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## ADMINISTRATION

Edmund Ezra Day, Ph.D., LL.D., President of the University.
Gustavus Watts Cunningham, A.M., Ph.D., Litt.D., LL.D., Dean of the Graduate School.
Otis Freeman Curtis, A.B., Ph.D., Secretary of the Faculty.

## GENERAL COMMITTEE

Professor Carl Stephenson, at large, term expires 1948.
Professor C. M. McCay, at large, 1949.
Professor G. W. Salisbury, at large, 1950.
Professor L. S. Cottrell, at large, 1950.
Professor James Hutton, Group A (Languages and Literatures), 1948.
Professor F. A. Southard, Jr., Group B (History, Political Science, Philosophy, Psychology, Agricultural Economics, Farm Management, Rural Sociology), 1950.
Professor L. P. Smith, Group C (Mathematics, Astronomy, Physics, Chemistry, Geology, Geography, Geodesy), 1950.
Professor P. A. Readio, Group D (Biological Sciences), 1949.
Professor E. M. Strong, Group E (Engineering, Architecture, Applied Physical Sciences, Rural Engineering, Landscape Design), 1948.
Professor C. V. Morrill, Group F (Preclinical Departments of the Cornell University Medical College in New York City), 1949.
Professor H. C. Thompson, Group G (Agricultural Sciences), 1949.
Professor B. F. Willcox, Group H (Law), 1950.
Professor P. J. Kruse, Group I (Education), 1948.
Professor J. W. McConnell, Group J (Division of Industrial and Labor Relations), 1949.
The Secretary of the Faculty.
The Dean, Chairman ex officio.
The Office of the Graduate School is in the Administration Building (first floor). The office hours are 8:30 to 4 .

## GENERAL INFORMATION

## THE FACULTY

The Faculty of the Graduate School has exclusive jurisdiction over graduate work leading to the degrees listed below. It consists of three groups: (1) an ex-officio group, including the President of the University, who is the presiding officer, the Deans or Directors of the several Faculties of the University, and the Directors of the Experiment Stations; (2) a variable academic group consisting of those professors, associate professors, assistant professors, and instructors who, as members of special committees, are actively engaged in supervising the work of graduate students; (3) a permanent academic group including those members of the University Faculty who, during five consecutive years, have been members of group (2).

Professors, associate professors, assistant professors, instructors who hold the Doctor's degree, and such other members of the teaching or research staff of the University as the Faculty may authorize are eligible for membership on the Special Committees which supervise the work of graduate students.

The General Committee of the Graduate School is the chief administrative body of the Faculty. It is composed of fourteen members elected by the Faculty and two members ex-officio. It is the duty of the General Committee to pass upon questions which do not involve a change of policy; to consider such matters as may be referred to it by the Faculty; and upon its own initiative to make recommendations to the Faculty regarding questions involving the interests of the Graduate School.

## DEGREES OFFERED

It is the purpose of the Graduate School to offer facilities for advanced study and research, to the end that adequately trained students may receive a comprehensive view of a field of knowledge and the training required for independent investigation in that field.

The requirement for receiving an advanced degree is a high grade of scholarly work rather than the fulfillment of routine requirements.

The following degrees are offered:

```
Master of Arts (A.M.)
Master of Science (M.S.)
Master of Science in Agriculture }\mp@subsup{}{}{1}\mathrm{ (M.S. in Agr.)
Master of Fine Arts (}\mp@subsup{}{}{2}\mathrm{ (M.F.A.)
Master of Architecture2 (M.Arch.)
Master of Landscape Architecture }\mp@subsup{}{}{2}\mathrm{ (M.L.A.)
Master of Regional Planning}\mp@subsup{}{}{2}\mathrm{ (M.R.P.)
Master of Science in Engineering (M.S. in Eng.)
Master of Chemical Engineering3 (M.Chem.E.)
Master of Civil Engineering}\mp@subsup{}{}{3}\mathrm{ (M.C.E.)
Master of Electrical Engineering3 (M.E.E.)
Master of Mechanical Engineering3 (M.M.E.)
Master of Laws (LL.M.)
Master of Education }\mp@subsup{}{}{5}\mathrm{ (M.Ed.)
Master of Science in Education }\mp@subsup{}{}{5}\mathrm{ (M.S. in Ed.)
Master of Science in Industrial and Labor Relations }\mp@subsup{}{}{6
(M.S. in I.L.R.)
Doctor of the Science of Law (J.S.D.)
Doctor of Philosophy (Ph.D.)
```


## ADMISSION

An application for admission should be made on the proper form, which will be supplied at the office of the Graduate School. No application will be acted upon until all the credentials enumerated in this form have been filed. In addition to presenting these credentials, the applicant is strongly urged to take the Graduate Record Examination and to submit his scores with his application. This exami-

[^0]nation does not require any special preparation, and it is available for a moderate fee. Information about the examination may be obtained and arrangements for taking it made by direct application to the Graduate Record Office, 437 West 59th Street, New York 19, New York.
Inquiries about admission should be addressed to The Graduate School, Cornell University, Ithaca, New York. Inquiries about facilities for advanced study and research should be addressed to the Department in which such work is done, or to the Division under whose jurisdiction the degree is granted.
For admission in the fall or spring term, new applications with all supporting documents should be filed in the office of the Graduate School not later than three weeks before the beginning of the term; for admission in the summer session, not later than two weeks. Applications completed later than these dates may fail of consideration in time for registration at the beginning of the term following.

To be admitted to the Graduate School an applicant (1) must hold a baccalaureate degree from a college or university of recognized standing, or have done work equivalent to that required for such a degree; (2) as judged by his previous scholastic record, or otherwise, must show promise of ability satisfactorily to pursue advanced study and research; and (3) must have had adequate preparation to enter upon graduate study in the field chosen.

A senior in one of the colleges of Cornell University who has completed the academic requirements for a Bachelor's degree, and who qualifies under (2) and (3), may be admitted to the Graduate School, provided his admission is approved by the dean of his college.

An applicant is admitted to the Graduate School in one of the following categories: (1) a candidate for a degree; (2) a non-candidate; (3) a resident doctor.

Candidates. Students admitted to the Graduate School usually pursue a course leading to one of the advanced degrees. The work of a candidate for a degree is directed by a Special Committee, selected by the student.
Candidates for the degrees A.M., M.S., M.Arch., M.L.A., or M.F.A. are expected to have had training in a foreign language equivalent to three college entrance units, or in two foreign languages equivalent to two college entrance units each. If an applicant cannot offer such training, he must pass within the first month of his candidacy
an examination in a foreign language approved by his Special Committee or a longer period of residence is required for the degree.

A candidate for an advanced professional degree given under the jurisdiction of some division of the Graduate School should examine the special requirements for the degree printed at the beginning of the announcement for the division which has jurisdiction over it.

Non-candidates. A properly qualified person who, for valid reasons, does not wish to meet the requirements for a degree may be admitted to the Graduate School as a "non-candidate" and may arrange a program of graduate study suitable to his purposes. A noncandidate is required to select from the members of the Graduate Faculty an adviser to direct his work. He must file with the Dean not later than two weeks after his first registration a statement of the field in which he wishes to work, approved by his adviser. A noncandidate is expected to pursue a coördinated program of graduate work, and his courses must as a rule be chosen from those titled in italic small letters in this Announcement. Each term he must file a statement of the courses which he means to pursue, approved by his adviser.

Resident Doctors. Persons who hold the Doctor's degree or who have equivalent standing may, with permission from the Dean, be admitted to the Graduate School as Resident Doctors, for the purpose of engaging in advanced study and research in a field in which they have had adequate preparation. On the recommendation of the Dean, Resident Doctors are exempt from the payment of tuition and all fees except laboratory charges. Ordinarily they are not permitted to attend classes.

MEDIGAL REQUIREMENTS...Every student matriculating in the University is required to present a satisfactory certificate of vaccination against smallpox. This must certify either to a successful vaccination within the five years preceding matriculation or to at least three unsuccessful attempts at vaccination within that period.
Within a month preceding or a month following matriculation every student must submit to the University Health Officer for permanent filing, a satisfactory chest radiograph taken within this two-month period. Such radiographs are made at the Infirmary at a special rate charged to students.

REGISTRATION...
The rules of the University provide: "All students taking work in the Graduate School or work leading to, or in contemplation of, an advanced degree, shall, at the beginning of each term or session, register both in the Graduate School and with the Registrar of the University." A fee of $\$ 5$ is required for late registration by matriculated students.
Candidates for advanced professional degrees shall register also with the division concerned.

A graduate student who has completed the requirements of residence for his degree and who remains in residence while working on his thesis or while doing other work in contemplation of a degree must register each term in which he is thus engaged.
A graduate student who returns to the University to present his thesis and to take the final examination for an advanced degree, all other work for that degree having been previously completed, shall register as a "candidate for degree only" and shall pay only an administration fee of $\$ 12.50$.
A graduate student who discontinues his work for any reason during a term in which he is registered should immediately report this fact at the office of the Graduate School.

## REQUIREMENTS FOR MASTERS' DEGREES

## RESIDENCE REQUIREMENTS...

The minimum residence requirement for a master's degree is two full terms.

Before he may be awarded any degree conferred by Cornell University, a student must have spent at least one full academic year, or the equivalent, in residence at the University and in study for that degree. In consequence, graduate work done elsewhere cannot be counted to reduce the residence requirement for a master's degree below one year.

To receive credit for residence a candidate must be regularly enrolled in the Graduate School. The satisfactory completion of his work, term by term, must be attested by the members of his Special Committee.

The amount of residence credit granted to a candidate who holds an appointment as instructor, as a teaching or research assistant, or
who is acting in any capacity involving a significant loss of time from his graduate work, shall be determined by the General Committee of the Graduate School, upon recommendation of the student's Special Committee. Ordinarily such credit shall not exceed three-fourths, and in the case of full-time instructors one-half, of full residence credit; but those whose teaching or research duties do not involve more than six clock-hours a week may receive full residence on recommendation of their Special Committees.

A candidate for an advanced degree is expected to complete his residence with reasonable continuity. All work for an advanced degree, including the final examination, must be completed within four years after the minimum residence requirement for the degree has been satisfied.

Work Under Personal Direction. A candidate for a master's degree who has been in residence for two academic terms and lacks not more than one-half of a term's residence for completion of the residence requirement may, on recommendation of his Special Committee and with approval of the Dean, be permitted to register under Personal Direction for completion of the requirement. Such registration must be made in advance at the office of the Graduate School, and satisfactory completion of the work must be certified by the professor supervising the work.

Residence credit in the Summer Session. ${ }^{1}$ For A.M., M.S., M.S. in I.L.R., and M.S. in Agr., residence during Summer Sessions may be counted at the rate of three Summer Sessions for one term of credit, and five sessions for two terms; for all other masters' degrees at the rate of two Summer Sessions for each term of credit.

To obtain residence credit in the Graduate School for work done in the Summer Session the candidate must register both in the Summer Session and in the Graduate School. He must file in the office of the Graduate School within one week after registration a statement of courses as provided for students in the regular session.

Additional requirements of residence for deficiency in foreign language. Candidates for the degree of A.M., M.S., M.S. in I.L.R., M.Arch., M.L.A., or M.F.A., are subject to the following special requirement in foreign language, which may affect the amount of residence required of them.
(a) A candidate must have had training in a foreign language

[^1]equivalent to three college entrance units, or in two foreign languages equivalent to two college entrance units in each; or
(b) if he lacks such training he must, at the beginning of his candidacy (i.e., within one month after registration), prove his ability to read either French or German (or another language other than English approved by his Special Committee) by passing an examination given by a member of the Language Examination Board.
(c) An applicant who, at entrance, cannot meet either of the requirements (a) or (b), but who is otherwise qualified for admission, may be admitted to candidacy subject (1) to presenting three terms of residence (instead of two) for graduation and (2) to demonstrating, before a member of the Language Examination Board not later than the beginning of his last term of residence, a reading knowledge of a foreign language as provided above. The General Committee of the Graduate School, upon the recommendation of the student's Special Committee, may waive the requirement of an extra term of residence, provided preparation in foreign language is made during a period when the student is not receiving residence credit.

REQUIREMENTS IN COURSE...Two plans of procedure are offered to candidates for masters' degrees, described below as Plan A and Plan B.

PLAN A. Open to candidates for A.M., M.S., M.S. in Agr., M.S. in I.L.R., M.F.A., M.Arch., M.L.A., M.R.P., M.S. in Eng., M.Chem. E., M.C.E., M.E.E., or M.M.E.

Plan A is intended for those candidates who wish to acquire a considerable degree of competence in a restricted field of work, frequently as a basis for further study and research, or for professional purposes.
The candidate works under the direction of a Special Committee, usually of two faculty members, representing a Major and a Minor Subject. He is required to present a thesis or an essay acceptable to his committee and to pass a final examination.
Major and Minor Subjects. A list of approved Major and Minor Subjects will be found below, in the announcement of each field of instruction. Before selecting his Major and Minor Subjects the student should consult members of the Faculty regarding suitable combinations of subjects. Ordinarily the candidate will devote the
major portion of his time - say something over one-half - to his Major Subject, and the remainder to his Minor Subject, the exact division being determined by his Committee. The requirements may consist of work in formal courses, informal work in seminars, or assigned reading or study and research in the discretion of the Special Committee. There are no requirements in semester hours under Plan A.

Special Committee. After the candidate has chosen his Major and Minor Subjects, he must select at least one member of the Faculty to represent each subject and to serve as the members of his Special Committee. The representative of the Major Subject is the chairman. Not later than two weeks after his first registration in the Graduate School a candidate must file, on the proper blank, a statement of the Major and Minor Subjects which he has selected. This statement must be signed by each member of the Special Committee as an indication of his approval and consent to serve on the committee.

A candidate may change the membership of his Special Committee with the approval of all the members of the newly constituted Committee. Notice of such change must be filed immediately with the Dean of the Graduate School. A vacancy on a Special Committee, caused by the absence of a member from the University, may be filled by the Dean on joint recommendation of the candidate and the members concerned.

Statement of Courses. At the beginning of each term a candidate shall make out in duplicate a list of all the courses which he plans to take during the term and shall have this list signed by the chairman of his Committee as an indication of approval. The chairman of the Committee shall retain one copy; the duplicate copy shall be filed in the office of the Graduate School within two weeks after registration. Any subsequent change in this list of courses must be certified to the office of the Graduate School by the chairman of the Committee. Courses primarily for undergraduates, printed in italic small letters, are ordinarily not open to graduate students.

Thesis or Essay. A candidate for any of the masters' degrees under Plan A must complete an acceptable thesis, or, in the discretion of his Special Committee, an essay. The thesis, or essay, is ordinarily written in the candidate's major field and under the direction of the chairman of his Special Committee. It must be approved, however, by all members of the Committee. For this purpose it should
be in the Committee's hands at least fifteen days before the final examination; and during the five days immediately preceding this examination a typewritten copy, approved by all members of the Special Committee, must be on file in the office of the Graduate School.

The thesis must be typewritten, double spaced, on a durable rag bond, $8 \times 101 / 2$ inches, with a left-hand margin of at least an inch and a quarter. The carbon copy need not be on bond paper. The title-page should be set up according to the following form:
[TITLE OF THESIS]

## A Thesis

Presented to the Faculty of the Graduate School of Cornell
University for the degree of
[ ]

## By

[Author's Name in Full]
[Date on which degree is to be conferred.]

Immediately following the title-page there must be a biographical sketch of the author, in length not exceeding 150 words.

Before the degree can be conferred two ${ }^{1}$ bound typewritten copies (one of which must be a ribbon copy) of the completed thesis, approved by the Special Committee, must be deposited in the office of the Graduate School. These copies become the property of the University Library.

When the Major Subject for the degree of Master of Architecture or the degree of Master of Landscape Architecture is in Design, the candidate is required to deposit, in place of the thesis, either his original drawings or a photographic reproduction of them.

Final examination. After the thesis, or essay, has been completed and filed in the office of the Graduate School, as provided above, and after the required period of residence has been substantially completed, the candidate is required to present himself for the final examination. No candidate may proceed to the final examination until the other requirements for his degree have been completed, except that the final examination may be given near the end of the

[^2]candidate's last term of residence. The examination covers the thesis and the Major and Minor Subjects. It may be written or oral, or both, at the option of the Special Committee.
An application for final examination, approved by the Special Cominittee, must be filed in the office of the Graduate School at least five days in advance of the examination.

Final examinations are conducted by the candidate's Special Committee and are open to all members of the Faculty. At the discretion of the Special Committee those under whom the candidate has worked may be invited to participate in the examination. But the Special Committee alone shall decide upon the merits of the candidate's performance.
A report on each final examination, whether passed or failed, shall be filed by the Special Committee in the office of the Dean. By permission of his Special Committee, a candidate who has failed in a final examination may present himself for one re-examination but only within a period of from three to six months after the failure.
PLAN B. Open to candidates for A.M., M.S., M.S. in I.L.R., or M.S. in Agr.

Plan B is designed for those who wish a somewhat broader training than is permitted under Plan A. It is intended to meet the needs of prospective or in-service teachers in secondary schools and of others who wish to supplement a four-year college course by an additional year of study at the graduate level. The candidate, working under the direction of a Special Committee, is required (1) to complete satisfactorily a minimum of thirty semester hours of work, comprising (a) work in formal courses and in seminars, including such examinations as may be given therein, and (b) either an acceptable expository or critical essay or problem in research, or, if he prefers, a formal thesis; and (2) to pass a final comprehensive examination.
Fields of Concentration. Of the thirty semester hours in formal courses, seminars, and the like required of a candidate working under plan B, approximately one-half must be in a field of concentration chosen by the candidate; and the remainder may be distributed in that field and in related fields, in the discretion of the candidate's Special Committee, as best meets his needs. Fields of concentration are broader than major and minor subjects specified under Plan A.

The following is a provisional list of fields of concentration from which selection may be made; but the student's choice is not limited to this list. If none of these is suitable, he should consult the Dean of the Graduate School or the professors in the field in which he is interested.

Agricultural Economics Biological Sciences<br>Education<br>English<br>Fine Arts<br>Foreign Languages<br>General Science<br>Home Economics

Mathematics<br>Industrial and<br>Labor Relations<br>Physical Sciences<br>Speech and Drama<br>Social Studies<br>Technical Agriculture

Special Committees. After the candidate has chosen his field of concentration, he must select two members of the Faculty to serve as his Special Committee. One of these, who is chairman of the Committee, must represent the field of concentration, the other may be chosen from either that field or some related field, depending on the candidate's program. The Committee members' consent to serve, together with a statement of the field of concentration approved by both members of the Committee, must be filed with the Dean of the Graduate School, on the proper blank, not later than two weeks after first registration.

A candidate may change the membership of his Special Committee with the approval of all the members of the newly constituted Committee. Notice of such change must be filed immediately with the Dean of the Graduate School. A vacancy on a Special Committee, caused by the absence of a member from the University, may be fited by the Dean on joint recommendation of the candidate and the members concerned.

Statement of Courses. At the beginning of each term a candidate shall make out in duplicate a list of all the courses which he plans to take during the term and shall have this list signed by the chairman of his Committee as an indication of approval. The chairman of the Committee shall retain one copy; the duplicate copy shall be filed in the office of the Graduate School within two weeks after registration. Any subsequent change in this list of courses must be certified to the office of the Graduate School by the chairman of the

Committee. Courses primarily for undergraduates, printed in italic small letters, are ordinarily not open to graduate students.

Thesis, Research, or Essay. A substantial part of the candidate's work in the field of concentration shall be devoted to studies requiring investigation, organization of material, and criticism. Whether the candidate is to meet this requirement by work in seminars, by writing an essay or a thesis, or in some other way is left to the Special Committee in consultation with the candidate. If a thesis is required, the candidate must follow the procedure for presenting theses outlined under Plan A.

The Special Committee will report to the office of the Graduate School the semester-hour equivalent and the grades for the thesis or the essay, or for other work, not otherwise reported in formal courses, done by the candidate in meeting this requirement.
Final Examination. After the candidate has substantially satisfied the minimum period of residence and has satisfactorily completed at least thirty semester hours of work approved by his Special Committee, he must present himself for the final comprehensive examination. No candidate may proceed to the final examination until the other requirements for his degree have been completed, except that the final examination may be given near the end of the candidate's last term of residence while he is still taking courses required for the degree. Eligibility for the final examination depends on satisfactory progress in those courses, and their completion is essential to meeting all requirements. The examination covers the thesis or essay, if presented, as well as work done in formal courses and seminars. The examination may be written or oral, or both, at the option of the Special Committee.

An application for final examination, approved by the Special Committee, must be filed in the office of the Graduate School at least five days in advance of the final examination.
Final examinations are conducted by the candidate's Special Committee and are open to all members of the Faculty. At the discretion of the Special Committee those under whom the candidate has worked may be invited to participate in the examination. But the Special Committee alone shall decide upon the merits of the candidate's performance.

A report on each final examination, whether passed or failed, shall be filed by the Special Committee in the office of the Dean. By
permission of his Special Committee, a candidate who has failed in a final examination may present himself for one re-examination but only within a period of three to six months after the failure.

## SPEGIAL REQUIREMENTS FOR PROFESSIONAL DEGREES...

The following special requirements apply in the case of the professional masters' degrees enumerated.

Master of Laws, LL.M. The degree of LL.M. is intended primarily for those who desire to increase their knowledge of the law by work in special fields. In addition to meeting the general requirements for admission, the candidate must have received the degree of Bachelor of Laws from an approved law school and must have shown a high level of professional ability. To complete the requirements for the degree the candidate (1) must work for a minimum period of two terms under the direction of a Special Committee of three or more, chosen by the candidate, after consultation with the chairman of the Division of Law, from the Faculty in Law and related fields (such as Economics, Government, History, and Philosophy); (2) shall complete with high merit such a program of instruction and investigation as shall be approved by his Special Committee and acceptable to the Division; (3) must demonstrate his ability creditably to pursue research in Law by the submission of articles or reports; and (4) must pass with superior standing a final examination and such other examinations as shall be required by his Special Committee and acceptable to the Division. For further information see page 240 of this Announcement and also the Announcement of the Cornell Law School.

Master of Education, M.Ed. This degree is awarded at the end of the fifth year of the five-year program for the preparation of secondary school teachers. Though a brief statement regarding the program for this degree is presented below in this Announcement, complete information may be found in the Announcement of the School of Education. Prospective candidates should communicate with the Director of the School of Education, 211 Stone Hall, Ithaca, New York.

