SHIANG HO (1967)
Graduate Assistant in Mathematics
B.A., Lincoln University, 1967.

WILLIAM R. HOOVER (1966)
Research Assistant in Metallurgy and Materials Science
B.S., Lafayette, 1966.

GREGORY STEPHEN HREBINIAK (1967)
Graduate Assistant in Computing Center
A.B., St. Peter's (N.J.) College, 1967.

JOSEPH JUIN-SHYONG HUANG (1966)
Research Assistant in Civil Engineering
B.S., National Taiwan University, 1965.

EVELYN Y. HUI (1967)
Research Assistant in Chemistry
B.S., Adamson University (Manila), 1963.

CLIFFORD WAYNE HUNTER (1965)
Research Assistant in Metallurgy and Materials Science
B.S., Oregon State University, 1962; M.S., Lehigh, 1964.

PAUL J. HUTTA (1967)
Graduate Assistant in Physics
B.S., Penn State, 1967.

STANLEY IOBST (1965)
Teaching Assistant in Chemistry
B.S., Moravian, 1964; M.S., Lehigh, 1967.

AKKANAD MATHAI ISAAC (1966)
Research Assistant in Information Sciences
B.S., Travancore, 1954; Dipl., Madras, 1955.

SAMPATH IVENGAR (1966)
Research Assistant in Civil Engineering
B.S., Central College, Bangalore (India), 1948; B.E., College of Engineering, Ponna (India), 1953; M.S., Washington State, 1953.

ALAN REED JEFFERY (1967)
Graduate Assistant in Mathematics
B.A., Dartmouth, 1967.

THOMAS JENSEN (1967)
Teaching Assistant in Chemistry
B.S., Lehigh, 1956; M.S., 1960.

JONATHAN R. JONES (1967)
Teaching Assistant in English
B.A., West Chester State College, 1967.

AGUSTIN BORONGAN JUMAWAN, JR. (1966)
Research Assistant in Chemical Engineering
B.S., University of San Carlos (Philippines), 1957; M.E., Stevens Institute of Technology, 1966.

PETEE BETH JUNG (1967)
Graduate Assistant in Mathematics
B.A., Hunter College, 1956; M.A., Emory University, 1957.

KENNETH JURIS (1967)
Research Assistant in Chemical Engineering
B.Ch.E., City University of New York, 1965.

KURT JOHN KAHLOW (1967)
Research Assistant in Metallurgy and Materials Science
B.S., Drexel Institute of Technology, 1964.

NATHAN KALOWSKI (1967)
Graduate Assistant in Mechanical Engineering
B.S., University of Rhode Island, 1967.

SAMARES KAR (1965)
Graduate Assistant in Civil Engineering
B.Tech., Indian Institute of Technology, Kharagpur (India), 1962.

MUNAWAR KARIN (1967)
Graduate Assistant in Physics
B.S., Dacca University, 1965; M.S., 1966.

EDWIN JOSEPH KAY (1967)
Graduate Assistant in Mathematics
B.S., Rensselaer Polytechnic Institute of Technology, 1964; M.S., Lehigh, 1966.

JOEL RAYMOND KEHLER (1967)
Teaching Assistant in English
A.B., Muhlenberg, 1967.

KARL KERCHMAR (1967)
Graduate Assistant in Electrical Engineering
Diploma Eng., University of Ljubljana (Yugoslavia), 1967.

HAN J. KIM (1966)
Research Assistant in Metallurgy and Materials Science
B.S., Seoul National University (Korea), 1960.

SUNG-WOO KIM (1967)
Research Assistant in Civil Engineering
B.S., Seoul National University (Korea), 1965; M.S., University of Utah, 1967.

ERHAN B. KIRAL (1967)
Research Assistant in Mechanics
B.S., University of Istanbul; M.S., 1962.

YOSHIO KISHIMA (1967)
Research Assistant in Civil Engineering
B.S., Kyoto University (Japan), 1965.

EDWARD ROBERT KLEIN (1967)
Graduate Assistant in Business Economics
B.S., Lehigh, 1967.

PETER N. KLOSE (1967)
Teaching Assistant in Biology
B.S., Muhlenberg, 1967.

RUDOLPH MARTIN KOCH (1966)
Graduate Assistant in Mathematics
B.A., Rutgers University (Newark), 1966.

FRANK W. KOKO, JR. (1967)
Teaching Assistant in Chemical Engineering
B.S., Lehigh, 1964.

PHILIP EDWARD KOZAK (1967)
Teaching Assistant in Mechanics
B.S., Penn State, 1967.

PETER K. KRUGMANN (1967)
Research Assistant in Civil Engineering
Dipl. Ing., Technological University (Stuttgart), 1966.

PAUL ALFRED KUEHNER (1966)
Graduate Assistant in Physics
B.S., Dickinson College, 1966.

JOHN DAVID LANDES (1966)
Research Assistant in Mechanics
 B.S., Lehigh, 1964; M.S., 1965.

HOWARD BARKER LANGE, JR. (1965)
Teaching Assistant in Chemical Engineering
 B.S., Lehigh, 1962; M.S., 1967.

GEORGE OMER LAPIERRE, JR. (1967)
Graduate Assistant in English
 B.A., Salem (W.Va.) State College, 1967.

EDWARD LAREAU (1967)
Teaching Assistant in Chemistry
 B.S., Tufts University, 1961.

ANGEL LAPUS LAZARO (1967)
Teaching Assistant in Civil Engineering
 B.S., University of the Philippines, 1964; M.S.E., Princeton 1966; M.A., 1967.

JAMES HONYIN LEE (1966)
Research Assistant in Civil Engineering
 B.S., Ohio University, 1966.

MICHAEL BARRY LEIBOWITZ (1963)
Teaching Assistant in Philosophy
 A.B., Lehigh, 1964.

THOMAS FRANKLIN LEMKE (1967)
Research Assistant in Chemistry
 A.B., Wake Forest University, 1964; M.S., Marshall University, 1966.

STEPHEN BARRY LEONARD (1963)
Graduate Assistant in Mathematics
 A.B., Middlebury College, 1963.

ROBERT BATTISTA LEONESIO (1966)
Research Assistant in Mechanics
 B.S., University of Massachusetts, 1963; M.S., Stanford, 1964.

ERNST ULRIK LETTAU (1967)
Graduate Assistant in German

WILLIAM L. LETTINGER (1966)
Teaching Assistant in Chemistry
 B.S., Ursinus College, 1965.

JOHN JAMES LEVKO III (1964)
Graduate Assistant in Mathematics
 B.A., Lehigh, 1964; M.S., 1966.

MERIN LEE LEVY (1966)
Teaching Assistant in Psychology
 B.S., Penn State, 1966.

GARY B. LEWIS (1966)
Teaching Assistant in Mechanics
 B.S., Lehigh, 1966.

KARL DAVID LIBSCH (1967)
Research Assistant in Metallurgy and Materials Science
 B.S., Lehigh, 1965.

JACK LIEF (1967)
Research Assistant in Psychology
 B.A., Rutgers University, 1967.

LEE-CHONG LIM (1966)
Research Assistant in Civil Engineering
 B.E., University of Sydney (Australia), 1964; M. Engr. Sc., 1966.

CHENG-SHUNG LIN (1966)
Research Assistant in Civil Engineering
 B.S., National Taiwan University, 1964.

NUNZIO LIPARI (1967)
Research Assistant in Physics
 Dottore in fisica, University of Messina (Italy), 1967.

RICHARD LITTLE (1966)
Graduate Assistant in International Relations
 B.S., London University, 1966.

DAVID EDWARD LUFT (1966)
Research Assistant in Civil Engineering
 B.S., Queen's University (Ontario), 1966.

BRUCE DEY MACDONALD (1967)
Teaching Assistant in Mechanics
 B.S., Drexel Institute of Technology, 1963; M.S., 1966.

GEORGE BUCHANAN MACDONALD (1964)
Graduate Assistant in English
 A.B., Boston College, 1962; M.A., Lehigh, 1964.

MARY LOUISE MACINNIS (1967)
Teaching Assistant in Education
 B.A., University of Rochester, 1956.

STEPHEN ANTHONY MACK (1965)
Graduate Assistant in Physics
 B.S., St. Francis College, 1965.

L. JOSEPH MALE (1965)
Teaching Assistant in Chemistry
 B.S., University of Rochester, 1964.

EDWARD T. MANNING, JR. (1967)
Teaching Assistant in Civil Engineering
 B.S., Cleveland State University, 1967.

GARY ALAN MARSHALL (1967)
Research Assistant in Biology
 B.A., Lafayette, 1967.

IWAO MATSUI (1967)
Research Assistant in Chemical Engineering
 B.E., Shibaura Institute of Technology (Tokyo), 1962; M. Ch.E., 1966.

WILLIAM LORNE MCINTOSH (1967)
Teaching Assistant in Economics
 B.S., Lehigh, 1967.

GREGORY MCMANEMIN (1966)
Teaching Assistant in Chemistry
 B.S., LaSalle College, 1965.

JOHN FREDERICK MILLER (1967)
Graduate Assistant in Mathematics
 B.S., Muhlenberg, 1965; M.S., Miami (Ohio) University, 1967.

PRATAP NARAIN MISRA (1965, 1967)
Graduate Assistant in Management Science
 B.Tech., Indian Institute of Technology, Kanpur, 1965.

MICHAEL FRANCIS MOHR (1967)
Research Assistant in Economics
 B.A., LaSalle College, 1967.

Faculty and Staff: Assistants

JAMES MOLNAR (1968)
Research Assistant in Chemistry
B.S., Moravian, 1965.

FREDERICK CARLTON MONSON (1965)
Teaching Assistant in Biology
B.A., Lehigh, 1965.

SHOSUKE MORINO (1967)
Research Assistant in Civil Engineering
B.S., Kyoto University (Japan), 1965; M.S., 1967.

DARYOUSH MOTARJAMI (1966)
Teaching Assistant in Civil Engineering
Engr. Dipl., University of Tehran, 1963; M.S., University of Illinois, 1966.