Master of Science in Education, M.S. in Ed. The degree is designed for persons of experience who wish to prepare themselves for
specialized form of educational work. The candidate, working under the direction of a Special Committee for a minimum of two terms, is required to complete an approved program of study adjusted to his needs. The candidate is required to pass a comprehensive final examination. For further details see below in this Announcement.
Master of Fine Arts, M.F.A. This degree is designed for students primarily interested in the practice of Dramatics, Painting, or Sculpture, who wish to supplement their practical work with studies in the history and theory of those arts. Normal residence requirement for this degree is two years following the baccalaureate.

Masters' Degrees in Engineering. For special requirements, see the announcement of the Engineering Division below.

## REQUIREMENTS FOR THE PH.D. DEGREE

Work leading to the Ph.D. degree is designed to give the candidate a thoroughly comprehensive view of a field of knowledge and to train him in methods of research and scholarship in that field. A candidate is expected to maintain a high grade of achievement and to show evidence of ability in independent investigation and study. The requirements for the degree include (1) a minimum of six terms of residence as a graduate student; (2) the satisfactory completion, under the direction of a Special Committee, of work in one Major Subject and two Minor Subjects; (3) certain requirements in foreign language; (4) the presentation of an acceptable thesis and an abstract of the thesis; and (5) the passing of a qualifying examination and a final examination.
RESIDENCE REQUIREMENTS...For the Ph.D. degree a minimum of six terms of residence is required; or seven terms if the candidate does not pass one of the examinations in foreign language (see below requirements in foreign language) on beginning candidacy at Cornell University.

To receive credit for residence a candidate must be regularly enrolled in the Graduate School. The satisfactory completion of his work, term by term, must be attested by the members of his Special Committee.

No candidate may earn more than two terms of residence credit in any twelve-month period except with the permission of the Dean
in special cases. (This rule is suspended to permit accelerated programs of study during the emergency.)

The amount of credit granted to a candidate who holds an appointment as instructor, as a teaching or research assistant, or who is acting in any capacity involving a significant loss of time from his graduate work, shall be determined by the General Committee of the Graduate School, upon recommendation of the Special Committee. Ordinarily such credit shall not exceed three-fourths, and in the case of full-time instructors one-half, of full residence credit; but those whose teaching or research duties do not involve more than six clock-hours a week may receive full residence on recommendation of their Special Committees.

A candidate for an advanced degree is expected to complete his residence with reasonable continuity. All work for an advanced degree, including the final examination, must be completed within four years after the minimum residence requirement for the degree has been satisfied.

At least two of the last four terms, and ordinarily the last two, must be spent in consecutive regular terms (other than the six-week Summer Session) at Cornell University.

Residence Credit for a Master's Degree. Residence credit earned as a candidate for a master's degree, either at Cornell or elsewhere, may be credited toward the Ph.D. degree. Normally not more than two terms of credit may be gained in this way, and the transfer requires the recommendation of the Special Committee.

Credit for Work in Other Universities. Upon the recommendation of the candidate's Special Committee residence up to a maximum of four terms may be credited toward the doctor's degree for work done in other universities. Application for such credit should be made by the student as soon as possible after registration, and not later than the end of the first term of residence at Cornell.

Residence in Summer Session. ${ }^{1}$ To obtain residence credit in the Graduate School for work done in the Summer Session the candidate must register both in the Summer Session and in the Graduate School. He must file in the office of the Graduate School within one week after registration a statement of courses, as provided for candidates in the regular session. For the Ph.D. degree residence during

[^3]Summer Sessions may be counted at the rate of three Summer Sessions for one term of credit, and five Sessions for two terms.

Credit toward the Ph.D. degree earned in Summer Sessions at Cornell or elsewhere is ordinarily limited to two terms. A candidate who has already earned two terms of credit by work in Summer Sessions and who has demonstrated ability in graduate work may, however, upon recommendation of his Special Committee and with the approval of the General Committee, earn one more term of credit by work in Summer Sessions at Cornell, with the privilege of credit for an additional term for research under personal direction. In this case, however, the last year of candidacy must be spent in residence at the University and in consecutive, regular terms (other than the six-week Summer Sessions).
Research under Personal Direction. A candidate for the Ph.D. degree who has demonstrated ability in graduate studies may, upon recommendation of his Special Committee and with the approval of the Dean, receive residence credit for research done during the summer under the personal direction of a member of the Faculty of the Graduate School. The privilege of working under Personal Direction will not ordinarily be granted to a student until he has completed at least one year of graduate work in regular terms (other than the six-week Summer Session). Application for the privilege must be accompanied by a statement of the member of the Faculty concerned showing the number of weeks during which he is prepared to supervise the work of the student and the nature of the research to be done. To obtain credit for such work, the candidate must register in advance at the office of the Graduate School, and the professor must certify to its satisfactory completion. A maximum of two terms may be earned in this way.

A candidate registered under Personal Direction during the summer may be admitted to the classes of the six-week Summer Session. Such candidates must register both in the Summer Session and in the Graduate School and must pay tuition at least equal to that required for the Summer Session.

Work in Absentia. A candidate for the Ph.D. degree may be credited with residence for work done away from the University, provided such an arrangement offers superior advantages for the prosecution of the candidate's work. Work in absentia is subject to the following conditions:
(a) An applicant for this privilege must be regularly registered in the Graduate School as a candidate for the doctorate, and while not in residence shall receive no compensation except from the University.
(b) He shall have spent at least two terms in Cornell University in study towards the doctor's degree.
(c) Permission to count such time as residence may be given by the Dean of the Graduate School for a period not to exceed one term, when the application is unanimously approved by the members of the applicant's Special Committee. When a longer period of outside study is required, application for an extension of time should be made to the General Committee, which may, at its discretion, extend the period to two terms. In no event, however, shall a candidate acquire a total of more than two terms' residence under these provisions.
(d) A candidate who avails himself of this privilege shall continue to work under the general direction of his Special Committee. Whenever possible, however, the work should be carried on under the immediate supervision of a competent director, acting for the Special Committee and to be designated by that Committee.
(e) Reports regarding the progress of the work shall be made as directed by the Special Committee at intervals not in excess of one month.
(f) In case a candidate desires to work in absentia during either or both of the last two terms of his residence, he must petition the General Committee for a waiver of the rule requiring him to spend these terms in residence at the University.

MAJOR AND MINOR SUBJECTS...A candidate for the Ph.D. degree must select a Major Subject and two Minor Subjects properly related to the Major Subject. He will devote more time to the Major Subject than to either Minor Subject, but the division of his time is left to the Special Committee. A list of approved Major and Minor Subjects will be found below, in the announcement of each field of instruction. The candidate should consult members of the Faculty regarding his choice of subjects. Work in Major and Minor Subjects consists of work in formal courses, informal work in seminars, assigned reading, and independent study, in the discretion of the Special Committee. There are no requirements in semester hours for the Ph.D. degree.

Special Committees. After the candidate has chosen his Major and Minor Subjects, he must select a member ${ }^{1}$ of the Faculty to represent each subject. The three persons so selected constitute the candidate's Special Committee, the representative of the Major Subject being chairman. Not later than two weeks after his first registration in the Graduate School a candidate must file, on the proper blank, a state-

[^4]ment of the Major and Minor Subjects which he has selected. This statement must be signed by each member of the Special Committee as an indication of his approval and consent to serve on the Committee.

A student may change the membership of his Special Committee with the approval of all the members of the newly constituted Committee. Notice of such change must be filed immediately with the Dean of the Graduate School. No such change in his Special Committee may be made after the fourth term of residence except with the approval of the Dean. A vacancy on a Special Committee, caused by the absence of a member from the University, may be filled by the Dean on joint recommendation of the candidate and the members concerned.

Statement of Courses. At the beginning of each term a candidate shall make out in duplicate a list of all the courses which he plans to take during the term and shall have this list signed by the chairman of his Committee as an indication of approval. The chairman of the Committee shall retain one copy; the duplicate copy shall be filed in the office of the Graduate School within two weeks after registration. Any subsequent change in this list of courses must be certified to the office of the Graduate School by the chairman of the Committee. Courses primarily for undergraduates, printed in italic small letters, are ordinarily not open to graduate students.

REQUIREMENTS IN FOREIGN LANGUAGES...A candidate for the Ph.D. degree whose native language is English must demonstrate his ability to read both French and German (or two languages, other than English, approved by his Special Committee), by passing in each of these languages an examination given by a member of the Language Examination Board. The examiner is to be designated by the Dean of the Graduate School. The two languages so approved shall be significantly useful in the candidate's field of work and not chosen solely with reference to the preparation of the thesis.

On recommendation of the Special Committee, English may be presented as a foreign language by a candidate whose native language is other than English. The examination will test the candidate's knowledge of the spoken as well as the written language, and the candidate's native language may not be presented as the second language.

A candidate for Ph.D. is expected to meet the foreign language requirements within one month after the beginning of his candidacy at Cornell University for that degree. A minimum of seven terms of residence is required of a candidate who does not pass at least one language examination at this time. The extra term of residence may be waived by the General Committee of the Graduate School upon recommendation of the student's Special Committee, if preparation in foreign language is made during a period when the candidate is not receiving residence credit.

All examinations to test a candidate's knowledge of a foreign language must be passed at Cornell University before a member of the Language Examination Board. In case of failure in an examination, no re-examination can be given, ordinarily, within one month.

A minimum of three terms of residence is required after completion of all language requirements, except in the case of a student admitted to candidacy with two or more terms of residence credit; in such case, a minimum of two terms is required.

Language examinations passed within one month after registration are considered as being passed at the time of registration.

THESIS . . A candidate for the Ph.D. degree is required to present a thesis. Ordinarily the thesis is written in the candidate's major field and under the direction of the chairman of his Special Committee. But with the approval of the representatives of the Major and Minor Subjects the candidate may elect to write the thesis under the direction of another member of the Faculty, who then becomes a member of the Special Committee.

The thesis must be approved by all members of the Special Committee and must be acceptable in respect both of scholarship and of literary quality. The completed thesis should be in the hands of the Special Committee at least fifteen days before the final examination (Examination B or C; see below). During the five days immediately preceding this examination a typewritten copy, approved by all members of the Special Committee, shall be on file in the office of the Graduate School. Under no circumstances may this final examination ( B or C ) be given before the thesis has been accepted and filed.

The thesis must be typewritten, double spaced, on a durable rag bond, $8 \times 101 / 2$ inches, with a left-hand margin of at least an inch and
a quarter. The carbon copy need not be on bond paper. The titlepage should be set up according to the following form:
[TITLE OF THESIS]

## A Thesis

Presented to the Faculty of the Graduate School of Cornell
University for the degree of

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[ ]
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## By

[Author's Name in Full]
[Date on which degree is to be conferred.]

Immediately following the title-page there must be a biographical sketch of the author, in length not exceeding 150 words.

Before the degree can be conferred two ${ }^{1}$ bound typewritten copies (one of which must be a ribbon copy) of the completed thesis, approved by the Special Committee, must be deposited in the office of the Graduate School. These copies become the property of the University Library.

Abstract of thesis. A candidate for the Ph.D. degree must deposit in the office of the Graduate School an abstract of his thesis in two copies, typewritten, double spaced, on bond paper, $8 \times 101 / 2$ inches. The abstract should be about 1500 words in length and should not exceed 1700 words. It must be approved by the Chairman of the Special Committee and presented in a form acceptable for printing.

The candidate must pay to the Treasurer of the University a fee of $\$ 12.50$ to cover the cost of publishing his abstract in an annual volume, "Abstracts of Theses." This volume will be available in the year following that in which the student receives his degree. A recipient of the degree who wishes to receive a copy of the volume containing the abstract of his thesis should file his name and address in the Office of the Graduate School at the time of submitting his abstract. Off-prints of an abstract may be obtained by agreement with the contracting printer.

[^5]EXAMINATIONS...
Qualifying Examination. A candidate for the Ph.D. degree must pass a qualifying examination given by his Special Committee. The primary purposes of the qualifying examination are: (1) to ascertain whether the candidate is qualified to continue work for the doctorate; and, if so, (2) to aid in planning his work during the remainder of his candidacy. The examination is ordinarily given at the end of the first year of graduate study, if that year is at Cornell. If the candidate has had one year or more of graduate work elsewhere, the qualifying examination should be given as soon as possible after his entrance into the Graduate School. The examination must be taken within one month after the beginning of a term if it is to be counted as having been taken in that term. The qualifying examination may be oral or written or both.

Any member of the Special Committee may waive his part of the qualifying examination. The report on the qualifying examination shall, however, be made by the Special Committee as a whole, after consultation. If a candidate fails to pass the qualifying examination, no re-examination shall be allowed except on recommendation of the Special Committee.

A report on each qualifying examination, whether passed, waived, or failed, shall be filed by the Special Committee in the office of the Graduate School.

Before presenting himself for Final Examination B or C (see next paragraph), a candidate must have earned at least two terms of residence credit after the passing or the waiving of the qualifying examination.

Final Examination. A candidate for the Ph.D. degree must pass a final examination, conducted by his Special Committee and covering (1) the Major and Minor Subjects and (2) the thesis and related topics. At the discretion of the Special Committee, the two parts of this examination may be given either separately or in combination.

When the two parts are given separately, an examination dealing mainly with the Major and Minor Subjects, designated as Final Examination A, may be given at the end of the fourth term of candidacy, or thereafter. Examination A will be both oral and written. The early completion of Examination A will leave the student free to devote his attention to the thesis and collateral studies during the remainder of his candidacy. Final Examination B, on the thesis and
related topics and on such other work as the student may have done after completing Examination A, will be given after the residence requirement has been satisfied and the thesis has been completed and filed as provided above. This examination may be oral, or both oral and written, at the discretion of the Special Committee. At the time of taking this examination the student must be registered in the Graduate School, either regularly or as candidate for degree only.

When the two parts of the final examination are given in combination, the combined examination, designated as Final Examination C, will be given after the residence requirement has been satisfied and the thesis has been completed and filed, as provided above. Examination C may be both oral and written.

No candidate may present himself for Final Examination B or C until he has satisfied the minimum period of residence and has filed the thesis as provided above.

Applications for final examinations, (A, B, and C), approved by the Special Committee, must be filed in the office of the Graduate School at least five days in advance of the examination.

Final examinations are conducted by the candidate's Special Committee and are open to all members of the Faculty. At the discretion of the Special Committee those under whom the candidate has worked may be invited to participate in the examination. But the Special Committee alone shall decide upon the merits of the candidate's performance.

A report on each final examination, whether passed or failed, shall be filed by the Special Committee in the office of the Graduate School. By permission of his Special Committee, a candidate who has failed in any of these final examinations may present himself for one re-examination but only within a period of from six to twelve months after the failure.

Final examinations must be completed within four years after the minimum residence requirement for the degree has been satisfied.

## REQUIREMENTS FOR THE J.S.D. DEGREE

Work leading to this degree is designed to train legal scholars and to stimulate original investigation in the purpose, administration, history, and progress of the law.

Admission: To be eligible for admission to candidacy for J.S.D.
the candidate shall have met the general requirements for admission; shall have received the degree Bachelor of Laws from an approved law school; shall have had some professional practice or teaching experience after obtaining that degree; and must have shown a high level of professional ability.

Residence and Special Committee. The candidate shall be in residence a minimum period of two terms working under the direction of a Special Committee of three or more chosen by the candidate after consultation with the Chairman of the Division of Law. The chairman of the committee and one other member shall be from the Faculty of the Law School, but the other member or members may be chosen from the Graduate School Faculty in a field or fields appropriate to the candidate's objective, which normally will be in the related fields of Economics, Government, History, or Philosophy.

Program. The candidate shall pursue with distinction a program of study and investigation approved by his Special Committee and acceptable to the Division of Law and shall pass with superior standing such examinations as his Special Committee shall prescribe.

Thesis. The candidate must embody the results of his investigation in a thesis which shall be a creditable contribution to legal scholarship and which shall be presented in a form suitable for publication. He is required to file two bound copies, together with two copies of a typewritten abstract thereof, in the office of the Graduate School. For the procedures to be followed in presenting the thesis see above.

Final Examination. After the thesis has been completed and filed in the office of the Graduate School, as provided above, the candidate is required to present himself for a final examination. A report on each final examination shall be filed by the Special Committee in the office of the Graduate School. By permission of his Special Committee, a candidate who has failed in a final examination may present himself for re-examination but only within a period of from six to twelve months after the failure.

For further information concerning J.S.D. see below in this $A n$ nouncement and also the Announcement of the Cornell Law School.

## TUITION AND OTHER FEES

GENERAL REGULATION...Tuition and other fees become due when the student registers. The University allows twenty days of grace in each term, five days in the six-week Summer Session. The last day of grace is generally printed on the registration coupon which the student is required to present at the Treasurer's office. Any student who fails to pay his tuition charges, other fees, and other indebtedness to the University, or who, if entitled to free tuition, fails to claim it at the Treasurer's office and to pay his other fees within the prescribed period of grace, is thereby dropped from the University unless the Treasurer has granted him an extension of time to complete payment. The Treasurer is permitted to grant such an extension when, in his judgment, the circumstances of a particular case warrant his doing so. For any such extension the student is assessed a fee of $\$ 2$. A reinstatement fee of $\$ 5$ is assessed against any student who is permitted to continue or return to classes after being dropped from the University for default in payments. The assessment may be waived in any instance for reasons satisfactory to the Treasurer and the Registrar, when such reasons are set forth in a written statement.

Students registering at any time during the last ten weeks of any term are required to pay tuition at the rate of ten per cent of the regular tuition of the term for each week or fraction of a week between the day of registration and the last examination day of the term. Students registering at any time during the last five weeks in the short summer courses are required to pay tuition at the rate of twenty per cent of the term's tuition for each week or fraction of a week between the day of registration and the last examination day of the term.
A tuition fee or other fee may be changed by the Trustees at any time without previous notice.

## FEES PAYABLE BY GRADUATE STUDENTS...

A Tuition Fee of $\$ 150$ a term is to be paid by all students registered in the Graduate School except candidates for the LL.M. and J.S.D. degrees, who must pay a fee of $\$ 200$ a term. It is payable at the beginning of each term.

Certain classes of students are exempt from the payment of the tuition fee. They are:

1. Graduate students holding certain appointments as University Fellows or Graduate Scholars, and holders of certain temporary fellowships and scholarships.
2. Resident Doctors, upon recommendation of the Dean.
3. Graduate students who have satisfactorily completed the requirements of residence for the degree but who remain in residence while working on their theses or while doing other work in contemplation of a degree.
4. In addition to students exempt under the charter of the University from the payment of tuition the following, to the extent herein mentioned, shall also be exempt from such payments of fees:

Upon recommendation by the appropriate college dean and by action of the Board of Trustees, for each appointment, waiver of tuition in the Graduate School, and of laboratory and shop fees in the department or line of work in which he is employed, may be made to a member of the teaching or scientific staff subject to the following limitations:
(a) If the salary for the academic year is not greater than $\$ 1600$, the tuition fee may be waived entirely;
(b) If the salary is greater than $\$ 1600$, but not greater than $\$ 1700,25 \%$ of the tuition will be charged and $75 \%$ waived;
(c) If the salary is greater than $\$ 1700$, but not greater than $\$ 1800,50 \%$ of the tuition will be charged and the balance waived;
(d) If the salary is greater than $\$ 1800$, but not greater than $\$ 1900,75 \%$ of the tuition will be charged and the balance waived;
(e) If the salary is greater than $\$ 1900$, no waiver will be made.

The word salary as used above means total pay - that is, base pay plus any bonus.

Graduate assistants on the nine or twelve months basis who are located here during the summer months, who are registered under personal direction for credit in the Graduate School, and who are required to give service in their department or college during that period, may be recommended for waiver of tuition during the Summer Term also under the above limitations. Those who are engaged only in graduate study and not doing productive work for the department during the Summer, may not have their tuition waived. The amount of tuition to which the above percentages will be applied is the prorated amount of the full tuition fee based upon the maximum amount of residence credit that can be earned.

An Administration Fee of $\$ 12.50$ a term, payable at the beginning of each term, is to be paid by all students registered in the Graduate School except Honorary Fellows and Resident Doctors.

A graduate student who returns to the University to present his thesis and to take the final examination for an advanced degree, all other work for that degree having been previously completed, shall register as a "candidate for degree only" and shall pay only an administration fee of $\$ 12.50$.

A Matriculation and X-ray Fee of $\$ 13$ is required of every student upon his first entrance into the University. It must be paid at the time of registration and is not refundable.

A Health and Infirmary Fee of $\$ 15$ a term is required of all students (except Honorary Fellows, Resident Doctors, students registered in the extramural course, and students registered in the Medical College in New York City) at the beginning of each term. For a statement of the privileges given in return for this fee, see the General Information booklet.

A Graduation Fee of $\$ 10$ is required, at least ten days before the degree is to be conferred, of every candidate for an advanced degree. The fee will be returned if the degree is not conferred.

An Abstract of Thesis Fee of $\$ 12.50$ is required, at least ten days before the degree is to be conferred, of each candidate for the degree Doctor of Philosophy. This fee, the cost of publication in the volume "Abstracts of Theses," is in addition to the $\$ 10$ graduation fee.

A Laboratory and Library Fee of $\$ 5$ a term is required of all graduate students.

A Willard Straight Hall Membership Fee of $\$ 5$ a term is required of all graduate students, except those registered in the extramural course.

Refunds of tuition and other fixed fees will be made to students who withdraw from the University prior to the completion of a term for reasons accepted as satisfactory. For students who do not complete a term, tuition and other fees will be charged at the rate of 10 per cent for each week, or fraction of a week, from the first day of registration to the date of withdrawal as certified by the College; provided, however, if withdrawal is made on or before the sixth day of instruction, no charge is assessed. The matriculation fee will not be refunded, nor will refund of the Health and Infirmary fee be made to a student who has been admitted to the Infirmary.

Fees for the Summer Session. Graduate students who attend classes in the Summer Session must register both in the Graduate School and in the Summer Session and must pay a tuition fee of $\$ 60$ for each Summer Session.

A graduate student who is registered in both the Summer Session and in the Graduate School must also pay a health service and infirmary fee of $\$ 5$. Please note that this paragraph refers only to fees for double registration in the Graduate School and the Summer Session.