JOHN FORREST MUNN (1967)
Teaching Assistant in Civil Engineering
B.S., University of Vermont, 1966.

RONALD MYERS (1968)
Research Assistant in Chemical Engineering
B.S., Lehigh, 1967.

JACK YOGISHWAR NARAYAN (1966)
Graduate Assistant in Mathematics
B.S., Mount Allison, 1966.

ROBERT DONALD NESS, JR. (1966)
Graduate Assistant in English
B.A., Lehigh, 1966.

KENT RONALD NILSSON (1966)
Teaching Assistant in Finance
B.S., Lehigh, 1965; M.B.A., 1966.

MICHAEL RICHARD NOTIS (1967)
Research Assistant in Metallurgy and Materials Science
B.S., Lehigh, 1960; M.S., 1963.

VINCENT ESIMAI OKWUOSA (1966)
Graduate Assistant in International Relations
B.A., Haile Selassie University (Ethiopia), 1966.

FREDERICK WILLIAM OSTERMAYER (1966)
Research Assistant in Physics
S.B., S.M., Massachusetts Institute of Technology, 1959.

STANLEY EUGENE PACE (1967)
Research Assistant in Mechanical Engineering
B.S., Lehigh, 1967.

ALBERT HENRY PACELLA (1967)
Teaching Assistant in Mechanics
B.S., Pittsburgh, 1966.

PAUL J. PATTERSON (1967)
Research Assistant in Civil Engineering
B.S., Ohio Northern University, 1967.

DONALD B. PECHART (1967)
Graduate Assistant in Mathematics
B.A., Shippensburg State College, 1966.

JOSEPH FRANK PERITORE (1967)
Graduate Assistant in Industrial Engineering
B.S., Lehigh, 1967.

LOUIS T. PERSSON (1966)
Research Assistant in Chemical Engineering
B.S., Stevens Institute of Technology, 1964.

JOHN WILMER PETERS (1966)
Research Assistant in Civil Engineering
B.S., Lehigh, 1966.

JOSEPH REED POLEK (1966)
Research Assistant in Chemical Engineering
B.S., Johns Hopkins, 1966.

DENNIS G. POTTER (1967)
Graduate Assistant in Information Sciences
B.S., Mt. St. Mary's (Md.), 1962; M.A., Niagara University, 1963.

TED FRANKLIN RABOLD (1967)
Teaching Assistant in Education
B.A., Gettysburg, 1967.

MOHAN MENGHRAJ RATWANI (1967)
Research Assistant in Mechanics
B.E., Baroda University, 1959; M.E., Poona University, 1962.

DAVID MILLER REED (1964)
Research Assistant in Philosophy
B.A., Lehigh, 1964; M.A., 1966.

PAUL ROBERT REED, JR. (1966)
Teaching Assistant in Chemistry
B.S., Ursinus College, 1966.

ROBERT FRANK REEVES (1966)
Teaching Assistant in History
B.A., Drew University, 1966.

JAMIL-U REHMAN (1967)
Teaching Assistant in Chemical Engineering
B.S., University of Punjab (India), 1957.

PHYLLIS REISNER (1967)
Research Assistant in Information Sciences
B.A., Hunter College, 1955.

ULISE C. RIVERA (1967)
Research Assistant in Civil Engineering
B.S., Drexel Institute of Technology, 1967.

JAMES FRANK ROACH (1965)
Research Assistant in Physics
B.S., College of William and Mary, 1959; M.A., 1962.

VICTOR SMITH ROBINSON III (1967)
Research Assistant in Metallurgy and Materials Science
B.S., Lehigh, 1962; M.S., 1964.

DOUGLAS N. RODGERS (1967)
Research Assistant in Chemical Engineering
B.S., Rutgers University, 1967.

ANOUSHIRAVAN ROKHSAR (1966)
Research Assistant in Civil Engineering
B.S., Penn State, 1966.

DONALD JOSEPH ROMANIK (1965)
Teaching Assistant in Chemistry
B.S., Ursinus College, 1965.

DAVID DONALD ROPER (1967)
Graduate Assistant in Economics
B.A., Lafayette, 1960.

CHARLES TYSON ROSE (1967)
Graduate Assistant in Psychology
B.A., Gettysburg College, 1966.

DONALD ROY RUTLEDGE (1967)
Research Assistant in Civil Engineering
 B.S., Texas Technological College, 1966.

BRUCE ALBERT RYAN (1963)
Research Assistant in Physics
 B.S., Boston College, 1963; M.S., Lehigh, 1965.

EDWARD F. SABOTKA (1966)
Graduate Assistant in Mathematics
 B.S., Castleton State College, 1966.

LOUIS E. SAGE (1967)
Research Assistant in Biology
 B.A., University of Vermont, 1964.

SAKDA SANTATHADAPORN (1967)
Research Assistant in Civil Engineering
 B. Engr., Chulalongkorn University (Thailand), 1963;
 M. Engr., SEATO Graduate School of Engineering,
 (Bangkok), 1965.

ANTHONY CHARLES SANTORE (1966)
Graduate Assistant in English
 B.S., East Stroudsburg State College, 1962.