Motor Vehicle Registration and Parking Fees. Any student, unless he has the rank of instructor in Cornell University, who owns, maintains, or for his own benefit operates, or has in charge a motor-driven vehicle in Tompkins County, within the immediate environment of Ithaca, is required to register his vehicle in person with the Campus Patrol, and, unless it is owned by another member of his immediate family who is a resident of Tompkins County, to pay a registration fee of $\$ 2$ a term. He must present (a) written consent of his parent or guardian if he is under 21 years of age, (b) evidence that the vehicle may be legally driven in New York State, (c) evidence that the operator may legally drive in New York State, and (d) evidence that the vehicle is effectively insured against public liability for personal injury and property damage for the standard minima of $5-10-1$. (Exceptions from the insurance requirement are: (1) Summer Session students who have not been registered in the University during the past term and (2) special students who are registered for six hours or less a term.) This registration, which includes obtaining a registration sticker and paying the fee, must be completed within the registration days at the beginning of the first term if the student is then subject to the rule. If he becomes subject to the rule after that time, he has one week in which to comply with it. Late registration of a vehicle makes the student liable to a penalty of $\$ 2$.

Motorcycles must be registered but may not be used anywhere on the campus during class hours.

Student parking on the campus during University hours is prohibited. Exemption may be granted by the Campus Patrol when the use of the car is essential to the student's attending classes or carrying on his academic or departmental work.

During the Summer Session, the rules are the same.
The student's registration in the University is held to constitute an agreement on his part that he will abide by its rules and regulations with regard to traffic and parking or suffer the penalty prescribed for any violation of them. All privileges here indicated may be denied a student who is not in good standing.
Personal Direction. Students carrying on studies during the summer under Personal Direction are required to register with the Registrar as well as in the Graduate School.
Students registered under Personal Direction, if they desire residence credit for their work, must pay a tuition fee proportionate to
the ratio which the credit desired bears to one entire term. Such students must pay the administration fee of $\$ 12.50$, the Willard Straight Hall membership fee of $\$ 5$, and the Health and Infirmary fee of $\$ 15$; provided, however, that one half of these fees will be remitted if the registration is for a period not exceeding 8 weeks. Such payment admits them to the current Summer Session classes without additional tuition payments, provided that the amount paid is at least equal to that charged students registered in the Summer Session. Students registered under Personal Direction during the summer, not for credit, are exempt from the payment of tuition, but may not attend, either as visitors or for subsequent credit, any of the classes or exercises of the Summer Session.

The privilege of taking work under Personal Direction during the summer without the payment of tuition shall be restricted to bona fide candidates for degrees at Cornell University, who have been in residence during the preceding academic year.

## FOREIGN STUDENTS

The University maintains on its staff a Counselor to Foreign Students, Mr. Donald C. Kerr, whose duty is to look after the welfare of all students from other countries. He may be consulted on personal problems, social questions, or any other matter in which he may be helpful. His office is in the Administration Building, Room 144. It is suggested that all foreign students write him before coming to Ithaca, or call on him immediately upon arrival. He will be glad to meet them at the train, help them find suitable living quarters, either at the Cosmopolitan House or elsewhere, and introduce them to other University officials and members of the faculty.

## LIVING EXPENSES IN ITHACA

A few men graduate students live in the University Residential Halls. For information about these, address the Manager of Residential Halls, Administration Building. The majority of graduate students live in rooms or apartments which are for rent in the
vicinity of the University. The lowest possible price is about $\$ 4.50$ a week. The usual figure is probably about $\$ 6$ to $\$ 8$. About the middle of each summer the University publishes a list of inspected rooms in which prices are quoted. For this list write to the Manager of Residential Halls.

The University offers no dining service in connection with its Residential Halls for Men. There are, however, two large cafeterias, one at Willard Straight Hall and the other at the College of Home Economics. Near the Campus there are many restaurants which cater chiefly to students.

Because of the scarcity of self-supporting labor, new graduate students are advised not to register in the University unless they have sufficient funds for their expenses at least during the first year.

For Women. All women graduate students at Cornell University live in houses approved by the Counselor for Women. Graduate women students who are under twenty-one years of age are required to live in the University Residential Halls. About the first of September the Office of the Counselor of Women issues a list of rooms off the campus available for the fall term. This list may be had by writing to the Counselor of Women who will give assistance in finding suitable rooms. For information regarding any possibilities of self-help for women, inquiries should be addressed to the same office.

## LOANS

THE GRADUATE STUDENT LOAN FUND...Contributions from the alumni of Cornell University have made it possible to establish a Graduate Student Loan Fund for use of graduate students already enrolled at Cornell University. Applications should be made to the Counselor of Students.

## LOAN FUND FOR WOMEN GRADUATE STUDENTS

There is available a loan fund for the use of women graduate students, provided by the Ithaca Branch of the Association of American University Women and Mu Chapter of Pi Lambda Theta. Applications should be made in writing to the Counselor of Women.

## THE BUREAU OF EDUCATIONAL RESEARCH AND SERVICE

The Bureau is designed to provide equipment and an organization whereby the various resources in the University can be utilized in the study of educational problems. These problems may arise in such areas as curriculum planning, testing and evaluation, administration and supervision, personnel management, youth adjustment and psychological foundations of education. They may exist in any of the various colleges of the University, in the public schools, or in the communities of the State. In addition to the coordination of research, the Bureau offers statistical and clerical assistance to the staff and graduate students in their independent research studies.

The Bureau also maintains an educational and vocational testing and guidance service for students referred by the various college or administrative offices. Persons not so referred may obtain such service upon application to the Bureau and the payment of a fee.

Other forms of service include the maintenance of information concerning schools and colleges and related matters, teaching aids for use by the staff in the preparation of teachers, an extensive library of psychological and educational tests, and a small selected library of technical books dealing with research in education and psychology. There are numerous opportunities for graduate students in education to obtain practical experience in the various activities of the Bureau as part of their programs of study. Arrangements for such experience are made through the Director of the Bureau and the student's advisory committee.

## THE SCHOOL OF EDUCATION PLAGEMENT OFFICE

The School of Education maintains a special service for the placement of teachers prepared at Cornell. Up-to-date files of credentials are kept for all potential teachers or former teachers who desire to register. Applicants are notified of any vacancies suitable to their qualifications and interests. The office will gladly send a registrant's papers to prospective employers upon request, and will make arrangements for interviews conducted on the campus. All inquiries
should be addressed to the Director of Placement, 102 Stone Hall, Cornell University.

## FELLOWSHIPS, SCHOLARSHIPS, PRIZES

HONORARY FELLOWSHIPS. . Holders of the Doctor's degree, or other persons of recognized standing as scholars, who wish to continue work in a field in which they have already achieved distinction may, in the discretion of the Faculty, be appointed to honorary fellowships. These fellowships cover all fees except the laboratory and library fee. Actual residence at the University and regular registration in the Graduate School are required of incumbents.

AWARD AND TENURE...Appointments to fellowships and scholarships are made on April 1 of each year. Forms for making application may be had from the Office of the Graduate School. These applications, together with supporting documents, must be filed in the Office of the Graduate School on or before the first of March.

The Faculty may combine the stipends of two or more scholarships or fellowships or may divide a fellowship into two or more scholarships. Appointments are made for one academic year.

The holder of a fellowship or a scholarship must devote his whole time to his studies, except that he may be called upon to assist in instruction up to a maximum of six clock-hours a week and for such assistance may receive extra compensation from the University. He may not accept any other appointment.

The stipends of fellowships and scholarships are payable at the office of the Treasurer of the University in eight equal installments, beginning July 15 or November 15; the other payments being due on the fifteenth of each month following.

FELLOWSHIPS AND SCHOLARSHIPS...All permanently endowed fellowships and scholarships carry exemption from tuition but not from other fees.

## ANY FIELD OF STUDY

Two Allen Seymour Olmstead Scholarships. Stipend $\$ 1,000$ each. These scholarships are open to graduate students in any field of study in which major work for the Ph.D. degree is offered.

## AGRICULTURE

Three Henry Strong Denison Fellowships in Agriculture. Stipend \$1,000 each. These fellowships are distributed annually among the following fields; plant sciences, animal sciences, social sciences, and agricultural engineering. Preference will be given to those applicants who expect to complete the requirements for the Ph.D. degree and who appear most promising from the standpoint of ability to conduct research.
The Clinton DeWitt Smith Fellowship in Agriculture. Stipend $\$ 400$. This fellowship is limited to students who come from farm homes and who have had farm training. Applicants should submit detailed statements covering such experience.
The University Fellowship in Agriculture. Stipend \$400.
See also under Animal Biology, Botany, and Entomology.

## ANIMAL BIOLOGY

The Simon Henry Gage Fellowship in Animal Biology. Stipend $\$ 500$.
The Schuyler Fellowship in Animal Biology. Stipend \$400.
The Graduate Scholarship in Animal Biology. Stipend $\$ 200$.
See also under Agriculture and Entomology.

## ARCHITECTURE

The University Fellowship in Architecture, Landscape Architecture, Fine Arts, and Regional and City Planning. Stipend $\$ 400$.

## REGIONAL AND CITY PLANNING

See Arćhitecture.

## FINE ARTS

See Architecture.

## LANDSCAPE ARCHITECTURE

See Architecture.

## BACTERIOLOGY

Applicants who wish to pursue work in Bacteriology should apply for either the fellowships in Agriculture or the scholarship in Veterinary Medicine.

## BOTANY

The Goldwin Smith Fellowship in Botany, Geology, or Physical Geography. Stipend $\$ 400$.

The Graduate Scholarship in Botany, Geology, or Physical Geography. Stipend \$200.

See also under Agriculture.

## CHEMISTRY

These fellowships are ordinarily awarded for the last year of residence for the doctorate.

The Sage Fellowship in Chemistry. Stipend $\$ 600$.
The du Pont Fellowship in Chemistry. Stipend $\$ 750$.
The Carl G. Schluederberg Fellowship. Stipend \$200.
The John E. Teeple Fellowship. Stipend $\$ 400$.

## CLASSICS

Two Fellowships in Greek and Latin. Stipends $\$ 500$ each.
These fellowships may be increased to three or more fellowships or scholarships with correspondingly reduced stipends.
One Graduate Scholarship in Greek and Latin. Stipend $\$ 200$.

## ECONOMICS

The President White Fellowship in Political and Social Science. ${ }^{1}$ Stipend $\$ 600$. Awarded in alternate years in Government and Economics.
A Fellowship in Political Economy. Stipend $\$ 600$. Awarded in alternate years.
A Fellowship in Political Economy. Stipend $\$ 500$. Awarded in alternate years.

## EDUCATION

## Tuition Scholarships for Prospective Secondary School Teachers

Ten tuition scholarships are available for students in the fifth year of the fiveyear program, who give promise of becoming outstanding secondary school teachers. Five of these scholarships are available for students who have received their undergraduate training in institutions other than Cornell. Applications should be made to the Director of the School of Education before July 1.

## ENGINEERING

Two or more of the following fellowships or scholarships may be combined if such combination be deemed desirable.

The McGraw Fellowship in Civil Engineering. Stipend \$400.
The Graduate Scholarship in Givil Engineering. Stipend \$200.
The Sibley Fellowship in Mechanical and Electrical Engineering. Stipend $\$ 400$ (Ordinarily awarded for work in Mechanical Engineering.)

The Charles Bull Earle Memorial Fellowship in Mechanical and Electrical Engineering. Stipend $\$ 400$. (Ordinarily awarded for work in Electrical Engineering.)

The Edgar J. Meyer Memorial Fellowship in Engineering Research. Stipend \$400. (Ordinarily awarded for work in Mechanical Engineering.)
See also the John McMullen Graduate Scholarships and the Elon Huntington Hooker Fellowships in Hydraulics, listed below.

[^6]
## THE JOHN McMULLEN GRADUATE SCHOLARSHIPS

The John McMullen Graduate Scholarships are open to candidates for advanced degrees in Aeronautical, Chemical, Civil, Electrical, or Mechanical Engineering. These scholarships were founded by a bequest of John McMullen, of Norwalk, Conn., to Cornell University "for the purpose of creating and maintaining free scholarship or scholarships for the education of young men as engineers, the details as to the amounts of said scholarships and the qualifications of the beneficiaries to be left to said institution to determine, said scholarships to be known as the John McMullen Scholarships." With the proceeds of this bequest the Board of Trustees has established fifteen scholarships of an annual value of $\$ 900$ each. The scholarships have not been assigned to any particular School of the College, but will be awarded as conditions dictate. Applications should be addressed to the Graduate School.

## THE ELON HUNTINGTON HOOKER FELLOWSHIP IN HYDRAULICS

This fellowship was founded in 1919 by E. H. Hooker, a graduate of the School of Civil Engineering of the class of 1894, and is offered for research in experimental hydraulics in Europe or America. It is open to graduates of the School of Civil Engineering and similar schools of equivalent rank. The stipend of the fellowship is $\$ 510$. Applications should be sent to the Graduate School.

## ENGLISH

## The Martin Sampson Teaching Fellowship. Stipend $\$ 900$.

This fellowship is offered annually to a graduate student who is preparing to become a teacher of English. The incumbent is required to teach one class during each term of the academic year.

The Cornell Fellowship in English. Stipend $\$ 600$.
This fellowship is ordinarily awarded only to an applicant who has completed a year of graduate study.

## ENTOMOLOGY

See The Comstock Scholarship in Entomology. Stipend $\$ 150$. See also under Agriculture and Animal Biology.

## COMSTOCK SCHOLARSHIPS

Under the terms of the will of the late Professor John Henry Comstock there have been established two graduate scholarships, each carrying a stipend of $\$ 150$. These scholarships have, by vote of the Faculty of the Graduate School, been allocated to the fields of Entomology and Nature Study. Applications should be made not later than March 1 to the office of the Graduate School.

## GEOLOGY

The Goldwin Smith Fellowship in Botany, Geology, or Physical Geography. Stipend $\$ 400$.

The Graduate Scholarship in Botany, Geology, or Physical Geography. Stipend $\$ 200$.

## THE ELEANOR TATUM LONG GRADUATE SCHOLARSHIP

The Eleanor Tatum Long Graduate Scholarship in structural Geology is open to graduate students who are majoring in the branch of Geology named. Application for the scholarship should be made to the Department of Geology not later than March 1. The stipend is approximately $\$ 1,200$ a year.

## CHARLES BEAN DeLONG GRADUATE RESEARCH FUND

A fund of $\$ 6,000$, the income from which is to be used at the discretion of the Department of Geology for the purpose of assisting male graduate students or assistants of the University who are majoring in and carrying out scientific research in economic or structural geology. An award from this fund does not exempt recipient from payment of tuition and fees.

## PHYSICAL GEOGRAPHY

See Geology.

## GERMAN

The University Fellowship in Germanic Languages. Stipend $\$ 400$.

## GOVERNMENT

The President White Fellowship in Political and Social Science. Stipend $\$ 600$. Awarded in alternate years in Government and Economics.

## HISTORY

These fellowships are ordinarily awarded only to applicants who have completed a year of graduate work or are able to submit written work of superion quality.
The President White Fellowship in Modern History. ${ }^{1}$ Stipend $\$ 500$. In the discretion of the Faculty this fellowship may be made a traveling fellowship, with a stipend of $\$ 800$.

The Fellowship in American History. Stipend $\$ 400$.
The George C. Boldt Fellowship in History. Stipend $\$ 1,000$.
The Graduate Scholarship in History. Stipend $\$ 200$.

## HOME ECONOMICS

The Anna Cora Smith Fellowship. Stipend $\$ 400$.
According to the bequest, this fellowship "is to be awarded annually to a young woman for research in home economics problems."

## MATHEMATICS

The Erastus Brooks Fellowship in Mathematics. Stipend $\$ 600$.
This fellowship is ordinarily awarded only to an applicant who has had a year or more of graduate study.

[^7]
## NATURE STUDY

The Comstock Scholarship in Nature Study. Stipend $\$ 150$. Because of accumulation, this scholarship will have a higher cash value during the year 1947-1948.

American Nature Association Research Fellowship. Two or three American Nature Association research fellowships of $\$ 400$ to $\$ 600$ are available to graduate students in nature study.

## PHILOSOPHY

Three Susan Linn Sage Fellowships in Philosophy. Stipends $\$ 600$ each. One or more of these fellowships may be divided to make two scholarships, stipends $\$ 300$ each.

## PHYSICS

The President White Fellowship in Physics. Stipend $\$ 600$. The stipend of this Fellowship may, in the discretion of the Faculty, be reduced to $\$ 400$ and the remaining $\$ 200$ be assigned to a Graduate Scholarship.

See also Special Temporary Fellowships, below.

## PSYCHOLOGY

The Susan Linn Sage Fellowship in Psychology. Stipend $\$ 400$.
The Susan Linn Sage Graduate Scholarship in Psychology. Stipend $\$ 200$.

## ROMANCE LANGUAGES

The University Fellowship in Romance Languages. Stipend $\$ 400$.
This fellowship is ordinarily awarded only to an applicant who has had a year or more of graduate study.

## VETERINARY MEDICINE

The Graduate Scholarship in Veterinary Medicine. Stipend $\$ 200$.
Through accumulation it is sometimes possible to increase the amount available for this scholarship.

## TUITION SCHOLARSHIPS

The Board of Trustees has established thirty tuition scholarships for graduate students. They entitle the holder to exemption from payment of tuition fees, but not other fees, for the duration of the appointment.

The holder of a tuition scholarship may not accept another appointment or be gainfully employed without permission from the General Committee of the Graduate School.

## CORNELL SIGMA XI FELLOWSHIP

The Cornell Sigma Xi Fellowship, established by the Cornell Chapter of the Society of Sigma Xi, is open to graduate students in the following fields of study: Mathematics, Physics, Chemistry, Astronomy, Sciences of the Earth, Biology in its various branches including Psychology, Medicine in its various branches, Anthropology, and Engineering in its various branches. This fellowship carries

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This course is intended primarily for students planning to teach biological science or to engage in professional work in ornithology or wildlife management. Feeding habits of birds, field collecting, preparation of specimens, and natural history photography are emphasized, together with classroom, museum, extension, and biological survey methods. Opportunity is also given for the preparation of radio talks on birds.
133. BIRD SPECIATION AND MUSEUM METHODS IN ORNITHOLOGY. Fall term. Credit three hours. Professor Allen and Mr. Warner. For students planning to participate in scientific expeditions and to carry on taxonomic work in ornithology. Prerequisite, courses $8,9,11,126$, and 13 , or permission to register.
136. ORNITHOLOGY SEMINAR. Throughout the year. M 7:30-9 p.m. Fernow Seminar Room. Required of all graduate students in Ornithology.

## VERTEBRATE TAXONOMY AND ECOLOGY

Stimson Hall; Professors W. J. Hamiliton, Jr. and E. C. Raney.
22. ICHTHYOLOGY. Spring term. Credit three hours. Assistant Professor Raney. Lectures, T Th 8. Stimson G-25. Laboratory, F 2-4:30. Stimson 225.

Lectures cover ecology, life histories, speciation, and the phylogeny of fishes. Laboratory periods are utilized in studies on structure and identification of fishes with field trips for studies on ecology and life histories.
[23. HERPETOLOGY. Spring term. Credit three hours. Associate Professor Hamilton and Assistant Professor Raney. Lectures, T Th 8. Stimson G-25. Laboratory, F 2-4:30. Stimson 225.
Lectures on amphibians and reptiles, their life histories, distribution, and taxonomy. Laboratory periods deal with identification and field trips. Not given in 1947-1948.]
25. MAMMALOGY. Fall term. Credit three hours. Associate Professor Hamilton. Lectures, T Th 8. Stimson G-1. Laboratory, F 2-4:30. Stimson 225.

Discussion of principal phases of mammalian life: origin, distribution, habits, and literature. Laboratory periods are devoted to methods of field collecting, census taking, life history studies, preparation of skins and skeletons, and identification of North American species.
112. LITERATURE OF ECONOMIC ZOOLOGY, CONSERVATION, AND ecology. Spring term. Credit one hour. Associate Professor Hamilton and Assistant Professor Raney. T 7:30 p.m. Stimson 225. Limited to upper-class students and graduates.
The literature of economic zoology, ecology, oceanography, and kindred fields; fish and fisheries; aquaria; amphibians and reptiles, their uses; zoological gardens; preserves; game farms, animals in relation to recreation.
67. SEMINAR IN SYSTEMATIC VERTEBRATE ZOOLOGY. Fall term. Associate Professor Hamilton and Assistant Professor Raney. T 4:30 p.m. Stimson 225. Limited to graduate students and upperclass zoology majors. Registration by permission of instructor.

## ZOOLOGY, ALL BRANCHES

40. RESEARCH PROBLEMS. Credit and hours to be arranged. Problems may be undertaken in any phase of zoology but the consent of the instructor concerned is a prerequisite.

## PLANT SCIENCES

NOTE-Laboratory space is limited and is often overtaxed, especially in courses which admit both graduate students and undergraduates. Graduate students who desire to enroll in such courses are warned to make application for space well in advance of the beginning of instruction. This holds particularly of the second term, since the College of Agriculture holds its preregistration for undergraduates in January. Failure to arrange for laboratory space in advance will probably result in exclusion from courses.

## BACTERIOLOGY

Dairy Buildings; Professors J. M. Sherman, Otto Rahn, C. N. Stark, Georges Knaysi, I. C. Gunsalus, and W. W. Umbreit; at Geneva, Professors R. S. Breed, h. J. Conn, G. J. Hucker, C. S. Pederson, M. W. Yale, and A. W. Hofer.

APPROVED MAJOR AND MINOR SUBJECTS (key to symbols on p. 47)

## Bacteriology 1, 2, 3, 4

(See also Pathogenic Bacteriology 1, 2, 3, 4. Moore Laboratory. Professors W. A. Hagan, Peter Olafson, E. L. Brunett, and A. Zeisig, under Veterinary Medicine.)
Before taking up graduate work in bacteriology, it is desirable that the student have general chemistry, qualitative and quantitative analysis, organic chemistry, and introductory courses in the biological sciences.
Formal courses open to undergraduate and graduate students are given in the following subjects:

1. GENERAL BACTERIOLOGY. Fall term. Credit six hours. Prerequisite, Chemistry 101. Professor Umbreit and assistants. Lectures, M W F 11. Laboratory practice, M W F 1:40-4. Dairy Industry Building 218 and 301.
An introductory course; a general survey of the field of bacteriology, with the fundamentals essential to further work in the subject.
2. APPLIED BACTERIOLOGY. Spring term. Credit six hours. Prerequisite, course 1, quantitative analysis, and organic chemistry. Professor Sherman, Professor Gunsalus, and assistants. Lectures, recitations, and laboratory practice, M W F 1:40-5. Dairy Industry Building 119 and 301.

An advanced course dealing with the important groups of bacteria which are of significance in water, milk, and foods, together with the methods used in the bacteriological analysis and control of these products.
105. HIGHER BACTERIA AND RELATED MICROORGANISMS. Fall term. Credit four hours. Prerequisite, course 1. Professor Knaysi and Miss Dyar. Lectures, recitations, and laboratory practice, T Th 1:40-5. Dairy Industry Building 119 and 323.
A study of the higher bacteria, together with the yeasts and molds that are of especial importance to the bacteriologists.
106. SOIL MICROBIOLOGY. (Same as Agronomy 106.) Spring term. Credit three hours. Prerequisite, course 1, Agronomy 1, and Chemistry 201 or its equiva-
lent. Lectures, M W 8. Caldwell 143. Laboratory, W or F 1:40-4. Caldwell 201. Professor J. K. Wilson.

A course in biological soil processes designed primarily for students specializing in soil technology or bacteriology. The laboratory work is supplemented by reports and by abstracts of important papers on the subject.
210. PHYSIOLOGY OF BACTERIA. Fall term. Credit two hours. Prerequisites, course 1 and at least one additional course in bacteriology. Professor Rahn. Lectures, T Th 8. Dairy Building 120.
An advanced course in the physiology of bacteria and the biochemistry of microbic processes.
210a. PHYSIOLOGY OF BACTERIA, LABORATORY. Spring term. Credit three hours. Must be preceded or accompanied by course 210. Professor Rahn and assistant. M 11 and M W 1:40-5. Dairy Building. Laboratory fee, $\$ 15$.

An advanced laboratory course dealing with the biological principles of growth, fermentation, and death of bacteria.
211. TAXONOMY OF BACTERIA. Spring term. Credit two hours. Prerequisites, course 1 and at least one additional course in bacteriology. Professor Rahn. Lectures, W F 11. Dairy Building 120.

An advanced course, dealing with the natural groups and variability of bacteria, with a study of the systems of nomenclature and classification.
212. SELECTED TOPICS IN BACTERIOLOGY. A two-term course, fall and spring terms. Credit one hour a term. Professor Rahn. F 8. Dairy Industry Building 120.
213. MORPHOLOGY AND CYTOLOGY OF BACTERIA. Fall term. Credit three hours. Professor Knaysi. Lectures, T Th S 9. Dairy Building 119.
The morphology, cytology, and microchemistry of microorganisms.
215. ChEMISTRY OF BAGTERIAL PROCESSES. Spring term. Credit two hours. Lectures, T Th 8. Dairy Industry Building 119. Professors Gunsalus and Umbreit.

The chemistry of metabolism, fermentation, and nutrition of microorganisms.
221. SEMINAR. Throughout the year. Without credit. Required of graduate students, specializing in the department. Professor Sherman. Hours to be arranged. Dairy Building.

Research problems may be selected in various phases of pure and applied bacteriology; taxonomy; physiology; technique; dairy bacteriology; food bacteriology; water and sanitary bacteriology; industrial fermentations. (For pathogenic bacteriology, see Animal Pathology and Bacteriology; for soil bacteriology, see Agronomy.)

## RESEARCH AT THE NEW YORK STATE EXPERIMENT STATION

Work in Dairy, Soil, Fermentation, Food, and Systematic Bacteriology is also offered at Geneva. For further information see page 251.

## BOTANY

Professors Lewis Knudson, A. J. Eames, O. F. Curtis, W. C. Muenscher, L. C. Petry, L. F. Randolph, D. G. Clark, K. C. Hamner, and R. T. Clausen; at Geneva, Professors M. T. Munn and W. F. Crosier.

> APPROVED MAJOR AND MINOR SUBJECTS (key to symbols on p. 47)

Botany 2, 4
Cytology 1, 2, 3, 4
Economic Botany 1, 2, 3, 4

Paleobotany 1, 2, 3, 4
Plant Physiology 1, 2, 3, 4
Plant Taxonomy 1, 2, 3, 4

Plant Morphology (including Anatomy) 1, 2, 3, 4
The laboratories of the department are in the Plant Science Building, one of the buildings of the College of Agriculture, and are well equipped with the necessary apparatus and collections for research. The herbarium contains both local and foreign material for taxonomic study.

The rich flora about Ithaca and its accessibility make the location especially advantageous for many phases of botany, as materials may be easily obtained. Greenhouses are also available for the growing of experimental material.

The University Library and the library of the College of Agriculture are well equipped with special works and periodicals dealing with all phases of botanical science. Books in more constant use are available in connection with the laboratories.

Seminars are conducted in several of the fields listed above. The purpose of these various seminars is not only to keep abreast of the literature of the subject, but to furnish to the student an opportunity to gain experience in presenting the results of his own research or in critically evaluating the work of others. Graduate students are expected to attend the seminars dealing with their special fields of work.

As a prerequisite for work in any phase of botany the student will be expected to have a knowledge of the fundamental features of botanical science. For work in paleobotany a knowledge of the fundamental features of both botany and geology is prerequisite.

A fundamental training in botany and chemistry is required of any student who expects to major in plant physiology. If it is not possible to obtain this training before entering upon graduate work at Cornell, the student will be expected to broaden his knowledge in botany and chemistry after beginning graduate work.

The University conducts a Summer Session in which there is opportunity for graduate study and research in botany. A prospective student contemplating summer work in botany and plant physiology should correspond with the appropriate member of the staff before coming to Ithaca.

A fellowship carrying a stipend of $\$ 400$ and a scholarship with a stipend of $\$ 200$ are awarded in alternate years to graduate students in Botany. These awards carry exemptions from the payment of tuition. In 1947-48 the scholarship will be awarded. One of the Henry Strong Denison Fellowships in Agriculture is awarded annually in the field of the plant sciences. This fellowship has a stipend of $\$ 1,000$, but does not carry free tuition.

## PLANT PHYSIOLOGY

31. 'Introductory Plant Physiology. Fall or spring term. Credit four hours. Lectures, T Th 10. Plant Science 141. Laboratory, T Th 2-4:30; W F 2-4:30. Assignment to laboratory section must be made at the time of registration.
32. PLANT PHYSIOLOGY, ADVANCED LECTURE COURSE. A two-term course, fall and spring. Credit three hours a term. Prerequisite, training in botany and chemistry, to be determined in each case by the department. Professors Knudson and Curtis. Lectures, M W F 10. Plant Science 141.
Lectures and discussions on physiological processes of plants and the factors influencing them and the relations of these processes to plant behavior.
33. PLANT PHYSIOLOGY, ADVANCED LABORATORY COURSE. A twoterm course, fall and spring. Credit three hours a term. Prerequisite or parallel, course 231. Professors Knudson and Curtis and Associate Professor Clark. Laboratory, M 1:40-4, S 8-12:30. Plant Science 241.

Principally a quantitative study of various phases of plant physiology. The student will apply chemical, physical, and biological methods in the study of plant physiological processes.
233. SEMINAR IN PLANT PHYSIOLOGY. Fall and spring terms. Required of graduate students in Plant Physiology. Professors Knudson and Curtis and Associate Professors Clark and Hamner. Conference, F 11. Plant Science.

The presentation and discussion of current contributions to plant physiology; reports on the research problems of graduate students and members of the staff.
234. PLANT PHYSIOLOGY, ADVANCED LECTURE COURSE. Fall term. Credit one hour. Prerequisite, plant physiology 231 or adequate preparation in botany and chemistry. Tuesday, 4:15-5 p.m. Plant Science 143. Associate Professor K. C. Hamner.

This course will deal primarily with physiology in relation to hormones, photoperiodism, and vernalization.

RESEARCH in PLANT PHYSIOLOGY. Professors Knudson and Curtis, Associate Professors Clark and Hamner.

## ANATOMY

123. PLANT ANATOMY. Fall term. Credit four hours. Prerequisite, course 1 or the equivalent. Professor Eames. T 9-12:30; Th S 9-11:30. Lecture to be arranged within these periods. Plant Science 228.
A detailed study of the internal structure of vascular plants with emphasis on determination and interpretation.
RESEARCH IN ANATOMY. Professor EAMES.

## CYTOLOGY

124. GENERAL CYTOLOGY. Fall term. Credit four hours. Prerequisite, Botany 1 or Zoology 1 or equivalent. Lectures, M W 9. Plant Science 143. Laboratory, M W or T Th 10-12:30. Plant Science 219. Assignment to laboratory section must be made at the time of registration.
The principal topics considered are cells and their components, nuclear and cell division, meiosis and fertilization, and the relation of these to problems of
development, reproduction, and heredity. Both plant and animal materials are used. Microtechnic is not included.
[224. ADVANCED' CYTOLOGY. Spring term. Credit two hours. Prerequisites, Botany 124, Plant Breeding 101, and permission to register. Lecture, F 9. Plant Science 143. Laboratory, F 10-12:30. Not given in 1947-1948.]

An advanced course dealing mainly with recent researches in cytogenetics.
research in cytology. Professor Randolph.

## MORPHOLOGY

(COMPARATIVE MORPHOLOGY OF FUNGI. Given in the Department of Plant Pathology.)
126. MORPHOLOGY OF VASCULAR PLANTS. Fall and spring terms. Credit three hours a term. Prerequisites, course 1 or its equivalent, and permission to register; first term prerequisite to second. Professor Eames. Lecture, F 9. Plant Science 143. Laboratory, W 9-12:30; F 10-12:30. Plant Science 228.

An advanced course in the comparative morphology, life histories, and phylogeny of vascular plants.
research in morphology. Professors eames and Petry.

## TAXONOMY

13. TREES AND SHRUBS. Fall term. Credit four hours. Prerequisite, course 1 or its equivalent. Associate Professor Clausen. Lectures, T Th 9. Plant Science 143. Laboratory or field work, T Th 2-4:30. Plant Science 211.

The identification, classification, distribution, and economics of woody plants. Attention is given to identification both in summer and in winter conditions. Part of the laboratory work is conducted outdoors.
117. TAXONOMY OF VASGULAR PLANTS. Spring term. Credit four hours. Prerequisite, course 1 or its equivalent. Associate Professor Clausen. Lectures, T Th 9. Plant Science 143. Laboratory, T Th 2-4:30. Plant Science 211.
A study of the kinds of seed plants and ferns, their classification into genera, families, and orders, and field work on the local flora. Emphasis is placed on wild plants, but the more commonly cultivated species receive some attention. Those desiring advanced work on special groups or problems may follow this with course 171.
219. ADVANCED TAXONOMY OF VASCULAR PLANTS. Fall term. Credit three hours. Prerequisite, course 117 or its equivalent and training in cytology and genetics. Associate Professor Clausen. Lectures, T Th 11, and one period to be arranged. Plant Science 211.
A study of variation, isolation, and hybridity in relation to taxonomy, together with a survey of the vegetation of North America. The practice period affords experience in floristic and revisionary methods and in identification.

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## PALEOBOTANY

RESEARCH IN PALEOBOTANY. Professors EAmes and Petry.

## ECONOMIC BOTANY

55. WEEDS AND POISONOUS PLANTS. Fall term. Credit three hours. Prerequisite course 1 or its equivalent. Lecture, F 8. Laboratory, W F 2-4:30. Plant Science 353. Professor Muenscher and assistant.

Special emphasis is given to the habits, characteristics, and properties which make weeds and poisonous plants harmful or undesirable, the losses and injury produced by them, and the methods for their prevention, eradication, and control.
56. SEED ANALYSIS. Spring term. Credit one hour. Prerequisite Course 1 or its equivalent. Lectures and laboratory, F 2-4:30. Plant Science 353. Professor Muenscher and assistant.

Designed for students in the applied plant science departments and those interested in preparing to be seed analysts. Practice will be given in making purity analyses and germination tests according to standard and official methods and recommendations.
[115. AQUATIC PLANTS. Spring term. Credit three hours. Prerequisite, course 1 or its equivalent. Lecture, M 9. Laboratory, M W 2-4:30. Plant Science 353. Professor Muenscher. Not given in 1947-1948.]

A study of the taxonomy and ecology of fresh-water plants, beginning with the algae and concluding with the aquatic angiosperms.
research in economic botany. Professor muenscher.

## GENERAL BOTANY

1. General Botany. Throughout the year. Two lectures and one laboratory period a week.

## OTHER COURSES

[161. HISTORY OF BOTANY. Fall and spring terms. No credit. Hours to be arranged. Plant Science 404. Not given in 1947-1948.]

A course of lectures given by various members of the staff with the purpose of acquainting advanced students of botany with the historical development of their science.
171. SPECIAL PROBLEMS IN GENERAL BOTANY, ECOLOGY, ECONOMIC BOTANY, TAXONOMY, MORPHOLOGY, ANATOMY, PALEOBOTANY, CYTOLOGY, AND PHYSIOLOGY. Throughout the year. Credit not less than two hours a term. Professors Knudson, Eames, Curtis, Petry, Muenscher, and Randolph, Associate Professors Clark, Clausen, and Hamner. Hours by appointment.

Students engaged on special problems may register in this course. They must satisfy the instructor under whom the work is taken as to preparation for the problem chosen. The laboratory fee depends on the nature of the work and on the number of credit hours.

## RESEARCH AT THE NEW YORK STATE EXPERIMENT STATION

Opportunity for graduate research work at Geneva, N. Y. is available in the following fields of botany. Cytological investigation on cultivated plants, taxonomic investigation on fruits and vegetables, and investigations on seeds. For further information see page 253.

# PLANT BREEDING 

Professors H. H. Love, R. G. Wiggans, S. S. Atwood, R. L. Cushing, N. F. Jensen, A. A. Johnson, J. R. Livermore, H. M. Munger, R. P. Murphy, H. H. Smith; Doctor Ernest Dorsey; at Geneva, Professor R. Wellington.

APPROVED MAJOR AND MINOR SUBJECTS (key to symbols on p. 47)
Genetics 1, 2, 4
Plant Breeding 1, 2, 4
Statistical Methods of Analysis 1, 2, 4
Students who are interested in crop improvement through breeding will register in plant breeding. Problems for research may involve studies of breeding technics, the application of genetic principles to breeding, and the correlation of knowledge from other fields in attacks on problems such as yield, quality, adaptability, and disease and insect resistance. The Department now has active research projects with cereal, forage, and vegetable crops, and certain materials from these are available for graduate student problems. Those students interested in theoretical phases will register in genetics and their research problems will generally deal with genic and chromosomal analyses, mutations, and gene action. Almost any suitable material can be utilized, but corn, tobacco, Drosophila, and certain microorganisms are currently available. For those students to whom problems of experimental technic and mathematical analysis of biological data hold the greater appeal, registration will be in statistical methods of analysis.

The facilities for graduate student research include garden, field, and a limited amount of greenhouse space for growing plants. The laboratories are equipped to handle the processing and storage of seed and plant materials from the research projects. Equipment and facilities needed in cytological approaches to genetical and breeding problems are available, as are calculating machines and some photographic equipment. The departmental library is rich in the important books, pamphlets and periodicals dealing with genetics, plant breeding, evolution, and statistics.

It is advisable that the student entering upon graduate work in this field be well grounded in the fundamentals of the natural sciences. The student should have had elementary courses in inorganic and organic chemistry, college algebra, botany or zoology or biology, and plant, animal, or human physiology. Broad training and experience in the field of agriculture is essential for those planning to major in the field of plant breeding.

Students majoring in plant breeding or genetics will find it necessary to remain in Ithaca during the summer, or to make satisfactory arrangements for growing and studying elsewhere the plant materials used in connection with their research problems. Since the department has accommodations for only a limited number, prospective students will find it to their advantage to correspond with a member of the departmental staff some months prior to entering upon their work.
101. Genetics. Fall term. Credit four hours. Prerequisite, a beginning course in a biological science. Courses in cytology and in taxonomic botany and zoology will be found helpful. Lectures, M W F 8. Plant Science 233. One conference period, to be arranged. Laboratory, M T or F 1:40-4. Plant Science 146. Associate Professor Cushing.

A course designed to acquaint the student with the fundamental principles of heredity and variation in plants and animals.

Laboratory studies of hybrid material in plants and breeding experiments with the vinegar fly, Drosophila.
102. PLANT BREEDING. Fall term. Credit three hours. (Students who have had course 101 are allowed two hours, credit.) Given in alternate years. Primarily for undergraduates. Prerequisite, Botany 1. Lectures, T Th 8. Plant Science 141. Lecture and practice, S 8-10. Plant Science 146. Associate Professor Munger.
[103. PLANT BREEDING. Fall term. Credit three hours. Prerequisites, Botany 1, a course in at least one of the following: field crops, vegetable crops, floriculture, or pomology, and course 101 or permission to register. Not given in 1947-1948.]
A study of the principles and practices of plant breeding. Lectures supplemented by periods in the greenhouse and experimental fields.
201. RECENT ADVANCES IN GENETICS. Spring term. Credit three hours. Prerequisites, Plant Breeding 101 and Botany 124. Associate Professor Cushing. M W F 8. Plant Science 146. Laboratory work to be arranged.

Group discussions of advanced principles of genetics, with special attention to methods of analysis as illustrated in problems on both hypothetical and experimental data. Laboratory studies on the artificial production of mutations in Drosophila and some plants, with as complete a genetic analysis of these as time permits.
211. STATISTICAL METHODS OF ANALYSIS. Fall term. Credit two hours. Associate Professor Livermore. Th 1:40-4. Plant Science 233.
A discussion of statistical methods for the study of variation, correlation, curve fitting, experimental error, the analysis of variance and covariance, and the application of these methods to problems in biology and related fields.
212. SPECIAL PROBLEMS IN STATISTICAL METHODS. Spring term. Noncredit course. Limited to graduate students who have had course 211 or similar work. Professor Love. Hours to be arranged.
A conference course dealing with the problems of plot technique and related topics, such as the design of experiments and interpretation of results.
222. SEMINAR. Fall and spring terms. Credit one hour. Required of all graduate students taking either a major or minor in this department. Members of departmental staff. F 4:30. Plant Science 404.

## PLANT PATHOLOGY

Professors L. M. Massey, Donald Redick, M. F. Barrus, H. M. Fitzpatrick, W. H. Burkholder, C. Chupp, C. E. F. Guterman, F. M. Blodgett, A. B. Burrell, D. S. Welch, A. G. Newhall, G. C. Kent, A. W. Dimock, L. J. Tyler, W. D. Mills, A. F. Ross, K. H. Fernow, K. G. Parker, J. S. Niederhauser, H. S. Cunningham, and L. C. Peterson; at Geneva, Professors O. A. Reinking, W. O. Gloyer, J .H. Hamilton, D. H. Palmiter, W. T. Schrofder, A. J. Braun, and R. E. Foster.

APPROVED MAJOR AND MINOR SUBJECTS (key to symbols on p. 47)
Mycology 1, 2, 3, 4
Plant Pathology 1, 2, 3, 4

The laboratories of the department are fully equipped for teaching and research in this subject. Many pieces of apparatus for use in connection with specialized research problems are available and additional apparatus can be supplied whenever it is needed. Greenhouses having about 12,000 square feet of floor space afford facilities for experimental work and for the culture of diseased and healthy plants for class use. These houses are divided into compartments so that various artificial conditions of temperature and moisture can be maintained for diverse types of plants and kinds of experimental work. Field laboratories in important crop sections of the State are maintained through co-operation with growers. These laboratories provide certain graduate students who receive fellowships (several of which are usually available each year) with an opportunity of pursuing investigations on a large scale under most favorable commercial conditions.

The pathological herbarium includes a local collection of fungi and pathological materials and sets of well-known fungous exsiccati. The library contains most of the important works on plant pathology, mycology, and bacteriology, complete sets of the more important journals, many monographs, and practically all the experiment station literature on these subjects.

Candidates for the Doctor's degree should spend at least one season in the field in order to come into contact with the practical aspects of control problems. They should also have some practice in teaching for which opportunity will be provided. Students preparing for graduate work in plant pathology are urged to obtain a thorough knowledge of elementary physics and chemistry, including organic and physical chemistry, and of general botany, plant histology, and plant physiology. A reading knowledge of French and German is indispensable in the phytopathological research and must be acquired before the beginning of the third semester of graduate work. Candidates for advanced degrees must have fundamental training in the subjects enumerated above. Opportunity is afforded for further study in these subjects after entering the Graduate School, but a student availing himself. of this opportunity can not expect to receive a degree in the minimum amount of time required for residence. Members of the staff are prepared to direct investigation in the various sub-divisions of the broader field. It is urged that prospective students correspond with a member of the departmental staff some months in advance of the time when they expect to enter upon their work.

1. Elementary Plant Pathology. Fall and spring terms. Credit three hours. Professors Kent and Welch and Associate Professor. L. J. Tyler. One lecture and two laboratories each week.
2. GENERAL PLANT PATHOLOGY. Fall term. Credit four hours. For graduate students with their major or minor in Plant Pathology. Open also to qualified graduate students in other fields. Prerequisite, permission to register. Professors Kent, Welch, and L. J. Tyler. Lecture, T 11. Plant Science 336. Practice, three 3 -hour periods weekly at the students' convenience.

A course designed to give the entering graduate student an introduction to the basic features and techniques of the science of phytopathology and to provide an adequate foundation for successful prosecution of research in this field.
2. PRINCIPLES OF PLANT DISEASE CONTROL. Fall or spring term; for graduates and undergraduates. Credit three hours. Prerequisite, Course 1 or 200 or the equivalent. Associate Professor L. J. Tyler. Lecture, Th 8, Plant Science 336. Laboratory, T Th 2-4:30. Plant Science 342.

A consideration of the principles and methods of plant disease control. Required of graduate students with major or minor in plant pathology.
201. ADVANCED PLANT PATHOLOGY. A two-term course, fall and spring terms. Prerequisites, courses 201, 2, 121 or 221, and permission to register. Professor Massey. Lecture, T 9. Plant Science 336. Practice, T Th 10-12:30. Plant Science 304.

A presentation and analysis of the experimental and empirical knowledge of plant diseases. The phenomena of inoculation, incubation, infection, susceptibility, and host reactions are critically considered. The course is designed chiefly for students majoring in plant pathology.
111. DISEASES OF TREES AND SHRUBS. Spring term. Credit three hours. Prerequisite, course 1 or 200. Professor Welch. Lecture, F 10. Plant Science 336. Practice, T Th 2-4:30. Plant Science 362.

A course dealing with the diseases peculiar to woody plants, their recognition and treatments.
121. COMPARATIVE MORPHOLOGY OF FUNGI. Fall term. Credit four hours. Prerequisite, Botany 1 or the equivalent, and permission to register. Professor Fitzpatrick. Lecture, M W 11. Plant Science 336. Practice, M W 2-4:30. Plant Science 329. Given in alternate years.

An introductory course designed to acquaint the beginning student with the general field of mycology. Emphasis placed on morphology rather than on taxonomy.
[221. MYCOLOGY. A two-term course, fall and spring terms. Credit five hours. Prerequisite, Botany 1 or the equivalent, and permission to register. Professor Fitzpatrick. Lecture, M W 11. Plant Science 336. Practice, M W 2-4:30 and one equivalent additional period to be arranged. Plant Science 329. Given in alternate years. Not given in 1947-1948.]