CHARLES RAYMOND SCAWTHORN (1966)
Teaching Assistant in Civil Engineering
 B.E., Cooper Union, 1966.

GEORGE OTTO SCHNELLER IV (1965)
Graduate Assistant in Mathematics
 B.S., Mount Union College, 1965.

WOLFGANG SCHUELLER (1967)
Research Assistant in Civil Engineering
 B.S., North Dakota State University, 1966.

HENRIK ARTHUR SCHUTZ (1967)
Teaching Assistant in Electrical Engineering
 B.S., Yale, 1967.

THOMAS MARIA SEBASTIAN (1967)
Teaching Assistant in Economics
 B.A., Madras University (India), 1959; M.A., 1962.

DAVID HENRY SEITZ (1966)
Research Assistant in Mechanics
 B.S., Lehigh, 1961.

EUGENE LOWRY SHENINGER (1966)
Research Assistant in Civil Engineering
 B.S., Newark College of Engineering, 1966.

NATHAN FRANK SIMMS (1966)
Graduate Assistant in Mathematics
 B.S., North Carolina College, 1954; M.S., 1960.

TIBOR SIPOS (1964)
Graduate Assistant in Biochemistry
 B.S., Lebanon Valley College, 1964.

ALMA DOREEN SMITH (1966)
Room Assistant in Education
 B.A., Queen Mary College, University of London, 1963.

CHRISTOPHER LYNAM SNYDER, JR. (1965)
Research Assistant in Economics
 B.S., Lehigh, 1964; M.S., 1966.

ALAN JAY SOLOMON (1965)
Research Assistant in Chemistry
 B.A., University of Connecticut, 1965.

PAUL MICHAEL SORRENTINO (1967)
Teaching Assistant in English
 A.B., Villanova, 1967.

ROBERT S. SPRAGUE, JR. (1967)
Teaching Assistant in English
 B.A., Washington & Jefferson College, 1966.

MYRTLE LOUISE STABLER (1967)
Graduate Assistant in Education
 B.S., Lock Haven State College, 1948; M.S., Bucknell
 University, 1965.

MICHAEL J. STAUFFER (1967)
Graduate Assistant in Mathematics
 B.A., Lehigh, 1967.

LESTER JOHN STEENBLOCK, JR. (1967)
Graduate Assistant in Geological Sciences
 B.S., San Jose State College, 1967.

CHARLES JEAN-PIERRE STEINER (1966)
Research Assistant in Metallurgy and Materials Science
 B.S., University of Aston (England), 1965.

STANLEY L. STEPEHNS (1965)
Graduate Assistant in Mathematics
 B.A., Anderson College, 1965.

LOUIS WILLIAM STERN (1964)
Graduate Assistant in Mathematics
 B.A., Temple, 1964; M.S., Lehigh, 1966.

LAWRENCE N. SUCCOP (1967)
Research Assistant in Metallurgy and Materials Science
 B.A., Lehigh, 1966; B.S., Lehigh, 1967.

WILLIAM SUNDAY (1968)
Research Assistant in Chemistry
 B.S., King's College, 1965.

HIROSHI TADA (1966)
Research Assistant in Mechanics
 B.E., University of Tokyo, 1964; M.E., 1966.

RICARDO TAN (1966)
Research Assistant in Chemical Engineering
 B.S., De La Salle College (Philippines), 1963.

ASHOK K. TAORI (1967)
Teaching Assistant in Chemical Engineering
 B.S., University of Bombay (India), 1967.

JOHN W. TARRANT (1967)
Graduate Assistant in Mathematics
 B.A., St. Peter's (N.J.) College, 1967.

THOMAS ERNST TAUBER
Graduate Assistant in Physics
 Dipl., Technichal University of Vienna, 1965.

JOHN WILLIAM TAYLOR (1965)
Graduate Assistant in Mathematics
 B.S., Lehigh, 1964.

DONALD ARTHUR THOMPSON (1966)
Graduate Assistant in Mathematics
 B.S., Mount Allison University, 1966.

PETER MICHAEL TINKER (1967)
Teaching Assistant in English
 A.B., Boston College, 1966.

Faculty and Staff: Assistants

MARIAN J. TOMIN (1967)

Research Assistant in Mechanics

Dipl. Lug., Technical University (Prague), 1967.

ELIAS HANNA TOUBASSI (1967)

Graduate Assistant in Mathematics

A.B., Bethel College, 1966.

RAMESH CHANDULAH TRIVEDI (1966)

Research Assistant in Chemical Engineering

B.S., Inst. of Tech. (India), 1962; M.S., Villanova, 1964.

CHARLES CHUN-SHU TSENG (1966)

Teaching Assistant in Mechanics

B.S., Taipei Institute of Technology, 1958; M.S., Northwestern University, 1963.

PETER DAVIES VAN DYKE (1963)

Research Assistant in Physics

B.S., Lehigh, 1963; M.S., 1965.

LEO H. M. VAN ZUILEN (1967)

Research Assistant in Civil Engineering

B.S., Technological University of Delft (The Netherlands), 1966; M.S., 1967.

DONALD B. VEIX (1967)

Graduate Assistant in Education

A.B., Seton Hall University, 1955; M.A., 1963.