A more intensive course than the preceding, and designed especially for students specializing in mycology or plant pathology. Emphasis is placed on morphology and taxonomy, but other aspects of mycology are embraced. Practice in identification of specimens is afforded in various groups, and field work is encouraged.
222. ADVANCED MYCOLOGY. Fall term. Credit five hours. Prerequisite, course 221. Professor Fitzpatrick. Lectures and practice periods to be arranged. Plant Science 329. Given in alternate years.

This course is designed chiefly for students majoring in mycology or in mycological phases of plant pathology. It supplements course 221, gives additional training in taxonomy and widens the students' horizon in the field as a whole. Emphasis is placed on field work, identification of specimens, herbarium practice, and library studies as a preliminary to research. Lectures deal with special topics.
231. HISTORY OF PLANT PATHOLOGY. A two-term course, fall and spring terms. Requires a reading knowledge of French and German. Professor Designed especially for graduate students specializing in Plant Pathology.
241. RESEARCH. Professors Massey, Reddick, Barrus, Fitzpatrick, Chupp, Burkholder, Blodgett, Welch, Fernow, Newhall, Mills, Guterman, Burrell, Kent, Parker, Dimock, Tyler, Niederhauser, H. S. Cunningham, A. F. Ross, and L. C. Peterson.
242. SEMINAR. Members of the staff. Weekly.
243. LITERATURE REVIEW. Members of the staff. Bi-weekly.

## PHYSICAL SCIENCES

## ASTRONOMY

## Professors R. W. Shaw and M. E. Stahr.

APPROVED MAJOR AND MINOR SUBJECTS (key to symbols on p. 47)
Astronomy 1, 2, 4
Astrophysics 1, 2, 4
Candidates for the degree of Doctor of Philosophy in Astronomy or Astrophysics will be required to take one minor in Physics unless a divided major is granted. In special cases a major in Astronomy or Astrophysics may consist partly of selected courses in Physics. In such cases one minor need not be in Physics.

Candidates for the degree of Doctor of Philosophy, Master of Arts, or Master of Science with a major in Astronomy or in Astrophysics will be required to offer for admission the equivalent of Introductory Astronomy, six hours of Interpretational Astronomy, and six hours of electives in the field of Astronomy.

Candidates electing a minor in the department may select such courses as meet their requirements provided the necessary prerequisites are offered.
Students with advanced standing in the sciences or in mathematics, but who do not desire to major or minor in Astronomy, may be admitted after consultation with the professor in charge to such courses in Astronomy as may seem desirable.
101, 102. Introduction to Astronomy. Three hours a week.
125. Air Navigation. Three hours a week.

127, 128. Navigation and Nautical Astronomy. Three hours a 'week.
182. Field Astronomy. Two hours a week.

## INTERPRETATIONAL ASTRONOMY

221. Origin of the Solar System. Three hours a week.
222. THEORY OF ORBITS. Spring term. Credit three hours. Prerequisite, Differential Equations. Assistant Professor Stahr. M W F 12. Rockefeller 358.
Theory of orbits of objects moving according to Newton's Law of Gravitation. Determination of the elements of the orbit of a comet or asteroid from three or more observations. Use of computing machines.
[231. STELLAR INTERIORS. Fall term. Credit three hours. Prerequisite, the Calculus. Staff. Not offered in 1947-1948.]
223. ASTROCHEMISTRY. Spring term. Credit three hours. Prerequisite, the Calculus. Associate Professor Shaw. Hours to be arranged. Rockefeller 358.
Chemical and physical structure of all types of celestial objects. Behavior of matter under extremes of temperature and pressure. Formation of spectral lines and the quantitative analysis of stellar atmospheres. Formation of molecules in planets, stars, and interstellar space. Molecular aggregates. Atomic transformations and the origin of the elements.
[241. THE GALAXY. Fall term. Credit three hours. Prerequisite, the Calculus. Assistant Professor Stahr. Not offered in 1947-1948.]
224. EXTERNAL GALAXIES. Fall term. Credit three hours. Prerequisite, the Calculus. Assistant Professor Stahr, M W F 12. Rockefeller 358.
A study of the forms, components, distances, and distribution of the extragalactic stellar systems. Our knowledge of the Magellanic Clouds, the neighboring systems, the metagalaxy, and the expanding universe from modern investigations.
[275. ASTROPHYSICS. Fall and spring terms. Credit three hours a term. Prerequisites, Differential Equations and Astronomy 231 or 238. Associate Professor Shaw. Not offered in 1947-1948.]
[285. ADVANCED GALACTIC STRUCTURE. Either term. Credit three hours. Prerequisites, Differential Equations and Astronomy 241 and 244. Assistant Professor Stahr. Not offered in 1947-1948.].
225. ADVANCED STUDY AND RESEARCH. Either term. Credit variable. Staff.
Extended study or research on special topics selected with the advice and consent of the staff. Upon sufficient demand the work may be given formally.

## OBSERVATIONAL ASTRONOMY

461. Astronomical Spectroscopy. Three hours a week.
462. Astrometry. Three hours a week.
463. Astronomical Photometry. Three hours a week.
464. ADVANCED ASTROPHYSICAL LABORATORY. Either term. Credit one to three hours. Prerequisites, Astronomy 461, 464, or 466, and the consent of the instructor. Staff.
The student will be given opportunity to familiarize himself with techniques involved in obtaining, reducing, and evaluating data of astrophysical interest. Laboratory work may be accompanied by lectures on method and technique.

## CHEMISTRY

Professors Peter Debye, S. H. Bauer, A. T. Blomquist, T. R. Briggs, C. K. Cain, J. L. Hoard, J. R. Johnson, J. G. Kirkwood, A. W. Laubengayer, F. A. Long, W. T. Miller, M. L. Nichols, J. Papish, E. R. Van Artsdalen, L. A. Wood; Doctors W. M. Cashin and D. F. Detar.

APPROVED MAJOR AND MINOR SUBJECTS (key to symbols on p. 47)

| Inorganic Chemistry 1, 2, 3,4 | Organic Chemistry 1, 2, 3, 4 |
| :--- | :--- |
| Analytical Chemistry 1, 2, 3, 4 | Physical Chemistry 1, 2, 3, 4 |

A graduate student who desires to take either a major or a minor subject in chemistry should select any one of the above branches.

A prospective graduate student is strongly advised to communicate, when applying for admission, with a member of the faculty in the branch of Chemistry in which he wishes to have his major subject. In general, members of the Special Committee should be chosen from different fields of Chemistry. It is desirable that candidates for the degree of Doctor of Philosophy select at least one minor subject outside of chemistry.

A graduate student who desires to take a minor subject in chemistry with some field other than chemistry as the major subject, will be required to offer introductory courses in inorganic chemistry, qualitative analysis, and quantitative analysis as preliminary to his graduate study. The work upon his minor subject in chemistry may be taken in any branch of the subject that he is qualified to pursue, and may comprise advanced courses selected from the subjoined list, with the approval of his Special Committee.

Graduate students intending to teach chemistry in secondary schools are advised to confer with the departmental graduate Scholarship Committee regarding preparation for this work.

Candidates for the degree of Master of Arts, Master of Science, or Doctor of Philosophy, with major in Chemistry will be required to offer for admission the equivalent of Introductory Inorganic Chemistry 101 and 102, or 105 and 106; Qualitative Analysis 201, 205 and 207, or 212; Quantitative Analysis 215, or 220 and 222; Introductory Organic Chemistry 307 and 308 and 311; Introductory Physical Chemistry 403 and 404 or 407 and 408 , and 411; they must also present the equivalent of two units of German.

Candidates for the degree of Doctor of Philosophy with major in Chemistry must have completed, before the beginning of the last year of residence, the equivalent of Quantitative Analysis 220 and 222, Introductory Organic Chemistry Laboratory 312, and Introductory Physical Chemistry Laboratory 412. Graduate students entering from approved universities may take during their residence for the advanced degree, such of these required courses as they have not already pursued. If a graduate student lacks at entrance several of these preliminary courses, more than the minimum periods of residence may be necessary.

Proficiency Tests will be required of all entering candidates for advanced degrees (M.S. or Ph.D.) in Chemistry. These tests, which will be given a few days before registration for the fall term, will cover the divisions of Inorganic, Analytical, Organic, and Physical Chemistry. Each test will be from two to two and one-half hours in length and will cover material normally presented in elementary courses in the subjects listed above.

Results of these tests will be used to aid the student's Special Committee in the selection of his program of courses. While the results will not be considered in the usual sense of "passing" or "failing", low marks in one or more of the tests may require a preponderance of elementary courses during a term and a reduced residence credit for that term.

Qualifying Examinations required of all candidates for the Ph.D. degree will follow the general procedure outlined on page 27 of this Announcement.

After the candidate has completed his minor subjects, he will be required to pass a general examination, both written and oral, on his major and minor subjects. Upon recommendation of the candidate's Special Committee, this examination may be taken toward the end of the term preceding his last year of residence. This procedure makes it possible for the candidate to devote his last year of residence to uninterrupted research on his thesis. At the close of his period of residence, and after the acceptance of his thesis, the candidate will be required to pass a final oral examination on the thesis and on related subjects.

As an alternative procedure, the general examination on major and minor subjects and on the thesis may be taken after the acceptance of the thesis.

Graduate students are required to register with the Department of Chemistry on the registration days at the beginning of each term. Entering students must
consult with the chairman of the departmental Graduate Scholarship Committee at this time.

For a more detailed description of the courses in the various branches of chemistry, see the Announcements of the Colleges of Arts and Sciences and of Engineering.

All courses in Chemistry are open to properly qualified graduate or undergraduate students. It may be necessary for a graduate student in chemistry to take one or more of the courses designated by italics as primarily for undergraduates, either as prerequisite to his graduate work or as an essential part of his major and minor subjects.

Fellowships and scholarships are ordinarily awarded only for the last year of residence for the Doctorate. Teaching and research assistantships are open to entering graduate students.

All courses listed below are to be given in the Baker Laboratory of Chemistry.

## INORGANIC CHEMISTRY

101 and 102. General Chemistry. Throughout the year. Two lectures and one recitation-laboratory period a week.

105 and 106. General Chemistry. Throughout the year. Two lectures and one recitation-laboratory period a week.

111 and 112. Introductory Inorganic Chemistry. Throughout the year. Fall term, three lectures a week. Spring term, two lectures a week.
115. Introductory Inorganic Laboratory. Fall term. One recitation and two laboratory periods a week.

575 and 576. ADVANCED INORGANIC CHEMISTRY. Throughout the year. Credit three hours a term. Prerequisite or parallel courses, Chemistry 403 and 404 , or 407 and 408 , or consent of the instructor. Professor Laubengayer. M W F 11. Baker 107.

The development of theories of atomic structure, the classification of the elements, and the nature of chemical bonding are considered. The elements are discussed in the order of the Periodic System, with special attention to the bearing of atomic structure on the properties of elements and their compounds and on the relations between the groups and periods. The less familiar elements are treated in detail and the stereochemistry of inorganic substances is emphasized.
580. ADV ANCED INORGANIC LABORATORY. Either term. Credit two to six hours. Prerequisite, Chemistry 307 and 308 and 311 and 312. Chemistry 580 is designed to accompany Chemistry 575 and 576 but may be taken separately. Professor Laubengayer. Day and hours to be arranged. Baker 178.

Laboratory practice. The preparation, purification, properties, and reactions of inorganic compounds, including those of the rarer elements.
[585. SELECTED TOPICS IN ADVANCED INORGANIC CHEMISTRY. Fall term. Credit two hours. Prerequisite, Chemistry 403 and 404, or 407 and 408, and 411 and 412, or consent of the instructor. Not given in 1947-1948.]
590. CHEMISTRY OF THE RARE ELEMENTS. Either term. Credit two or more hours. Prerequisite, Chemistry 575 and 576. Professor PapIsh. Day and hours to be arranged. Baker 318.

Laboratory practice. Extraction, recovery, and purification of the rare elements, and preparation of their salts. Chemical analysis of the rare elements.

## ANALYTICAL CHEMISTRY

201. Introductory Qualitative Analysis. Either term. One lecture and two laboratory periods a week.
202. Introductory Qualitative Analysis. Fall term. Three lectures a week.
203. Introductory Qualitative Laboratory. Fall term. Three laboratory periods a week.
204. Introductory Qualitativé Analysis. Spring term. Two lectures, one recitation, and two laboratory periods a week.
205. Introductory Quantitative Analysis. Either term. Two lectures and two laboratory periods a week.
206. Introductory Quantitative Analysis. Either term. Two lectures and one recitation a week.
207. Introductory Quantitative Laboratory. Either term. Three laboratory periods a week.
208. SPECIAL METHODS OF QUANTITATIVE ANALYSIS. Either term. Credit three hours. Prerequisite, Chemistry 220 and 222 , or the consent of the instructor. Professor NichoLs and assistants. Lecture, T 11, Baker 207. Laboratory, M T or Th F 2-4:30, or W 2-4:30 and Th 10-12:30. Baker 282 and 294.

The complete analysis of coal gas, the analysis of coal, the determination of the heating value of gaseous and solid fuels, and gas evolution methods. The application of instrumental methods to quantitative analysis including nephelometric, refractometric, colorimetric, electrolytic, combustion, conductometric, and potentiometric methods.
[250. GAS AND FUEL ANALYSIS. Fall term. Credit three hours. Prerequisite, Chemistry 220 and 222, or consent of the instructor. Professor Nichols and assistants. Lecture, F 10, Baker 207. Laboratory, S 8-1. Baker 282. Not given in 19471948.]
265. ADVANCED QUANTITATIVE LABORATORY. Spring term. Credit three hours. Prerequisite, Chemistry 215 or 220 and 222. Professor Nichols and assistant. Conference, one hour a week, to be arranged. Laboratory, M T W Th or F 2-4:30. Baker 294.

Laboratory practice in the application of special methods of quantitative analysis and the analysis of special materials.
275. QUANTITATIVE MICROANALYSIS. Fall term. Credit three or more hours. Prerequisite, consent of the instructor. Enrollment is limited. Professor Nichols and assistant. Laboratory, W F 9-5. Baker 358.
Laboratory practice in typical methods of both organic and inorganic quantitative microanalysis.
280. EMISSION SPECTROSCOPY IN CHEMICAL ANALYSIS. Either term. Credit three or more hours. Prerequisite, consent of the instructor. Professor Papish, and assistant. Conference, one hour, to be arranged. Laboratory, hours to be arranged. Baker 396.
The construction and use of spectroscopic equipment; spectrum excitation; qualitative and quantitative spectrochemical analysis.
[290. ADVANCED QUANTITATIVE ANALYSIS. Spring term. Credit two hours. Prerequisite, Chemistry 403 or 407 . Professor Nichols. Lectures, W F 9. Baker 207.
A discussion of selected topics in quantitative analysis, and the development and present status of various analytical methods. Given in alternate years. Not given in 1947-1948.]

## ORGANIC CHEMISTRY

303. Elementary Organic Chemistry. Either term. Four lectures a week.
304. Elementary Organic Laboratory. Either term. Two laboratory periods a week.

307 and 308. Introductory Organic Chemistry. Throughout the year. Three lectures a week.
311 and 312. Introductory Organic Laboratory. Throughout the year. Three laboratory periods a week.
320. IDENTIFICATION OF ORGANIC COMPOUNDS. Either term. Credit four hours. Prerequisite, Chemistry 305 and 306 and 311 and 312, at grades of 75 or better. Associate Professor Miller and assistants. Lectures, T Th 8. Baker 377. Laboratory, M W or T Th 2-4:30, or F 2-4:30 and S 10-12:30. Baker 378.

The classification reactions of organic compounds and the preparation of solid derivatives are applied to the identification of unknown organic substances.
330. ADVANGED ORGANIC LABORATORY. Either term. Credit two to four hours. Prerequisite, Chemistry 312 and 320 , and the consent of the instructor. Professor Johnson, Associate Professor Mileer, Assistant Professors Blomquist and Cain and Doctor DeTar. Hours to be arranged. Baker 352.

An advanced course in organic synthetic procedures, involving preparation of intermediates for organic research and use of standard reference works.

365 and 366. ADVANCED ORGANIC CHEMISTRY. Throughout the year. Credit two hours a term. Prerequisite, Chemistry 307 and 308, 311 and 312 and 320 , or the consent of the instructor. Students may register for either term separately. Professor Johnson, Assistant Professor Blomquist, and Doctor DeTar. Lectures, T Th 9. Baker 177.

First term: survey of the more important classes of organic compounds and their reactions. Second term: discussion of general topics (tautomerism, molecular rearrangements, stereochemistry).

375 and 376. SELECTED TOPICS IN ORGANIC CHEMISTRY. Throughout the year. Credit two hours a term. Prerequisite, Chemistry 365 and 366. Assistant Professor Blomquist. Lectures, M W 12. Baker 377.

First term: organic compounds of nitrogen and of sulfur. Second term: the simpler heterocycles and alicyclic compounds.
[380. CHEMISTRY OF HIGH POLYMERS. Spring term. Credit two hours. Prerequisite, Chemistry 320 or 365 and 366 , and 403 and 404 , or 407 and 408 and the consent of the instructor. Associate Professor Mileer. Lectures, M W 10. Baker 377. Given in alternate years. Not given in 1947-1948.]
385. PHYSICAL ASPECTS OF ORGANIC CHEMISTRY. Fall term. Credit two hours. Prerequisite, Chemistry 320 or 365 and 366 , and the consent of the instructor. Associate Professor Miller. Lectures, M W 10. Baker 377.
A discussion of recent theoretical developments in organic chemistry and their application to typical reactions. Given in alternate years.
[395 and 396. CHEMISTRY OF NATURAL PRODUCTS. Throughout the year. Credit two hours a term. Prerequisite, Chemistry 320 or 365 and 366. Students may register for either term separately. Assistant Professor Cain. Lectures, T Th 11. Baker 377. Given in alternate years. Not given in 1947-1948.]

## PHYSICAL CHEMISTRY

403 and 404. Introductory Physical Chemistry. Throughout the year. Three lectures a week.

407 and 408. Introductory Physical Chemistry. Throughout the year. Three lectures a week.

411 and 412. Introductory Physical Laboratory. Throughout the year. One recitation and two laboratory periods a week.
431 and 432. APPLIED ELECTROCHEMISTRY. Throughout the year. Credit two hours a term. Prerequisite, Chemistry 403 and 404 or Chemistry 407 and 408. Professor Briggs. Lectures, T Th 11. Baker 7.
Elementary theory of electrolysis and electromotive force. Electrolytic refining and extraction of metals; electroplating; electrolytic preparation of organic and inorganic compounds; electrothermal electrolysis; storage cells.
By electing Chemistry 465 (two or more hours), the student may obtain laboratory practice in many of the subjects which are presented in the lectures. Given in alternate years.
435. INTRODUCTORY ELECTROCHEMISTRY. Spring term. Credit three hours. Prerequisite, Chemistry 403 and 404 or Chemistry 407 and 408. Professor Briggs and assistant. Lectures, M W 12, Baker 7. Laboratory, one period a week to be arranged. Baker 1A.
The theory of electrolysis and the voltaic cell. Laboratory practice in electrolysis, measurement of electromotive forces, transference numbers, decomposition voltages, and similar subjects.
[441 and 442. COLLOID CHEMISTRY. Throughout the year. Credit two hours a term. Prerequisite, Chemistry 403 and 404 or Chemistry 407 and 408. Professor Briggs. Lectures, T Th 11, Baker 7. Given in alternate years. Not given in 19471948.]
445. APPLICATION OF THE PHASE RULE. Fall term. Credit three hours. Prerequisite, Chemistry 403 and 404 or Chemistry 407 and 408. Professor Briggs. Lectures, M W F 12. Baker. 7.
The study and interpretation of typical phase diagrams, especially in the systems of two and three components, followed by a brief treatment of systems containing four or more components. Special attention will be given to metal alloy diagrams, to equilibria in saturated salt solutions, and to the problem of indirect analysis.
450. SOLID STATE. Spring term. Credit three hours. Prerequisite, Chemistry 403 and 404 or Chemistry 407 and 408. Professor Hoard. Hours to be arranged. Baker 177.
Discussion of structural types established for crystals through X-ray analysis, ionic and atomic radii, coordination number, packing relations, and stereochemistry of molecules and complex ions. Correlation of structure with physical properties, especially for ionic and metallic crystals.
[455. KINETICS OF CHEMICAL REACTIONS. Spring term. Credit three hours. Prerequisite, Chemistry 403 and 404 or Chemistry 407 and 408. Professor Long. Not given in 1947-1948.]
460. CHEMICAL PHYSICS. Fall term. Credit three hours. Open to seniors and graduate students majoring in chemistry or physics. Professor Debye. M W F 10. Baker 177.

An elementary presentation of the principles involved in describing the structure and behavior of matter; atomic structure and the periodic table; interatomic forces; structure of solids; electrons in metals; temperature equilibrium and statistics.
465. ADVANCED LABORATORY PRACTICE IN PHYSICAL CHEMISTRY. Either term. Credit variable, but not to exceed six hours a term. Prerequisite, determined in each case by the professor in charge. Professors Briggs, Hoard, Kirkwood, and assistants. Hous and place to be arranged.

471 and 472. THERMODYNAMICS. Throughout the year. Credit three hours a term. Prerequisite, Chemistry 403 and 404 or 407 and 408. Professor Kirkwood, M W F 9. Baker 107.

Development of the general equations of thermodynamics from the first and second laws. Exposition of the concepts of entropy and free energy. Applications to the study of physicochemical equilibria in gases, liquids, solids, and liquid solutions. Problems.
[475. THEORY OF SOLUTIONS. Fall term. Credit three hours. Prerequisite, Chemistry 471 and 472. Professor Kırkwood, M W F 12. Baker 107. Not given in 1947-1948.]
[480. STATISTICAL MECHANICS. Spring term. Credit three hours. Prerequisite, Chemistry 471. Professor Kirkwood. M W F 12. Baker 107. Given in alternate years. Not given in 1947-1948.]
490. INTRODUCTORY QUANTUM MECHANICS WITH CHEMICAL APPLICATIONS. Spring term. Credit three hours. Open to qualified students by permission. Professor Kirkwood. M W F 12. Baker 107.

Elementary presentation of the principles of quantum mechanics. Development of the basic ideas underlying the quantum mechanical theory of the chemical bond, Given in alternate years.
[495. MOLECULAR SPECTRA. Fall term. Credit three hours. Prerequisite, consent of the instructor. Associate Professor Bauer. Hours to be arranged. Baker 18. Not given in 1947-1948.]

## GEOLOGY AND GEOGRAPHY

Professors O. D. von Engeln, C. M. Nevin, W. S. Cole, A. L. Anderson, and J. D. Burfoot, Jr.

## APPROVED MAJOR AND MINOR SUBJECTS (key to symbols on p. 47)

Regional Geography 1,2
Mineralogy 1, 2, 3, 4
Economic Geology 1, 2, 3, 4
Paleontology 1, 2, 3, 4
Petrology 1, 2, 3, 4
Metamorphism 1, 2, 3, 4
Geomorphology 1, 2, 3, 4

Glacial Geology 1, 2, 3, 4
Structural Geology 1, 2, 3, 4
Stratigraphy 1, 2, 3, 4
Sedimentation 1, 2, 3, 4
Physical Geography 2, 4
Geology 4
Geography 4

Under the general title of geology and geography are included structural geology, physical, regional, and economic geography, geomorphology, glaciologe, mineralogy, crystallography, petrology, paleontology and stratigraphic geology, and economic geology.

Graduate work in Geology may include, in addition to work done in Ithaca, the opportunity to spend part of the time in investigation under approved direction in the field away from Ithaca.

The University Library has a very large collection of private publications, magazines, and geological society transactions, as well as files of North American, European, and other geological survey reports. In the Geological Department there is the entire library of the late Professor H. S. Williams and a collection of over 60,000 authors' separates.

Special rooms are available for graduate students for carrying on research.
The department is provided with apparatus for different kinds of photographic work, and for polishing and sectioning ores, minerals, and rocks.
101-102. General Geology and Physiography. Throughout the year. Two lectures and one laboratory period a week.
105. General Geography. Fall term. Three lectures a week.

107-108. Mineral Resources. Throughout the year. Two lectures a week.
111. Ancient Life. Spring term. Three lectures a week.
113. Engineering Geology. One term, repeated each term. Two lectures and two laboratory periods a week.
115. Introductory Geology. One term, repeated each term. Two lectures and one laboratory period a week.

## STRUCTURAL GEOLOGY, SEDIMENTATION, AND PETROLEUM GEOLOGY

## Professor Nevin.

Graduate research in any of these subjects should preferably be based on field work.
301. STRUCTURAL GEOLOGY. First term. Credit three hours. Prerequisite, Geology 101-102 or equivalent. Professor Nevin. Two lectures, one laboratory. M W 11, M 2-4:30. McGraw 150.

Geologic structures and their causes.
303. SEDIMENTATION. Second term. Credit three hours. Prerequisite, Geology 101-102 or equivalent. Professor Nevin. Two lectures, one laboratory. M W 11, M 2-4:30. McGraw 150.

The principles involved in the formation of sediments.
321. PETROLEUM GEOLOGY. Second term. Credit three hours. Prerequisite, Geology 101-102 or equivalent. Professor Nevin. Two lectures, one laboratory. T Th 8, Th 2-4:30. McGraw 150.

The geology of oil and natural gas, and a discussion of the methods used to discover them.

391-392. SEMINAR IN STRUCTURAL GEOLOGY AND SEDIMENTATION. Throughout the year. Credit variable. For advanced students. Professor Nevin. M 4:45. McGraw 150.

395-396. ADVANCED OR SPECIAL WORK IN STRUCTURAL GEOLOGY, sedimentation, and petroleum geology. Throughout the year. Credit variable. Professor Nevin. McGraw 150.

Advanced course work and original investigation adapted to the needs of the student. Day and hour to be arranged.
901. GEOLOGIC MAPPING. Given at the summer field camp. Credit six hours. Professor Nevin. (Special circular, on request, from the department.)

## GEOMORPHOLOGY AND GLACIAL GEOLOGY

## Professor von Engeln.

The region around Ithaca affords excellent and varied illustrations of physiographic and glacial phenomena. For many years the teachers and advanced students of geomorphology and glacial geology have been engaged in investigation of the local field problems, and there is further opportunity of this kind. The main laboratory is well equipped with topographic maps and photographs; the collection of relief models is notably complete; and there is an experimental laboratory with apparatus and facilities for carrying on a variety of experiments in the development of land forms, etc. The work in this branch also includes an introductory course in general geography. This, in correlation with physical geography and geomorphology, may be the preparation for advanced regional study and investigation. For teachers of Physical Geography in the secondary schools who wish to secure a Master's degree a definite program with a thesis subject appropriate to their needs has been outlined. Such work can be pursued in successive Summer Session terms.
401. GEOMORPHOLOGY. First term. Three hours credit. Prerequisite, Geology 101-102 or equivalent. Professor von Engeln. T Th 9. Laboratory, T 2-4:30. McGraw 265.

The technology of geomorphological description and interpretation of land forms with regard to process and stage and the adjustment of topography to structure. The precepts of the German school are given consideration.
403. GLACIERS AND GLACIATION. Second term. Three hours credit. Prerequisite, Geology 101-102 or equivalent. Professor von Engeln. T Th 9. Laboratory, T 2-4:30. McGraw 265.

Living glaciers and the phenomena of the glacial period. One or more Saturdays devoted to all-day excursions in the spring. Mapping and interpretation of glacial deposits.
495-496. ADVANCED OR SPECIAL WORK IN GEOMORPHOLOGY AND GLACIAL GEOLOGY. Throughout the year. Credit variable. Prerequisite, an adequate background of course work in geology. Professor von Engeln. Hours to be arranged. McGraw 265.

Particular problems, especially those of glaciology and the relation of geological structure to topography and physiographic history. In general students with a minor in this branch are expected to undertake work in this course.

## MINERALOGY AND PETROLOGY

## Associate Professor Burfoot.

The laboratory equipment for optical, chemical, physical, and crystallographic investigations in these fields is relatively good. The study collections of minerals
and rocks are entirely adequate, and collections from many localities over the earth are available for advanced work and reference. Thin sections have been prepared of the representative specimens of most of the collections of rocks. The collection of minerals includes the Benjamin Silliman, Jr., collection, which was acquired before the opening of the University in 1868.

Advanced work is adapted to the needs of the individual student, but majors and minors are expected to acquire fundamental knowledge of and basic working skill in the advanced and specialized concepts and methods in these fields.
205. ELEMENTARY MINERALOGY. Fall term. Two lectures and one laboratory period a week.
501. OPTICAL MINERALOGY. Fall term. Credit three hours. Prerequisite, Geology 205. Associate Professor Burfoot. Lectures, M. W 10. McGraw 145. Laboratory, F 9-11:30. McGraw 345. Registration with department before beginning of course required.

The theory and use of the petrographic microscope in the determination and study of minerals and rocks. The commoner rock-forming minerals are studied in fragments and in thin sections.
502. PETROLOGY. Spring term. Credit three hours. Prerequisite, Geology 501. Associate Professor Burfoot. Lectures, M W 10. McGraw 145. Laboratory, F 10-12:30. McGraw 345. Registration with department before beginning of course required.

A consideration of the commoner kinds of igneous rocks, of various classifications used, and of the general principles of petrology, including the origin of and the conditions under which igneous rocks are formed. In the laboratory, rock types are studied in thin sections under the petrographic microscope, with especial emphasis being given to the interpretation of textural and structural relationships.
521. SEDIMENTARY PETROGRAPHY. Spring term. Credit three hours. Prerequisite, Geology 501. Associate Professor Burfoot. Lectures, M W 11. McGraw 145. Laboratory, S 9-11:30. McGraw 345 and B-65. Registration with department before beginning of course required.

The methods of preparation of mineral grains for study and the identification and interpretation of these grains by means of the petrographic microscope. Some thin section work is included.
577. METAMORPHIC GEOLOGY. Spring term. Credit three hours. Prerequisite, permission of instructor. Associate Professor Burfoot. Lectures, M W 11. McGraw 145. Laboratory, S 9-11:30, McGraw 145 and 345. Registration with department before beginning of course required.

A general survey of the field of metamorphic geology with special emphasis on processes and criteria. Metamorphic differentiation, the facies classification of metamorphic rocks, and retrogressive metamorphism are among the subjects considered. Special suites illustrating these phenomena are used.

591-592. SEMINAR IN MINERALOGY AND PETROLOGY. Throughout the year. Credit one hour a term. Prerequisite, permission of instructor. Associate Professor Burfoot. W 4:45. McGraw 145.

Literature, special topics, advanced methods.
595-596. ADVANCED OR SPECIAL WORK IN MINERALOGY AND PE-

TROLOGY. Throughout the year. Credit variable. Prerequisites, variable. Associate Professor Burfoot. Days and hours to be arranged. McGraw 145, 345, B-65.
Adapted to the needs of the individual student. Specialized topics, advanced methods, special problems, research.

## PALEONTOLOGY AND STRATIGRAPHIC GEOLOGY

## Professor Cole.

The University is so situated that excellent exposures of Devonian formations are at its very door, and the typical sections of New York State which are of fundamental importance in American Paleozoic geology are within short excursion range. The most important of these are the Rochester and Niagara gorges, Trenton Falls and the Helderberg escarpment, the Chemung Valley, and the coal fields of northern Pennsylvania.
Facilities are afforded to those desiring to study the later formations, since the department has collections made in the West Indies, Central and South America, as well as different parts of the United States and Europe. There is also the Newcomb collection ( 10,000 species of recent shells); and a wealth of conchological literature in the geological and the general library.
201. HISTORIC GEOLOGY. Fall term. Credit three hours. Prerequisite, Geology 101-102. Professor Cole. Lectures, M W 9. Laboratory, W 2-9:30. McGraw 450.
Systematic study of the geologic history of the earth with reference to the rocks from the earliest periods to the present, their nature and distribution, orogenies, paleogeography, and the fossil remains and other characteristics on which their identification and correlation depend. Special emphasis on American geology. Field studies in the laboratory period in so far as weather and other circumstances permit.

601-602. INVERTEBRATE PALEONTOLOGY. A two-term course: fall and spring terms. Credit three hours a term. Prerequisite, Geology 201 and, if possible, Invertebrate Zoology. Professor Cole. Lectures, T Th 10. McGraw 450. Laboratory, Fall term, Th 2-4:30; Spring term, W 2-4:30. McGraw 450.
Fall term: paleobiology and classification of important fossil invertebrate organisms; spring term: key fossils of the geologic periods. Certain laboratory periods will be devoted to the collection and determination of fossil assemblages from selected horizons of the Paleozoic formations of central New York.
605. STRATIGRAPHY. Spring term. Credit three hours. Prerequisite, Geology 201. Professor Cole. Lectures, M W F 9. McGraw 450.

The principles of stratigraphic nomenclature and correlation developed by study of selected North American and European rock sequences.
675. MICROPALEONTOLOGY. Spring term. Credit two hours. Prerequisite, permission of the instructor. Student should have Geology 101-102, 201, 605, and 601-602. Professor Cole. F 10:30-1 and S 8-10:30. McGraw 450.
Study of the microfossils, chiefly Foraminifera, in their relation to correlation of strata, as used in the development of oil fields.
681. GEOLOGY OF NEW YORK STATE. Spring term. Credit two hours. Prerequisites, Geology 101-102, 201, 605, 601-602, or permission of instructor. Professor Cole. Lectures in winter months, all day field trips in spring months. Hours and days to be arranged. McGraw 450.

The outstanding geologic phenomena of New York State will be studied through lectures, readings, and field observations. Special emphasis will be given to the classic Paleozoic section of central New York. Course given only if sufficient number of qualified students are registered.

695-696. ADVANCED OR SPECIAL WORK IN PALEONTOLOGY AND STRATIGRAPHY. Throughout the year. Credit variable. Prerequisites, Geology 605 and 601-602. Professor Cole. Day and hours to be arranged. McGraw 450.

Particular problems in paleontology and stratigraphy adapted to the needs of the individual student.

## ECONOMIC GEOLOGY

## Associate Professor Anderson.

The work in economic geology is designed to familiarize the student with the origin, occurrence, and distribution of the mineral products of economic value, and also with the practical application of geological principles. The laboratory contains an excellent study collection of economic materials from the United States, Canada, Mexico, Europe, and Africa, including ores, fuels, clays, abrasives, building stones, etc., most of these representing suites of materials collected by members of the staff of instruction on geological trips. This collection is supplemented by maps and models.

In addition to the collections, the economic geology laboratory has facilities for general work and research on economic materials; the equipment for metallographic work on ores is excellent.

The work of graduate instruction consists in part of lectures and in part of special work arranged to suit the needs of the individual student. Students who are registered for a major subject in economic geology are expected to engage in research, which should preferably be based on field work.

Excursions may readily be taken to the anthracite regions of Pennsylvania; to the iron, slate, cement, and talc regions near Easton, Pa.; to the metal mines of the Adirondacks, etc. Field trips of greater or less length are taken to some of these localities every year.
701-702. GENERAL ECONOMIC GEOLOGY. A two-term course. Credit three hours a term. Prerequisite, Geology 101-102 or 113 and 205 or permission of the instructor. Associate Professor Anderson. Lectures, T Th 11. Laboratory, F 2-4:30. McGraw 150.

Nature, mode of occurrence, distribution, and utilization of the more important mineral deposits. Fall term deals with the non-metalliferous deposits such as building stone, ceramic materials, coal, petroleum, phosphate, gypsum, salt, gems, etc.; the spring term deals with the metalliferous deposits such as iron, copper, lead, zinc, gold, silver, platinum, etc. Field trips to be included as a part of the laboratory work.

721-722. MICROSCOPIC STUDY OF ORE MINERALS. Two terms. Credit one hour a term. Prerequisite, Geology 205. Associate Professor Anderson. S 911:30. McGraw 250.
Identification of ore minerals in polished sections with reflected light by means of etch and microchemical reactions; study and interpretation of mineral relationships; and preparation of photomicrographs to illustrate paragenesis. The course is designed as a tool in the study of ore deposits.
[731-732. MINERAL EVALUATION AND TECHNOLOGY. Two terms. Credit two hours a term. Prerequisites, Geology 205 and $701-702$ or by special permission. Associate Professor Anderson. Given in alternate years; given in 19481949. M W 1. McGraw 150.]

Methods of sampling and mine evaluation; mining methods; and principles and methods of mineral concentration. Designed to improve the background of economic geologists and engineers for work in the mineral industry.

775-776. GENESIS OF MINERAL DEPOSITS. A two-term course. Credit three hours a term. Prerequisites, Geology 501, 701-702, and 721-722. Associate Professor Anderson. Two lectures, one laboratory. Lectures, M W 8; Laboratory, F 9-11:30. McGraw 150.

Structural occurrence and origin of the economically important mineral deposits. Fall term: the deposits of primary origin associated more or less closely with igneous phenomena; spring term: the deposits of secondary origin associated more or less directly with processes of weathering and sedimentation.

791-792. ECONOMIC GEOLOGY SEMINAR. Throughout the year. Credit one hour a term. Associate Professor Anderson. T 4:45. McGraw 150.

Seminar on timely topics in Economic Geology.
795-796. ADVANCED OR SPECIAL WORK IN ECONOMIC GEOLOGY. Throughout the year. Credit variable. Prerequisite, dependent on the nature of the work. Associate Professor Anderson.

Work arranged to meet the needs and training of the student. Guided study of geologic problems of advanced or special nature, and research in Economic Geology.

## MATHEMATICS

Professors W. A. Hurwitz, R. P. Agnew, J. B. Rosser, B. W. Jones, Wm. Feller, W. W. Flexner, R. J. Walker, Mark Kac, and Harry Pollard.

## APPROVED MAJOR AND MINOR SUBJECTS (key to symbols on p. 47)

Algebra 1, 2, 3
Mathematical Analysis 1, 2, 3
Geometry 1, 2, 3
If mathematics (as distinct from one of its subdivisions) is chosen as major subject, the minor subject or subjects must be chosen from some other field or fields of study.
It is recommended that when the major subject for the degree of Ph.D. is in the field of mathematics, at least one minor subject be chosen from some other field.
The graduate work provides instruction in the principal branches of mathematics and furnishes preparation and material for independent investigation. Only a portion of the whole field can be covered by the courses given in a single year. The courses are changed, therefore, from year to year in order to meet the needs of students.
In addition to the regular instruction, individual guidance and advice are offered to any student who wishes to follow a particular line of inquiry.

Students who take mathematics as a major subject for an advanced degree must have completed previously the equivalent of the elementary course in analytic geometry and calculus, and further study in at least one more advanced subject, as for example, differential equations, advanced calculus, modern algebra, or projective or advanced analytic geometry.

The Oliver Mathematical Club, composed of teachers and advanced students, meets weekly, and has for its object the systematic presentation by the members of some specified mathematical theory of recent development, and of reports on articles in recent journals and on results of special reading and investigations. Discussion and reading groups or seminars are also frequently organized to meet other special interests, sometimes with the co-operation of teachers and students in fields other than Mathematics.

The equipment consists of a collection of about three hundred surfaces, including the various forms of the cyclides, the Kummer surface, the surface of centers, and minimum surfaces; plaster models illustrating positive, negative, and parabolic curvature, and constant measure of curvature; plaster models illustrating the theory of functions, among them models of simply and multiply connected surfaces, and of several forms of Riemann surfaces, and models representing the real parts of algebraic, exponential, logarithmic, and elliptic functions; wooden and glass models of crystals and polyhedra, wire and thread models of twisted curves and ruled surfaces, and skeleton frames for minimum surfaces.

The library has a large collection of books on pure and applied mathematics, including collected works of mathematicians, complete sets of all the important mathematical journals, transactions, and other publications of scientific societies, and doctoral theses from the leading American and European universities.

The Erastus Brooks Fellowship of $\$ 600$ is awarded annually in the field of Mathematics. The fellowship is ordinarily awarded only to applicants who have had one year or more of graduate study.

It is expected that the following and some other courses will be offered. For possible additional courses and changes in these courses, consult the Announcement and Supplementary Announcements of the College of Arts and Sciences. The courses mentioned in brackets will not be given in 1947-1948, but are given from time to time.

111 [B]. Basic Mathematics. Either term. Three hours a week, one hour credit. 121, 122 [1]. Elementary Concepts of Mathematics. Two terms. Three hours a week.

129 [5]. Solid Geometry. Either term. Three hours a week.
131 [10]. College Algebra. Either term. Three hours a week.
133 [15]. Plane Trigonometry. Either term. Three hours a week.
151 [51]. Analytic Geometry and Calculus. One term. Five hours a week.
155, 156 [55a, b]. Analytic Geometry and Calculus. Two terms. Five hours a week.

161, 162, 163 [60a, b, c]. Analytic Geometry and Calculus. Three terms. Three hours a week.

171, 172, 173 [65a, b, c]. Analytic Geometry and Calculus. Three terms. Three hours a week.

201 [200]. Elementary Differential Equations. Either term. Three hours a week. 221 [90]. Teachers' Course. One term. Three hours a week.

## ALGEBRA

301 [133]. DETERMINANTS AND MATRICES. Spring term. Credit three hours. Prerequisite, Mathematics 173 or the equivalent. T Th S 9. White 121.
A treatment of such topics as determinants, matrices, linear dependence, linear equations and linear transformations, numerical methods of computation and reduction by means of orthogonal transformations.
341 [140]. ELEMENTARY THEORY OF NUMBERS. Fall term. Credit three hours. Prerequisite, Mathematics 172 or the equivalent. T Th S 9. White 121.
A study of properties of divisibility, linear and quadratic congruences, primitive roots, quadratic residues and other topics.
347. ALGEBRAIC NUMBERS. Spring term. Credit three hours. Prerequisite, Mathematics 341 or consent of the instructor. T Th S 9. White 123.
Fundamental concepts of algebraic numbers, unique factorization of ideals, minimal bases, the Dirichlet theorem on units.
349 [142]. ANALYTIC THEORY OF NUMBERS. Spring term. Credit three hours. Prerequisite, Mathematics 532. M W F 10. White 123.
The course will stress the great diversity of methods which can be applied to the solution of problems in the theory of numbers. Topics will be selected from the following: Bernoulli numbers and polynomials, prime number theorem, partitions, lattice-point problem, Goldbach's theorem. No particular knowledge of number theory is required.
329. GALOIS THEORY. Fall term. Credit three hours. Prerequisite, 321 or the equivalent. T Th S 9. White 123.

Normal and simple extensions of fields, Kummer's fields, Galois groups, application of Galois theory to equations solvable by radicals and ruler and compass constructions.
[FOUNDATIONS OF MATHEMATICS. Not given in 1947-1948.]
[SYMBOLIC LOGIC. Not given in 1947-1948.]
[ADVANCED THEORY OF MATRICES, Not given in 1947-1948.]
[GROUPS, RINGS, AND FIELDS. Not given in 1947-1948.]
[ADVANCED THEORY OF NUMBERS. Not given in 1947-1948.]
[THEORY OF EQUATIONS. Not given in 1947-1948.]
[LINEAR ALGEBRAS, Not given in 1947-1948.]
[QUADRATIC FORMS. Not given in in 1947-1948.]
[TOPOLOGICAL GROUPS. Not given in 1947-1948.]

## GEOMETRY

401, 402 [310]. PROJECTIVE GEOMETRY. Throughout the year. Credit three hours a term. Prerequisite, Mathematics 172 or the equivalent. M W F 9. White 123.

A first course in projective geometry, including both synthetic and analytic methods.
411. TOPOLOGY. Fall term. Credit three hours. Prerequisite, Mathematics 321 and consent of teacher. M W F 9. White 121.

An introduction to basic topologic concepts, with applications to the theory of complexes.
439. RIEMANNIAN GEOMETRY. Spring term. Credit three hours. Prerequisite, Mathematics 173 and consent of teacher. M W F 9. White 121.

The methods of tensor analysis are developed and used to investigate the differential geometry of surfaces and configurations of more than two dimensions.
[ALGEBRAIC CURVES. Not given in 1947-1948.]
[DIFFERENTIAL GEOMETRY. Not given in 1947-1948.]
[ALGEBRAIC SURFACES. Not given in 1947-1948.]
[ADVANCED TOPOLOGY. Not given in 1947-1948.]
[DIMENSION THEORY. Not given in 1947-1948.]

## ANALYSIS

501, 502 [215]. ADVANCED CALCULUS. Throughout the year. Credit three hours a term. Prerequisite, Mathematics 173 or the equivalent. M W F 11. White 111.

A careful study of limits, continuity, derivatives, and Riemann integrals. Functions of several variables. Multiple and line integrals. The course is designed to furnish necessary preparation for advanced work in analysis and applied mathematics. Emphasis on the logical development of calculus.