RICHARD F. VERHANOVITZ (1967)

Graduate Assistant in Physics

B.S., Wilkes College, 1966.

ERICO FRANCISCO JAVIER VON EUW (1966)

Research Assistant in Mechanical Engineering

B.S., The Cooper Union, 1966.

GEORGE B. WALZ (1965)

Teaching Intern in Psychology

B.S., University of Pennsylvania, 1962; M.S., Lehigh, 1966.

EDMOND ARTHUR WATTERS III (1964, 1967)

Graduate Assistant in Education

B.A., Lehigh, 1961; M.A., 1966.

ANTON W. WEGMULLER (1967)

Research Assistant in Civil Engineering

M.E., Technical College of Berne (Switzerland), 1960; C.E., Swiss Federal Institute of Technology, 1965.

ROBERT CARL WEGNER (1967)

Teaching Assistant in Geology

B.A., Queens College, 1967.

NEIL STEVEN WETCHER (1967)

Graduate Assistant in Mathematics

B.S., Brooklyn College, 1967.

LAWRENCE E. WHITE (1965)

Graduate Assistant in Industrial Engineering

B.S., Lehigh, 1964; M.S., 1965.

SCOTT WARNER WILLIAMS (1964)

Graduate Assistant in Mathematics

B.S., Morgan State College, 1964.

STANLEY JEFFRESS WILLIAMS (1967)

Teaching Assistant in Geology

B.S., Allegheny, 1967.

DOUGLAS H. YANO (1967)

Graduate Assistant in Mechanical Engineering

B.S., Lehigh, 1962; M.S., 1964.

NORIAKI YOSHIDA (1966)

Research Assistant in Civil Engineering

B.E., Hokkaido University, 1963.

CHING-KUO YU (1962)

Research Assistant in Civil Engineering

B.S., Taiwan Cheng-Kung University, 1960; M.S., Lehigh, 1964.

UMUR YUCEOGLU (1965, 1966)

Research Assistant in Mechanics

Dip. Eng. Technical University of Istanbul, 1956; M.S., Polytechnic Institute of Brooklyn, 1965.

WILLIAM FRANK ZAK (1966)

Graduate Assistant in English

B.A., Boston College, 1966.

JOSEPH FRANCIS ZALESAK (1966)

Graduate Assistant in Physics

B.A., LaSalle, 1963.

Fellows, Trainees, and Scholars

(The key to abbreviations of sponsors in the following list of fellows, scholars, and trainees is: MRC, Materials Research Center; NIH, National Institute of Health; Taga, Thomas R. Caton; NASA, National Aeronautics and Space Administration; NDEA, National Defense Education Act; NSF, National Science Foundation; Inc., International Nickel Company.)

ROBERT A. ADAMS*NDEA Fellow in Chemical Engineering*

B.S., Bucknell, 1967.

STANLEY R. ALMONEY*NSF Trainee in Physics*

B.S., Lowell Technological Institute, 1966; M.S., Lehigh, 1968.

ROGER WILLIAM BENTON*NSF Trainee in Biology*

B.S., Hobart College, 1967.

HARRY AARON BICK*Chemical Metallurgy Fellow*

B.S., Tufts, 1966.

THOMAS KENNETH BOLLAND*NASA Fellow in Physics*

B.S., Stevens Institute of Technology, 1962.

ANDREW DUDLEY BRIDGES, JR.*NSF Fellow in Electrical Engineering*

B.S., Lehigh, 1965; M.S., 1967.

ROBERT JAMES BUCCI*NASA Fellow in Mechanics*

B.S., Northeastern, 1964; Brown, 1967.

ANTHONY MICHAEL BUTTO*Calder Fellow in Chemistry*

B.S., Penn State, 1961; M.S., Lehigh, 1964.

GARY M. CALLAHAN*NASA Fellow in Mechanical Engineering*

B.S., University of Miami, 1964; M.S., 1966.

VICTOR M. CATANO*NSF Trainee in Psychology*

B.S., Drexel Institute of Technology, 1967.

SHERMAN CLEBNIK*University Scholar in Geological Sciences*

B.A., University of Massachusetts, 1965; M.A., University of Indiana, 1967.

EDWARD JAMES CODY*Alumni Fellow in History*

B.S., St. Peter's College, 1965.

JOHN J. CONVILLE*NDEA Fellow in Chemistry*

B.S., Clarkson College of Technology, 1965.

EVAN W. CONYERS*NDEA Fellow in Philosophy*

B.A., Lehigh, 1966.

JOHN FREDERICK COPELAND*NSF Trainee in Metallurgy and Materials Science*

B.S., Drexel Institute of Technology, 1966.

RICHARD J. COPPINS*Management Science Fellow*

B.A., Lehigh, 1967.

FRANK P. CORCIONE*NSF Fellow in Economics*

B.A., Moravian College, 1967.

JOHN PATRICK COYNE*NDEA Fellow in Philosophy*

B.S., Iona College, 1967.

CORNELL G. CRAIG*Management Science Fellow*

B.S., B.A., Rutgers University, 1967.