531, 532 [240]. COMPLEX VARIABLES. Throughout the year. Credit three hours a term. Prerequisite, Mathematics 502. T Th S 11. White 111.

Among the topics considered will be the complex number system; the elementary functions, complex differentiation and integration; Cauchy's theorem; Taylor's series; singularities; conformal mapping; Riemann surfaces; Fourier and Laplace transformations; differential and integral equations. Applications will be made to physical and engineering problems.
551 [260]. INFINITE SERIES. Fall term. Credit three hours. Prerequisite, Mathematics 502 and consent of teacher. M W F 10. White 111.
Modern theory of convergent and divergent series.
[THEORY OF FUNCTIONS OF A REAL VARIABLE. Not given in $1947-$ 1948.]
[MEASURE AND INTEGRALS. Not given in 1947-1948.]
[CALCULUS OF VARIATIONS. Not given in 1947-1948.]
[INTEGRAL EQUATIONS. Not given in 1947-1948.]
[ABSTRACT SPACES. Not given in 1947-1948.]
[FOURIER SERIES AND INTEGRALS. Not given in 1947-1948.]

## APPLIED MATHEMATICS

605. [410]. NUMERICAL AND GRAPHICAL METHODS. Fall term. Credit three hours. Prerequisite, Mathematics 201 or the equivalent. M W F 10. White 123.

Graphs, scales and alignment charts; analytical approximations to empirical curves; interpolation and extrapolation; mechanical quadratures; numerical and
graphical solutions of algebraic, transcendental, and differential equations. Applications to problems in chemistry, physics, and engineering will receive special attention.

611, 612 [201, 224b]. HIGHER CALCULUS FOR ENGINEERS AND PHYSICISTS. Throughout the year. Credit three hours a term. Prerequisite, some familiarity with ordinary differential equations. T Th S 10. White 121.
Infinite series, partial differentiation, multiple and line integrals, Fourier series, partial differential equations, vector analysis, complex variables, orthogonal expansions, calculus of variations, Laplace and Fourier transforms with applications. The second term will be accepted as prerequisite to Complex Variables. Emphasis on applications of the calculus.

621, 622 [Physics 405]. MATHEMATICAL METHODS IN PHYSICS. Throughout the year. Credit three hours a term. Prerequisite, Mathematics 173 or the equivalent, and at least two years of general physics. M W F 12. White 115.
Lectures and problem work designed to give the students a working knowledge of the principal mathematical methods used in advanced physics.
681, 682 [480]. DIFFERENTIAL EQUATIONS OF MATHEMATICAL PHYSICS. Throughout the year. Credit three hours a term. Prerequisite, Mathematics 502. M W F 11. White 115.
The derivation of the differential equations, with appropriate boundary conditions, which arise in certain problems of mathematical physics; the mathematical properties of solutions, and the physical meanings of these properties.
721, 722 [400a, b]. PROBABILITY AND STATISTICS. Throughout the year. Credit three hours a term. Prerequisite, Mathematics 153 or the equivalent. T Th S 10. White 115.
Introduction to the modern theory of probability with emphasis on random variables, distribution functions, moment generating functions and limit theorems. Normal distribution with various applications. Derivation of fundamental distributions used in practical statistics and physics.
723. PROBABILITY. Fall term. Credit three hours. Prerequisite, Mathematics 722. T Th S 11. White 101.

Selected topics of the advanced theory of probability.
[VECTOR ANALYSIS. Not given in 1947-1948.]
[POTENTIAL THEORY. Not given in 1947-1948.]
[RELATIVITY. Not given in 1947-1948.]
[ANALYTICAL MECHANICS. Not given in 1947-1948.]
[ORTHOGONAL FUNGTIONS. Not given in 1947-1948.]

## READING, RESEARCH, AND INFORMAL STUDY

For properly qualified students, members of the Department will direct reading and research not necessarily associated with any course.
Mathematics 931. Reading in Algebra.
Mathematics 941. Reading in Geometry.
Mathematics 951. Reading in Analysis.
Mathematics 961. Reading in Applied Mathematics.
Mathematics 971 . Reading in Probability and Statistics.

## METEOROLOGY

Professor R. A. Mordoff.
APPROVED MAJOR AND MINOR SUBJECTS (key to symbols on p. 47)
Meteorology 1, 2, 4
A broad field for investigation and research is offered in meteorology. The weather and climatic factors, in their relation to crop distribution and production and to engineering, transportation, economic, and social problems, are suitable subjects for graduate study.

A graduate student in meteorology should have completed the elementary courses in meteorology and climatology, physics, mathematics, geology, and elementary statistics.

1. Elementary Meteorology. Spring term. Three hours a week.
[2. CLIMATOLOGY. Fall term. Prerequisite, Meteorology 1 or the equivalent. Professor Mordoff. M W 9. Plant Science 114. Not given in 1947-1948.]

A course covering general climatology and the various climates of the United States with emphasis on those of New York State.
221. RESEARCH. Spring term. Prerequisite, Climatology 2 or the equivalent. Professor Mordoff. Hours by appointment.

Original investigations in meteorology and climatology.
212. SEMINAR. Spring term. Prerequisite, Climatology 2 or the equivalent. Professor Mordoff. Hours to be arranged. Plant Science 114.

Preparation and reading of reports on special topics. Abstracts and discussions of papers dealing with the current literature of meteorology and climatology.

## PHYSICS

Professors L. P. Smith, R. F. Bacher (On leave), L. L. Barnes, H. A. Bethe, J. R. Collins, D. R. Corson, R. P. Feynman, G. E. Grantham, K. I. Greisen, P. L. Hartman, H. E. Howe, B. D. McDaniel, P. Morrison, C. C. Murdock, H. F. Newhall, L. G. Parratt, R. L. Sproull, D. H. Tomboulian, and R. R. Wilson; Doctors C. P. Baker, E. D. Courant, J. W. DeWire, C. W. Gartlein, and C. D. Swartz.

APPROVED MAJOR AND MINOR SUBJECTS (key to symbols on p. 47)

Physics 1, 2, 3, 4
Experimental Physics 1, 2, 3, 4

Applied Physics 1, 2, 3, 4
Biophysics 3, 4

Theoretical Physics 1, 2, 3, 4
NOTES - The major and both minor subjects for the Ph.D. should not be chosen inside the field of physics.

The major subject for the Ph.D. may be called Experimental Physics only if accompanied by Theoretical Physics as a minor, and Theoretical Physics only if accompanied by Experimental Physics as a minor.

Applied Physics as a major for the Ph.D. must be accompanied by a minor subject in the field of Physics.

Members of the staff are especially interested in directing graduate research in the following fields.

EXPERIMENTAL PHYSICS. Nuclear Physics; cosmic rays; atomic spectra, including nuclear effects; absorption spectra; x-rays; x-ray and electron diffraction; electronics, electrical phenomena in gases, and physics of solids.

THEORETICAL PHYSICS. Quantum mechanics, particularly the theory of nuclei, fundamental particles, and radiation.

Members of the staff who are in residence in Ithaca during the summer often stand ready to consult with investigators.
NOTE - Since only a limited number of graduate students can be accommodated in physics, students should make arrangements for admission by application to the Dean of the Graduate School before coming to Ithaca.

A colloquium in general physics and a seminar in theoretical physics meets regularly, and seminars in special fields as arranged.

U 103, 104. Introductory Physics. Credit three hours.
U 107, 108. Introductory Physics. Credit four hours.
U 115, 116, 117, 118. General Physics. Credit three hours. Two-year sequence for students of engineering.

U 200. Physics for students of Biology and Medicine. Credit three hours.
U 203, 205; 204, 206. Advanced General Physics. Credit three or five hours.
U 210. Advanced Laboratory. Credit three hours a term.
215. OPTICS. Fall term. Credit three or five hours. Prerequisites, Physics 205, 206, or their equivalents, and the Calculus. Lectures, M W F 8. Laboratory, T W or Th F 1:40-4:30. Professor Collins.

Geometrical optics, lens systems, Gauss points, aberrations, stops, photometry of optical systems, interference, application of various forms of interferometers; Fresnel and Fraunhofer diffraction patterns and their applications to optical instruments; polarized light, production, detection, measurements and applications of plane and elliptically polarized light.
225. ELECTRICITY AND MAGNETISM. Fall term. Credit three hours. Prerequisites, Physics 21 or 63 or 206. Lectures, T Th S 9, and one optional problem period to be arranged. Professor Murdock.
Electrostatic and electromagnetic fields, polarization of dielectrics and magnetic media, displacement current, plane electromagnetic waves, the Poynting vector.
236. ELECTRICITY AND MAGNETISM. Spring term. Credit three or five hours. Prerequisites, Physics 225 and Differential Equations. Lectures, T Th S 9, and two laboratory periods to be arranged. Associate Professor Tomboulian.
General circuit theory from the standpoint of fields. Steady current circuits and networks, transients, alternating current circuits and networks, frequency characteristics of networks, circuits with distributed parameters, non-linear elements.
242. ANALYTICAL MECHANICS. Spring term. Credit three hours. Prerequisites, Physics 205 and Mathematics 201, or their equivalents. M W F 9. Assistant Professor Sproull.

Analytical mechanics of material particles, systems of particles, and rigid bodies; oscillations and forced vibrations; planetary motion; stability of orbits; Euler's equations; gyroscopic motion.
243. ATOMIC AND MOLECULAR PHYSICS. Fall term. Credit three hours. Prerequisite, Physics 225. T Th S 9. Assistant Professor Morrison.
The fundamental particles; statistical physics; the concepts of quantum mechanics; atomic structure and spectra; the periodic table; molecular structure and the chemical bond; fundamentals of nuclear physics.
[253. WAVE MOTION AND SOUND. Fall term. Credit three or five hours. Prerequisites, Physics 242 or its equivalent; Physics 236 is desirable. Lectures, M W F 8. Laboratory, T W or Th F 1:40-4:30. Not offered in 1947-1948.]
254. ELECTRONIC PROPERTIES OF SOLIDS AND LIQUIDS. Spring term. Credit three or five hours. Prerequisite, Physics 243. Lectures, T Th S 9. Two laboratory periods as arranged. Associate Professor Sack.
Lattice structure of solids; magnetic, dielectric, and thermal properties of solids; electrical and optical properties of metals, semi-conductors, and ionic crystals; electron emission and barrier layer effect; relaxation phenomena in liquids and solids.
020. INFORMAL STUDY IN PHYSICS. Either term. Reading or laboratory work in any branch of Physics under the direction of a member of the staff. Hours to be arranged.
NOTE - The Special Topics laboratory courses from 382 to 393, inclusive, cover systematic laboratory work in the field indicated, together with appropriate lectures and discussions.
380. ADVANCED LABORATORY. Either term. Credit three hours. Prerequisite, Physics 210 or its equivalent, and consent of the instructor. Laboratory periods to be arranged. Professor Collins, Associate Professor Parratt, and Assistant Professor Hartman.

A course of experiments designed to broaden the student's acquaintance with the methods of physical measurements and their interpretation and to afford training in the use of modern physical equipment.
382. high temperature measurements. Spring term. Credit two hours. Professor Collins.

Application of radiation methods to the measurements of temperature.
[383. X-RAY EXPERIMENTS. Fall term. Credit two hours. Not offered in 1947-1948.]
[387. SPECTROSCOPY. Credit two hours. Not offered in 1947-1948.]
[388. X-RAY DIFFRACTION BY CRYSTALS. Credit two hours. Not offered in 1947-1948.]
391. ELECTRONICS AND IONICS. Fall term. Credit two or three hours. Assistant Professor Sproull.

Vacuum technique and low pressure measurements, ionization and resonance potentials, e and e/m for electrons, mass spectroscopy, work functions, secondary emission, photoelectric effects, and construction of special tubes.
393. NUCLEAR PHYSICS LABORATORY. Fall term. Credit two hours. Prerequisite, consent of instructor. Dr. DeWire and Dr. Swartz.

Operation and use of the cloud chamber, Geiger counter, and ionization chamber. The production of artificial radioactivity, using the cyclotron, alpha-particle range measurement, half life determination, beta and gamma ray absorption.
396. COSMIC RAY EXPERIMENTS. Spring term. Credit two hours. Prerequisite, consent of instructor. Assistant Professor Greisen. Two consecutive afternoons each week, T W Th F 1:30-4:30.
Detection of cosmic rays, their absorption and shower production, by means of cloud chamber, proportional counter, and Geiger counter telescope.
475. THEORETICAL MECHANICS. Fall term. Credit three hours. Prerequisite, Physics 242 or its equivalent. T Th S 11. Professor Bethe.
Classical mechanics, including the equations of Lagrange and Hamilton, theory of vibrations, special relativity theory.
476. ELECTRODYNAMICS. Spring term. Credit three hours. Prerequisite, Physics 225 or its equivalent. T Th S 11. Associate Professor Feynman.
Maxwell's equations and their applications, including electromagnetic radiation, scattering, refraction and interference of light, waves in guides, cavity resonators, etc.
477. STATISTICAL MECHANICS AND KINETIC THEORY. Fall term. Credit two hours. Prerequisites, Physics 475, and (or in parallel) Physics 485. M F 10. Assistant Professor Morrison.

Statistical mechanics, including quantum statistics, application to the properties of gases, vapor pressure, etc., transport phenomena, statistics of radiation and of electrons in metals.
480. THEORETICAL PHYSICS - READING COURSE. Fall term. Repeated in the spring term. Credit two hours. Hours to be arranged. Professor Bethe.

Supervised reading and problem work in thermodynamics and optics. This course should, in general, be completed by physics majors not later than Physics 477.
485. INTRODUCTORY QUANTUM MECHANICS. Fall term. Credit three hours. Prerequisites, Physics 475 and 476. T Th S 12. Assistant Professor Morrison.
The Schrodinger equation. Uncertainty principle. Oscillator, rotator, hydrogen atom. Perturbation theory.
486. APPLICATIONS OF QUANTUM MECHANICS. Spring term. Credit three hours. Prerequisites, Physics 485. T Th S 12. Professor Bethe.
Discussion of various useful applications of quantum mechanics such as collision theory, theory of spectra of atoms and molecules, theory of solids, emission of radiation, theory of measurement in quantum mechanics.
490. PROBLEMS IN THEORETICAL PHYSICS. Fall term. Repeated in the spring term. Credit two to six hours. Prerequisites, Physics 477 and 485; also Mathematics 621, 622, or the equivalent. Hours to be arranged. Assistant Professor Feynman.
Problem work requiring the integration of knowledge acquired in several theoretical physics and mathematics courses.
[491. ADV,ANCED QUANTUM MECHANICS. Credit three hours. Prerequisite, Physics 486. Not offered in 1947-1948.]
582. X-RAY CRYSTALLOGRAPHY. Spring term. Credit three hours. Prerequisite, Physics 225 or consent of the instructor. M W F 10. Professor Murdock.

Crystal symmetry, lattices, and space groups, the reciprocal lattice, diffraction of waves by three dimensional gratings, the wave properties of x-rays and of beams of electrons, the interpretation of $x$-ray and electron diffraction data, structure determination by Fourier synthesis, resolving power of crystalline powders, interpretation of diffraction patterns of polycrystalline metals and of fluids.
588. X-RAYS. Spring term. Credit three hours. Open to qualified students by consent of the instructor. M W F 10. Associate Professor Parratt.
X-ray production and measurement, scattering, absorption, diffraction, and spectra; the relation of these processes to modern concepts of atomic and solid structure.
681. ADVANCED ELECTRON PHYSICS. Fall term. Credit three hours. Prerequisites, Mathematics 201, Physics 225, and 391, or their equivalents. Assistant Professor Newhall.
Lectures covering such topics as the motion of electrons and ions in solids; thermionics, secondary and field emission; electron and ion collision phenomena, electronic phenomena in the conduction of electricity through gases, microwave spectroscopy, etc.
683. THE THEORY AND PROPERTIES OF SOLIDS. Fall term. Credit three hours. Prerequisite, Physics 485 or its equivalent. M W F 11. Professor Smith.
Lectures covering the theory and experimental techniques connected with the principal properties of the various solid types. The topics will include the structure of solids and their cohesive properties, the electronic behavior of metals, ionic crystals, series conductors, etc., and the magnetic and optical properties of solids.
692. ADVANCED ELEGTRONICS LABORATORY. Spring term. Credit three hours. Prerequisite, Physics 681. Hours to be arranged. Professor Smith and Assistant Professor Sproull.
Advanced laboratory work partly of a semi-research nature designed to furnish experience and knowledge of modern techniques in such topics as thermionics, secondary and field emission, excitation and ionization cross-sections, electrical phenomena in gases, electron behavior in solids, mass spectrometry, etc.
781. NUCLEAR PHYSICS. Fall term. Credit two hours. Prerequisites, Physics 243 or the equivalent and consent of the instructor. Professor Wilson. M F 9.

The phenomena and methods of nuclear physics. A study of stable and radioactive nuclei, the interaction of nuclear particles and the interpretation of measurements in terms of basic nuclear concepts.
782. THEORY OF NUCLEI. Spring term. Credit two hours. Prerequisites, Physics 485 and 781, or the equivalent. M F 9. Associate Professor Feynman.

Properties of atomic nuclei and fundamental particles. Theory of simple nuclear systems. Theory of nuclear transformations.
784. COSMIC RAYS. Spring term. Credit three hours. Prerequisite, a course in introductory Theoretical Physics. Lectures, T Th S 9. Assistant Professor Greisen.
080. INFORMAL STUDY IN PHYSICS. Either term. Special reading or problem work done under the direction of some member of the staff.
090. SPECIAL LABORATORY WORK. Either term. Laboratory work in any branch of physics under the direction of a member of the staff. Hours to be arranged.

# AGRICULTURE, INCLUDING FORESTRY 

## AGRICULTURAL ECONOMICS

> (BUSINESS MANAGEMENT, FARM MANAGEMENT, FARM FINANCE, LAND ECONOMICS and AGRICULTURAL GEOGRAPHY, MARKETING, PRICES and STATISTICS, PUBLIC ADMINISTRATION AND FINANCE.)

Professors G. P. Scoville, E. G. Misner, F. A. Pearson, Leland Spencer, V. B. Hart, M. P. Rasmussen, F. F. Hill, M. S. Kendrick, M. C. Bond, S. W. Warren, f. A. Harper, L. C. Cunningham, G. W. Hedlund, W. M. Curtiss, T. N. Hurd, Herrell DeGraff, Ivan R. Bierly, L. B. Darrah, and E. A. Lutz.

APPROVED MAJOR AND MINOR SUBJECTS (key to symbols on p. 47)
Agricultural Economics 4
Business Management 1, 2, 3, 4
Farm Management 1, 2, 3, 4
Farm Finance 1, 2, 3, 4
Land Economics and Agricultural Geography 1, 2, 3, 4
Marketing 1, 2, 3, 4
Prices and Statistics 1, 2, 3, 4
Public Administration and Finance 1, 2, 3, 4

## BUSINESS MANAGEMENT

Attention is directed to the courses in administrative engineering in the College of Engineering, in economics in the College of Arts and Sciences, and in administration in the Department of Hotel Administration.
[120. Personal Financial Management. Spring term. Credit three hours.]
Planning an individual's financial program; sources and terms of credit; savings and investments; insurance of property and income; acquisition and disposition of property; provision for dependents. Not given in 1947-1948.]
121. FINANCIAL STATEMENTS. Fall term. Credit three hours. Professor . Lectures, M W 11. Warren 225. Discussion and quiz, W 2-4. Warren 201.
For persons who wish to understand and interpret the statements of financial condition and income of cooperatives and other businesses. Content of and relationship between balance sheet, operating statement, and statement of surplus; methods of valuing assets; analysis by means of ratios.
122. ACCOUNTING METHOD. Spring term. Credit three hours. Two lectures and one laboratory period a week. (Not given in 1947-1948.)

For persons who wish to understand the records and procedures commonly used in keeping accounts of cooperatives and other businesses. Recording business transactions and deriving financial statements; analyses of costs and budgets.
126. FARMERS' COOPERATIVES. Spring term. Credit three hours. Professor Hedlund. Lectures, M W 8. Warren 225. Discussion. T 2-4. Warren 201.
What cooperatives have tried to do and what they have done; their special problems of organization, finance, and control.
127. business law. Fall term. Credit three hours. Mr. Allan H. Treman. Lectures, M W F 8. Warren 25.

Consideration is given chiefly to legal problems of particular interest to persons who expect to engage in business, including contracts, liens, mortgages, and negotiable instruments; ownership and leasing of property; wills; estates; inheritance taxation; and other practical problems.

## FARM MANAGEMENT

102. farm management. Spring term. Credit five hours. Professor Warren. Lectures, M W F 10. Warren 25. Laboratory, F 4-6. Warren 101. On days when farms are visited laboratory period will be 1:40-6.

Farming as a business; farm accounts; factors affecting profits; size of business; choice of enterprises, forms of tenure and leases; methods of getting started in farming; choosing a farm; planning the organization and management of specific farms. One all-day trip and five half-day trips are taken to visit farms in nearby regions.
203. BUSINESS ORGANIZATION AND MANAGEMENT OF SUCCESSFUL NEW YORK FARMS. Fall term. Credit four hours. Prerequisite, course 102 or its equivalent. Professor Scoville. F 2-4, S 8-10. Warren 140. Approximate transportation expenses for trips, $\$ 20$.

During the term some all-day trips are taken, usually on Saturdays. Two twoday trips are taken, leaving Friday morning and returning Saturday night.
204. FARM COSTS AND WORK SIMPLIFICATION. Spring term. Credit three hours. Prerequisite, course 102 or its equivalent. Associate Professor Bierly. Lectures, M W 11. Warren 325. Discussion and laboratory, M 2-4. Warren 340.

The significance of differences in unit costs; methods of measuring costs; opportunities of reducing unit costs, with special attention to labor, equipment, and building costs; trends in important cost items; work simplification procedures as a means of finding easier and more economical ways to do farm work.
207. METHODS AND RESULTS OF RESEARCH IN FARM MANAGEMENT AND LAND ECONOMICS. Fall and spring terms. Credit two hours each term. Professors Hill and Warren and other members of the departmental staff. Th 4-6. Warren 140.

A discussion of research problems in farm management and land economics. Opportunity will be given to study special problems suggested by members of the group.

## FARM FINANCE AND FARM APPRAISAL

184. FARM FINANCE. Fall term. Credit three hours. Associate Professor Darrah. Lectures, T Th 8. Discussion, Th 2-4. Warren 125.

A study of the credit institutions which serve agriculture.
187. FARM APPRAISAL. Fall term. Credit three hours. Professor Warren. Lecture, T 10. Laboratory, T 2-6. Warren 101.