NAROLYN P. CROSSLEY*University Scholar in English*

B.A., Houghton College, 1962.

ANDREW WILLIAM DEGRAFF*NSF Trainee in Chemical Engineering*

B.S., Newark College of Engineering, 1966.

JOHN BEST DURKEE*Esso Fellow in Chemical Engineering*

B.S., Lehigh, 1962; M.S., Lehigh, 1964.

JOSEPH JAY DUBOIS*NASA Fellow in Mathematics*

A.B., Boston College, 1963; A.M., 1965.

KENNETH HALL ECKELMEYER*Hornor Fellow in Metallurgy and Materials Science*

B.S., Lafayette, 1965.

WALTER LUDWIG ERHARD*General Telephone & Electronics Fellow in Metallurgy and Materials Science*

B.S., Lehigh, 1966.

RONALD F. EVILIA*Student Chemistry Foundation Fellow*

B.A., Lehigh, 1965.

RICHARD W. FARRAND*NDEA Fellow in Chemical Engineering*

B.S., Penn State, 1965.

LEO B. FREEMAN, JR.*NASA Fellow in Electrical Engineering*

B.S.E.E., Lehigh, 1963; B.S. E.P. 1964; M.S., Stanford, 1965.

LARRY L. FUNCK*NSF Fellow in Chemistry*

B.S., Lebanon Valley College, 1964.

PHYLLIS W. FURST*University Scholar in Education*

B.A., Ursinus College, 1962; M.A., Lehigh, 1968.

DARIEN GARDNER*NDEA Fellow in Information Sciences*

B.A., Haverford, 1965.

THOMAS B. GARRETT*Hornor Fellow in Chemistry*

B.S., Carnegie-Mellon, 1964.

BARRY J. GILBERT*NSF Trainee in Physics*

B.S., Polytechnic Institute of Brooklyn, 1963; M.S., Lehigh, 1965.

CHARLES THEODORE GRANT*NASA Fellow in Physics*

B.S., Yale, 1962; M.S., Lehigh, 1965.

Faculty and Staff: Fellows and Scholars

BARRY S. GRIFFIN
Management Science Scholar
B.S., North Carolina State University, 1965; M.S., Lehigh, 1967.

VIRGINIA GRISCOM
University Scholar in History
B.A., Bates College, 1966.

RAYMOND DANIEL GUMB
NDEA Fellow in Philosophy
B.S., Massachusetts Institute of Technology, 1960; M.A., Emory, 1967.

GOPAL D. GUPTA
Gotshall Scholar in Mechanical Engineering
B.S., Indian Institute of Technology, 1967.

JOHN K. HAMPSON
NDEA Fellow in Mathematics
B.S., Dickinson College, 1967.

LAURENCE J. HEITZ
NDEA Fellow in Chemistry
B.S., Lehigh, 1966.

MALCOLM B. HIGGINS II
Alumni Fellow in International Relations
B.A., Whitman College, 1967.

WILLIAM H. HINKEL
University Scholar in Government
B.A., Lebanon Valley College, 1964.

KENNETH MARLIN HOFFMAN
NDEA Fellow in Mechanics
B.S., Penn State, 1967.

VOLKER HUELCK
Proctor and Gamble Fellow in Chemical Engineering
B.S., University of Karlsruhe (Germany), 1967.

GEORGE ALAN HUFF
NDEA Fellow in Mathematics
A.B., Kenyon College, 1966.

JOHN WILLIAM HUMES
NDEA Fellow in Philosophy
B.S., Lehigh, 1958; M.S., 1966.

RONALD DENNIS ISTIVAN
NSF Trainee in Chemical Engineering
B.S., Newark College of Engineering, 1967.

JUDITH LYNN JANSSEN
NSF Trainee in Biology
B.S., Denison College, 1966.

PETER GORDON JESSUP
NDEA Fellow in Mathematics
A.B., Kenyon College, 1965.

RICHMOND B. JOHNSON
Higher Education Act Fellow in Psychology
A.B., Lafayette, 1956; M.A., University of Connecticut, 1959.

DONALD DAVID JOYE
NDEA Fellow in Chemical Engineering
B.S., Princeton, 1967.

PAUL KARPOV
University Scholar in Civil Engineering

C.E., Belgrade University (Yugoslavia), 1939; Dipl. Ing., Berlin Technical University (Germany), 1951.

BRIAN J. KELLY
NDEA Fellow in Mathematics
B.S., St. Peter's (N.J.) College, 1967.

JOHN JAMES KIBLER
NSF Trainee in Mechanical Engineering
B.S., Lehigh, 1966; M.S., 1967.

MARLIN EUGENE KIPP
NSF Trainee in Mechanics
B.S., Lehigh, 1967.

HARRY JOSEPH KYLER
NIH Fellow in Psychology
B.A., LaSalle, 1965; M.S., Lehigh, 1967.

JOSEPH ARTHUR LAVELLE
Taga Fellow in Chemistry
B.S., University of Scranton, 1958.

RICHARD A. LAZARUS
NSF Fellow in Chemistry
B.S., Lafayette, 1964.

EDWARD STAFFORD LIPPITT, JR.
NSF Trainee in Chemical Engineering
B.S., Princeton, 1967.

CHIH-CHIANG LIU
University Scholar in Mechanical Engineering
B.S.E., Cheng-Kung University, 1966.

GORDON K. LONG (1967)
NSF Trainee in Physics
B.S., Muhlenberg College, 1963.

ROBERT V. LORENZE, JR.
NSF Trainee in Physics
B.S., Clarkson, 1967.

PAUL MARTIN MACHMEIER
Gotshall Scholar in Metallurgy and Materials Science
B.S., University of Missouri, 1963; M.S., 1965.

CAROL SUE MARCUS
University Scholar in Social Relations
B.A., State University of New York (Buffalo), 1966.

WILLIAM J. MCDONOUGH
NASA Fellow in Metallurgy and Materials Science
B.S., State University of New York (Alfred), 1960.

EDWARD MCCAFFERTY
NASA Fellow in Chemistry
B.S., Wilkes College, 1959; M.S., Lehigh, 1963.

SUSAN LINDA MCGINTY
University Scholar in English
B.S., University of Idaho, 1963.

PAUL FRANCIS MCLAUGHLIN
NASA Fellow in Metallurgy and Materials Science
B. Met. Engr., Rensselaer Polytechnic Institute, 1967.

ROBERT C. MCMAHON
NDEA Fellow in Economics
B.A., University of Washington, 1959; M.A., 1961.

JOHN E. MENEAR
NDEA Fellow in Chemistry
B.S., Shippensburg State College, 1965.

CHARLES JOSEPH MESSA
NDEA Fellow in Chemical Engineering
 B.S., Lehigh, 1965; M.S., 1967.

STEVEN JEFFREY MICHAELS
NSF Trainee in Mathematics
 A.B., Providence College, 1966.

CONRAD A. M. MILLER
NDEA Fellow in Chemical Engineering
 B.S., Newark College of Engineering, 1966; M.S., Lehigh, 1967.

RAYMOND J. MISIEWICZ
NDEA Fellow in Mechanical Engineering
 B.S.M.E., Newark College of Engineering, 1967.

PHILIP WARREN MOHR
Kingsley Fellow in Biology
 B.S., Muhlenberg, 1967.

KATHERINE IRENE MORRIS
Hood Fellow in English
 B.A., Marietta College, 1967.

MARCIA ANN MOSOLF
NDEA Fellow in Mathematics
 B.S., Niagara University, 1967.

THOMAS PATRICK NOLAN
NASA Fellow in Physics
 B.S., University of Scranton, 1964.

MINORU OHTA
Visiting Research Fellow in Civil Engineering
 B.E., Shinshu University (Japan), 1967.

STANLEY J. ORLOWSKI
NASA Fellow in Biology
 B.A., Wilkes College, 1964.

THEODORE JOHN O'TANYI, JR.
NIH Fellow in Biology
 B.S., Pennsylvania Military College, 1963.

NED GEORGE PAULSON
NASA Fellow in Psychology
 B.S., Old Dominion College, 1967.

THOMAS L. PAXSON
NDEA Fellow in Mechanical Engineering
 B.Me., University of Delaware, 1967.

MORTON PERLMAN
Air Reduction Fellow in Metallurgy and Materials Science
 B.Me., City College of New York, 1960.

DIETER H. PETERMICHL
Gotshall Scholar in Metallurgy and Materials Science
 Dipl. Ing., Leoben Mont. Hochschule, 1966.

PAUL H. PETTIT, JR.
NSF Fellow in Chemistry
 A.B., Princeton, 1964.

JAMES POBICKI
NDEA Fellow in Economics
 B.A., Duquesne University, 1966.

WAYNE B. POWELL
NASA Trainee in Philosophy
 B.S., Case Institute of Technology, 1964; M.S., Lehigh, 1965.

GEORGE H. P. POPPER
Kingsley Fellow in Geology
 B.C., CCNY, 1962; M.S., University of Massachusetts, 1965.

THOMAS PAUL RICH
NASA Fellow in Mechanical Engineering
 B.S., Carnegie Institute of Technology, 1965; Lehigh, 1967.

MARCIA RODRIGUEZ
Hood Fellow in English
 B.A., Cedar Crest, 1967.

STEVE M. ROHDE
NSF Trainee in Mathematics
 B.S., Newark College of Engineering, 1967.

CARL A. ROTH
NSF Trainee in Industrial Engineering
 B.S., Lehigh, 1967.

MARK P. SAKS
NDEA Fellow in Mathematics
 B.S., Drexel Institute of Technology, 1967.

KENNETH G. SALTER
NSF Trainee in Electrical Engineering
 B.S., Lehigh, 1967.

EMORY WILLIAM SARVER
NASA Trainee in Chemistry
 A.B., West Virginia University, 1964; M.S., Marshall University, 1966.

FRED ROBERT SAUERWINE
NDEA Fellow in Metallurgy and Materials Science
 B.S., Lafayette, 1966.

JACK MARK SCHLEIN
Thorne Fellow in Biology
 B.S., Brooklyn College, 1966.

NEIL CHARLES SCHOEN
NASA Trainee in Physics
 B.S., Rensselaer Polytechnic Institute, 1963; M.S., Lehigh, 1965.

JOSEPH SHUNTA
Air Products Fellow in Chemical Engineering
 B.S., Michigan Institute of Technology, 1964.

RICHARD DAVID SIEGEL
U.S. Steel Fellow in Chemical Engineering
 B.S., Tufts, 1964; M.S., 1966.

DAVID SMALLWOOD
Texaco Fellow in Chemical Engineering
 B.S., Drexel Institute of Technology, 1967.

RONALD B. SMITH
NDEA Fellow in Metallurgy and Materials Science
 B.Met.E., Rensselaer Polytechnic Institute, 1967.

SAMUEL SOKOL
NIH Fellow in Psychology
 B.A., Washington & Jefferson, 1963; M.A., Bryn Mawr, 1965.

EMMETT J. SPEICHER
Gotshall Scholar in Chemical Engineering
 B.S., Catholic University of America, 1967.

Faculty and Staff: Fellows and Scholars

GAIL RITA STEINER (1967)

NDEA Fellow in Chemical Engineering
B.S., Newark College of Engineering, 1963; M.S., Syracuse University, 1967.

ROBERT DAVID STETTEN

NASA Fellow in Psychology
B.A., Lehigh, 1961; M.A., University of Iowa, 1962; M.A., 1963.

ROGER H. STOUDT

NDEA Fellow in Mechanical Engineering
B.S., Lehigh, 1967.

FRANK A. SZUMILO

NDEA Fellow in Economics
B.S., Wilkes College, 1966.

JOHN A. TADDIE

University Scholar in Education
B.S., Indiana State University, 1951; M.Ed., University of Maryland, 1959.

LAWRENCE A. TAYLOR

NASA Fellow in Geology
B.S., University of Indiana, 1961; M.A., 1963.

TREVOR TAYLOR

Packer Fellow in International Relations
B.Sc., London University, 1967.

NEGUSSE TEBEDGE

Research Fellow in Civil Engineering
B.S., Hailie Selassie University (Ethiopia), 1965.

PAUL TEBO

NSF Trainee in Chemical Engineering
B.S., Tufts, 1965; M.S., Lehigh, 1966.

JOHN H. THOMAS III (1967)

NSF Trainee in Physics
B.S., Drexel Institute of Technology, 1965.

RICHARD TOMALESKY

NASA Trainee in Chemistry
B.S., Lehigh, 1965.

DENNIS F. TOROK, JR.

NDEA Fellow in Mechanical Engineering
B.S., Lehigh, 1963; M.S., Penn State, 1965.

GEORGE TREVINO

NSF Trainee in Mechanics
B.S., Texas A & I College, 1965.

JOHN WAYNE WAGENER

NSF Trainee in Psychology
B.A., Johns Hopkins University, 1965.

JERRY L. WAGNER

NDEA Fellow in Mechanical Engineering
B.S., Rhode Island, 1967.

M. BRENT WALL

NDEA Fellow in Philosophy
B.A., Ursinus, 1964.

JOHN HERBERT WEBER, JR.

Inco Fellow in Metallurgy and Materials Science
B.S., Lehigh, 1963.

GORDON M. WHITE

NASA Fellow in Chemistry
B.S., Miami University (Ohio), 1965.

EMMETT J. WOLFE

NASA Fellow in Mechanical Engineering
B.A.S.E., University of Florida, 1964; M.S., Lehigh, 1966.

JAMES D. WOMER

NSF Scholar in Electrical Engineering
B.S., Lehigh, 1966; M.S., 1967.

YAO-CHING WU

Baldwin Fellow in Civil Engineering
B.S., National Taiwan University, 1955; M.S., University of Michigan, 1962.

SHANE SHIAN YEN

MRC Fellow in Metallurgy and Materials Science
B.S., Taiwan Provincial Cheng Kung University, 1961; M.S., University of Missouri, 1965.

HIROSHI YOSHIDA

Brink Fellow in Civil Engineering
B.S., Kanazawa University (Japan), 1961.

DARELL RILEY ZERBE

NSF Trainee in Industrial Engineering
B.A., B.S., Rutgers University, 1966.

National Science Foundation Institute in Economics, 1967-68

STANLEY S. ANTONIOTTI
B.A., Marietta, 1964

JAMES MARSHALL BARKER
B.S., Indiana State, 1962; M.S., 1963.

LEWIS M. FOX
B.A., University of Texas, 1961; M.A., 1962.

BARRY PATRICK KEATING
B.B.A., Notre Dame, 1967.

FORREST EARL KEESBURY
B.S., Defiance College, 1961; M.A., Bowling Green (Ohio) State University, 1965.

ROBERT MACFARLAND LACY
B.A., Allegheny, 1946; M.A., Ohio State University, 1950.

JOSE MAGNET
M.B.A., E.S.A.D.E. (Barcelona), 1967.

ROBERT MCGINTY
B.S., University of Idaho, 1962; M.S., 1965.

EDILBERTO LIBREA RODRIGUEZ
A.B., DeLaSalle College (Manila), 1963; B.S.B.A., 1965.

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