A study of factors governing the price of land; methods of land valuation; the appraisal of farms for use, for sale, for the purpose of making loans ${ }_{4}$ and for taxation.

## LAND ECONOMICS AND AGRICULTURAL GEOGRAPHY

2. AGRICULTURAL GEOGRAPHY. Fall term. Credit three hours. Associate Professor DeGraff. Lectures, W F 11. Warren 25. Discussion, graduate students, F 4-6. Warren 101.

Historical perspective on present-day agriculture; adjustment of agriculture to natural and to economic environment; crop and livestock production in New York State, the United States, and other countries; interregional trade in agricultural products.
181. LAND ECONOMICS. Spring term. Credit three hours. Professor Hill. Lectures, T Th 8. Warren 125. Discussion and laboratory, T 2-4. Warren 140.
Physical characteristics of land as related to land use; population, technological advance, institutions, and other factors as they affect land utilization; economics of land use; local, regional, and national land-use problems and policies, including tenancy, land valuation, credit, taxation, and conservation.

## MARKETING

141. MARKETING. Fall term. Credit three hours. Professor -_. Lectures, W F 10. Warren 225. Laboratory and discussion; graduate students, Th 2-4. Warren 225; undergraduates, F 2-4. Warren 225.
A general course dealing with problems of distribution of farm products. Characteristics of consumer demand; factors to be considered in judging the best marketing plan from the standpoint of when, where, in what form, and through what channels to sell; public regulation and controls.
142. MARKETING FRUITS AND VEGETABLES. Fall term. Credit four hours. Professor Rasmussen. Lectures, M W F 9. Warren 225. Laboratory, F 2-4. Warren 240.

A study of the economic factors involved in the marketing of fruits and vegetables. Regional and seasonal competition; areas of distribution; methods of handling; costs of marketing; types of marketing organizations; sales methods; transportation and carrier services; produce law and methods of credit ratings; terminal problems; aspects of retailer and consumer demand.
143. MARKETING DAIRY PRODUCTS. Spring term. Credit three hours. Professor $S_{\text {Pencer. Lectures, M W 9. Warren 225. Laboratory, Th 2-4. Warren } 240 .}$ Field trips to visit dairy plants will be arranged in place of one or more laboratory meetings.

This course is designed to give the student a general view of the marketing system for dairy products and to acquaint him with significant facts and principles that pertain to the pricing and distribution of milk.
144. MARKETING POULTRY, EGGS, AND LIVESTOCK. Spring term. Credit three hours. Associate Professor Darrah. Lectures, T Th 10. Warren 225. Laboratory, Th 2-4. Warren 225.

A study of the economic factors involved in the marketing of eggs, poultry, hogs, cattle, and sheep. Subjects to be discussed include demand, areas of production, balancing demand and supply, marketing systems, marketing costs, and ways of reducing marketing costs.
147. MARKETING TRIP TO NEW YORK CITY. Spring term. Credit one hour. Professor in charge. Representatives of other departments cooperate in the course. Given only if twenty or more students register. Enrollment limited to 40 .

Five days of the spring vacation are spent in New York City inspecting and studying the marketing of dairy products, eggs, poultry, fruits, vegetables, livestock, and meat. A short series of introductory lectures precede the trip, at hours to be arranged.

A $\$ 5$ deposit for bus hire and incidental expenses is payable 10 days before the trip. Total cost of the trip need not exceed $\$ 40$ in addition to transportation to and from New York City.
160. FOOD ECONOMICS. Spring term. Credit three hours. Associate Professor DeGraff. Designed especially for students in the School of Nutrition and in the College of Home Economics. Not open to students in the College of Agriculture except by permission of the instructor. Lectures and discussion, M W F 8. Warren 325.

Economic aspects of food, including production, distribution, and consumption, with special emphasis on the economics of diet.
240. RESEARCH IN MARKETING. Fall and spring terms. Credit two hours a term. Designed to be taken continuously by graduate students interested in marketing. W 4-6. Warren 201. Members of the staff will have charge in rotation.

Among the subjects to be considered are: the scope of marketing research; analyses of marketing problems; planning of projects; collecting and analyzing data; presentation of results; critical reviews of marketing research at various institutions.
243. MARKETING PROBLEMS IN THE FLUID MILK INDUSTRY. Spring term. Credit three hours. Professor Spencer. Discussion periods, T Th 11-12:30. Warren 240. Open to those who have done superior work in course 143, and to others by special permission.

This course provides for the study of some major problems that arise in connection with the pricing and distribution of fluid milk, such as balancing supply and demand in the city milk sheds, reduction of spread between consumer and producer prices, and the like.

## PRICES AND STATISTICS

Attention is directed to courses in mathematics in the College of Arts and Sciences.
111. STATISTICS. Fall term. Credit three hours. Professor Pearson. Lecture, M 8. Warren 125. Laboratory, M 2-4. Warren 25.

A study of the principles involved in the collection, tabulation, and interpretation of agricultural and marketing statistics. Analysis of statistical problems with an 80 -column tabulating machine.
112. STATISTICS. Spring term. Credit three hours. Professor Pearson. Prerequisite, course 111. Lecture, M 8. Laboratory, M 2-4. Warren 125.

A continuation of course 111. A study of the application of probable error; sampling; gross, partial, and multiple correlation; curve fitting to problems in this field. Methods of using 80 -column tabulating equipment for multiplecorrelation analysis.
115. PRICES. Spring term. Credit three hours. Professor Pearson. Lectures, T Th 9. Laboratory, W 2-4. Warren 25.

A study of prices of farm products in relation to agricultural and industrial conditions.
215. PRICES. Fall and spring terms. Credit one hour a term. Professor Pearson. Prerequisite, course 115. (Not given in 1947-1948.)

## PUBLIC ADMINISTRATION AND FINANCE

Attention is directed to the courses in Government and to Economics 52 (state and local finance) in the College of Arts and Sciences.
135. LOCAL GOVERNMENT. Fall term. Credit three hours. Associate Professor Lutz. Lectures, T Th 9, Warren 125. Laboratory, M 2-4, Warren 201.

Historical development, organization, and operation of local government. Particular attention is given to receipts, expenditures, and administration of counties, towns, and school districts in New York.
138. TAXATION. Fall term. Credit three hours. Professor Kendrick. Lectures, M W F 11. Plant Science 233.
A study of the principles and practices of public finance with emphasis on taxation. Among the topics examined are: the growth of public expenditures; the changing pattern of federal, state, and local taxation; general-property, inheritance, business, and personal income taxation; and the problem of post-war finance.
236. PROBLEMS IN PUBLIC ADMINISTRATION. Fall term. Credit three hours. Associate Professor Lutz. Time and room to be arranged. Primarily for graduate students.
Attention is given to a number of problems in public administration with special reference to New York including state and local planning, personnel administration, financial administration, and administrative organizations.
238. SEMINAR IN PUBLIC FINANCE. Spring term. Credit two hours. Professor Kendrick. W 2-4. Warren 218. Prerequisite, graduate status with necessary preparation.
An examination of basic problems in public finance.

## AGRICULTURAL POLICY

[151. PUBLIC PROBLEMS OF AGRICULTURE. Spring term. Credit two hours. Time and place to be arranged. Not given in 1947-1948.]

A discussion of some of the more important problems of agriculture that involve collective or governmental action.

## DEPARTMENTAL SEMINAR

299. SEMINAR. Continues through fall and spring terms. Departmental staff. M 4. Warren 401.

## AGRICULTURAL ENGINEERING

Professors B. B. Robb, A. M. Goodman, B. A. Jennings, L. M. Roehl, and F. B. Wright.

## APPROVED MAJOR AND MINOR SUBJECTS (key to symbols on p. 47)

Farm Structures 1, 2, 3, 4
Farm Equipment 1, 2, 3, 4
Agricultural Engineering 1, 2, 3, 4
Engineering of Soil Management 1, 2, 3, 4
The laboratories of the Department are well equipped for the usual types of investigations in the fields listed. Special equipment can generally be supplied when needed.

Students desiring to undertake work in Agricultural Engineering should have, first of all, adequate grounding in the fundamentals of the phase studied and ability to perceive the applications of these fundamentals, since the applications of engineering practices to agriculture, though of great economic importance, are usually successful in proportion as they are direct and simple. First hand knowledge of farm life and of rural conditions generally are most essential for some problems. Whether a student's preparation is adequate for any given line of advanced study can be determined only by special consideration of each case.

1. Farm Mechanics. Either term. Three hours a week.
[101. Electricity on the Farm. Second term. Three hours a week. Not given in 1947-1948.]
2. Farm Power. First term. Three hours a week.
3. Field Machinery. First term. Three hours a week.
4. Household Mechanics. Either term. Three hours a week. For women students.
5. Farm Engineering. Either term. Three hours a week.
6. Farm Engineering, Advanced Course. Second term. Two hours a week. Given in alternate years.
[122. Drainage and Irrigation. Second term. Two hours a week. Given in alternate years. Not given in 1947-1948.]
[24. Farm Concrete. First term. Two hours a week. Not given in 1947-1948.]
7. Farm Structures. First term. Three hours a week.
8. Farm Shop Work. Either term. Two hours a week.
9. Shop Work for Rural High School Teachers. Either term. Three hours a week.
10. Farm Blacksmithing. Either term. One or more hours a week:
11. RESEARCH IN AGRICULTURAL ENGINEERING. Prerequisite, permission to register. Professors Robb, Goodman, Jennings, and Roehl, and Associate Professor F. B. Wright. Hours as arranged. Investigations for which the student is prepared and for which adequate facilities can be provided.
12. SEMINAR. Required of graduate students. Both terms, credit one hour a term. Professor Robb. T 4:30-5:45. Presentation and discussion of papers on special problems in agricultural engineering.

## AGRONOMY

Professors R. Bradfield, H. O. Buckman, J. K. Wilson, A. F. Gustafson, F. B. Howe, H. B. Hartwig, R. F. Chandler, Jr., R. B. Musgrave, Michael Peech, M. G. Cline, H. A. MacDonald, M. B. Russell, J. E. Dawson, and R. E. Blaser.

## APPROVED MAJOR AND MINOR SUBJECTS (key to symbols on p. 47)

Soils 1, 2, 4
Field Crop Production 1, 2, 4
The laboratories of the Department are well equipped for chemical, physical, and microbiological investigations of soil and field crops. Greenhouses are available for soil and crop experimentation during the winter and a field, conveniently located and well equipped, is available for experiments on a larger scale during the summer. Special equipment can generally be supplied when needed. The Departmental library contains the more important journals, reference works, and experiment station literature.

Members of the staff will be especially interested in directing research in the field as listed: Professor Bradfield, in soil fertility; Professor Peech in soil chemistry; Professor Russell in soil physics; Professor Buckman in soil genesis and geography; Professors Howe and Cline in the morphology, classification, and cartography of soils; Professor J. K. Wilson in soil microbiology; Professor Dawson in organic soils; Professor Chandler in forest soils; Professor Gustafson in soil erosion control; Professor Hartwig in field crop production; Professors Blaser and MacDonald in pasture management; and Professor Musgrave in field crop ecology. Prospective students are urged to correspond with the member of the staff whose interests are most closely related to their own a few months in advance of the time they expect to enter upon their work, as only a limited number of students can be accommodated.

Students preparing for graduate work in Agronomy are urged to obtain a thorough knowledge of general physics, mathematics through calculus, analytical, organic, and physical chemistry, general botany, bacteriology, plant physiology, and geology. Opportunity will be afforded for further study of some of these subjects after entering the Graduate School, but a student deficient in two or more of these foundation courses cannot expect to receive a degree in the minimum time required for residence. Some practical experience with soil and crop management problems is also desirable. Opportunity to acquire additional experience will be afforded a limited number of students majoring in the Department by summer employment on Departmental projects.

Students must consult professor in charge before registering for any course numbered above 100 .

## AGRONOMY

[A. Introductory Agronomy. Fall term. Credit three hours. Open to freshmen only. Not given in 1947-1948.]

## SOIL SCIENCE

1. The Nature and Properties of Soils. Fall or spring term. Credit five hours.
2. Soils. Fall term. Credit three hours. For two-year students only.
3. SOILS OF NEW YORK: ORIGIN, IDENTIFICATION, CLASSIFICATION. Spring term. Credit three hours. Prerequisite, course 1. Lectures, T Th 10. Caldwell 100. Field trips to be arranged. Professor Howe.

A course dealing with the origin, profile characteristics, classification, and mapping of soils in the field. An important part of the course is devoted to the interpretation of soil maps with particular reference to their use in farm planning. Cost of field trips is included in laboratory fee.
102. SOIL CONSERVATION. Spring term. Credit two hours. Prerequisite, courses 1 or 6 and 2 or 11 or their equivalent. Farm background essential. Lectures, T Th 11. Caldwell 143. Professor Gustafson.

An analysis of the causes of the decline in the inherent productivity of soils and of the practical methods of management that will hold them in place and permanently maintain their productivity. The causes of erosion and its control by agronomic methods receive special emphasis. Two all-day Saturday field trips.
103. ORGANIC SOILS. Fall term. Credit two hours. Given in alternate years. Prerequisite, course 1 and Chemistry 201. Assistant Professor Dawson.
Physical and chemical properties of organic soils used for crop production, for soil conditioning, and mulching, and for packing of flowers and nursery stock. One all-day Saturday field trip. Transportation costs to be arranged.
[104. FOREST SOILS. Fall term. Credit two hours. Given in alternate years. Prerequisite, course 1 and Botany 31. Professor Chandler. Not given in 19471948.]

Assigned readings and semi-weekly discussions of the more important forestsoils literature. There are occasional field trips. Transportation costs to be arranged.
106. SOIL MICROBIOLOGY. Spring term. Credit three hours. With the approval of the instructor, the lectures without the laboratory may be taken for two-hours credit. Prerequisite, course 1, except for students majoring in bacteriology, Bacteriology 1, and Chemistry 201 or its equivalent. Lectures, M W 8. Caldwell 143. Laboratory, F 1:40-4. Caldwell 201. Professor Wilson.

A course in biological soil processes designed primarily for students specializing in soil technology or bacteriology. The laboratory work is supplemented by reports and by abstracts of important papers on the subject.
201. SOIL CHEMISTRY, LECTURES. Spring term. Credit three hours. Prerequisite, course 1 and Qualitative and Quantitative Analysis. A course in physical chemistry is recommended. M W F 9. Caldwell 143. Associate Professor Peech.
Chemical composition and properties of soils. Discussion of chemical processes and changes in the soil, including the behavior of different plant-nutrient elements.
202. CHEMICAL METHODS OF SOIL ANALYSIS. Spring term. Credit three hours. Prerequisite, course 1 and Qualitative and Quantitative Analysis. Enrollment limited. T Th 1:40-4. Caldwell 350. Professor Peech.
Lectures, laboratory exercises, and demonstrations designed to familiarize the student with different chemical techniques for studying soils.
203. THE GENESIS, MORPHOLOGY, AND CLASSIFICATION OF SOILS. Fall term. Credit three hours. Lectures, M W F at 9. Caldwell 143. Professor Chandler and Associate Professor Cuine.

A course dealing with the factors and processes of soil formation with particular reference to the development and utilization of the great soil groups of the world. An advanced treatment of soil classification systems is included. Two all-day Saturday field trips. Transportation expenses to be arranged.
205. SOIL FERTILITY, ADVANCED COURSE. Fall term. Credit three hours. Prerequisite, course 1 and Chemistry 201 or its equivalent. Lectures, T Th S 8. Caldwell 143. Professor Bradfield.

A study of the soil as a source of the mineral nutrients needed for efficient crop production and of the properties and use of liming materials, fertilizers, and manures.
207. SOIL PHYSICS, LECTURES. Fall term. Credit three hours. Prerequisite, course 1, Physics 3 and 4, and Chemistry 201. A course in physical chemistry is recommended. M W F 8. Caldwell 143. Professor Russell.
A study of physical processes and changes that take place in soils, with emphasis upon their application and significance.
208. PHYSICAL PROPERTIES OF SOILS, LABORATORY. Fall term. Credit three hours. Must be preceded or accompanied by course 207. Enrollment limited. M W 1:40-4. Caldwell 294. Professor Russell.
Lectures, laboratory exercises, and demonstrations designed to familiarize the student with different physical and physiochemical techniques used in soil investigations.
209. ReSEARCH IN SOIL SCIENCE. Fall and spring terms. Professors Bradfield, Buckman, Gustafson, Howe, Wilson, and Russell, Associate Professors Chandler and Peech, Associate Professor Cline, and Assistant Professor Dawson.
210. SELECTED TOPICS IN SOIL SCIENCE. Fall and spring term. Credit one to three hours. Prerequisite, ten credit hours in Soil Science. Time to be arranged.
Topics for 1947-1948:
Fall term:
(a) Clay Minerals. Professor Russell. One credit hour.
(b) To be arranged. Staff. One to three credit hours.

## Spring term:

(a) Soil Moisture. Professor Russell. One credit hour.
(b) Ionic Exchange in Soils. Professor Peech. One credit hour.
(c) To be arranged. Staff. One to three credit hours.

## FIELD CROPS

2. Introduction to Field Crops. Spring term. Credit three hours. Open to freshmen.
3. Production of Field Crops. Fall term. Credit four hours.
4. SPECIAL TOPICS IN FIELD CROPS. Fall and spring terms. Credit one to two hours. Professors Blaser, Hartwig, MacDonald, Musgrave. Meeting once weekly November to April for graduate students and undergraduate majors. The student is expected to review and evaluate the more important current research publications that deal with field crop production. Research methods and techniques will also be discussed.
5. PASTURE AND HAY CROPS. Spring term. Credit three hours. For graduate students and juniors and seniors. Prerequisite, Courses 1 and 11 or their
equivalent. Lectures and discussions, T Th 9. Caldwell 143. Laboratory and field trip, Th 1:40-4. Professor Blaser.
The establishment, maintenance, productivity and quality of various pasture and hay crops are discussed, especially those for humid temperate climates. Practical applications will be emphasized. Of particular value to those interested in agronomy, animal production, and soil conservation.
[213. CROP ECOLOGY. Fall term. Credit three hours. Given in alternate years. Prerequisite, course 11 and Botany 31 or their equivalent. Associate Professor Musgrave. Not given in 1947-1948.]
An analysis of the environment of crop plants and their ecological responses, with emphasis on the cereals and on the legumes and grasses used for forage.
6. GRASSLAND ESTABLISHMENT, MANAGEMENT, AND USE. Fall term. Credit three hours. Prerequisite, courses 1 and 11. Plant Breeding 102 and Botany 31 or their equivalent. Associate Professor MacDonald.
Consideration of principles and practices in relation to hay and pasture production; characteristics, adaptation, production, management, and use of various grassland plants; current problems and research methods. Special problems and discussion will be arranged for graduate students.
7. RESEARCH IN FIELD-CROP PRODUCTION. Fall and spring terms. Professors Hartwig, Blaser; and Associate Professors Musgrave, MacDonald.

## DEPARTMENTAL SEMINAR

290. SEMINAR. Fall and spring terms. Required of graduate students taking work in the department, S 11-12:30. Caldwell 143.

## ANIMAL HUSBANDRY

Professors K. L. Turk, S. A. Asdell, J. K. Loosli, L. A. Maynard, C. M. McCay, J. I. Miller, F. B. Morrison, G. W. Salisbury, and J. P. Willman; Associate Professors A. A. Spielman and S. E. Smith; Assistant Professors R. W. Bratton and J. J. Wanderstock.
APPROVED MAJOR AND MINOR SUBJECTS (key to symbols on p. 47)
Animal Husbandry 1, 2, 3, 4
Animal Nutrition 1, 2, 3, 4 (See also under Animal Nutrition)
Animal Breeding 1, 2, 3, 4, (See also under Animal Breeding)
Dairy Husbandry 1, 2, 4
Note. If the major for the Ph.D. degree lies in one of these fields, not more than one of the other two should be selected for a minor.

For the special facilities of the Animal Husbandry department in Animal Breeding and Animal Nutrition and detailed descriptions of the courses in these fields see the statements under these subjects.

The department is well equipped with herds and flocks of animals of the leading breeds of livestock and with modern barns adapted for experimental work. The livestock includes a herd of over 300 dairy cattle, a herd of beef cattle, studs of draft horses, a flock of over 200 sheep, and a herd of breeding swine. The library includes a very full collection of the herd and flock registers of all of the
breeds of domestic animals kept in this country, amounting to more than one thousand volumes, and affording excellent facilities in heredity and genetics.

The animals of the herds and flocks and their records provide opportunity for studying problems of nutrition, livestock feeding, breeding, and production.

Slaughter and meat laboratories are available for the study of the relation of breeding and nutrition to anatomical structure and to chemical composition and food value. The college animals are available for studies relating to the production and the processing, sale, grading, and measuring of their various products such as milk, meat, and horse power, including animal mechanics.

In order to enter upon graduate study in animal production, the student should have the equivalent of the following courses: elementary feeds and feeding, elementary breeding, and the elementary production courses in dairy and beef cattle, horses, sheep, and swine.

Also, the student should have basic courses in general biology or zoology, introductory chemistry, organic chemistry, animal physiology, and genetics. In the course of their graduate study, candidates for the doctor's degree will be expected to take training in biochemistry, physiology, genetics, biometry, and other related fields.

1. Livestock Production. Fall term. Two lectures and one laboratory period a week.
2. Livestock Feeding. Fall and spring terms. Three lectures and one laboratory period a week.
3. Animal Breeding. Fall term. Two lectures and one laboratory period a week.
4. Livestock Judging: Beef Cattle, Horses, Sheep, and Swine. Fall term. One lecture and laboratory period a week.
5. Advanced Livestock Judging: Beef Cattle, Horses, Sheep, and Swine. Spring term. Two lectures and laboratory periods a week.
6. Advanced Livestock Judging: Beef Cattle, Horses, Sheep, and Swine. Fall term. Two lecture and laboratory periods a week.
7. Dairy Cattle. Spring term. Two lectures and one laboratory period a week.
8. Dairy Cattle Judging. Spring term. Two practice periods a week.
9. Advanced Judging, Dairy Cattle. Fall term. Hours by appointment.
10. Beef Cattle. Spring term. Two lectures and one laboratory period a week.
11. Swine. Spring term. Two lectures and one laboratory period a week.
12. Sheep. Fall term. Two lectures and one laboratory period a week.
13. Meat and Meat Products. Fall term, to be repeated in spring term. One lecture and two laboratory periods a week.
14. Meat Cutting. Fall term, to be repeated in spring term. One period a week.
15. PRINCIPLES OF NUTRITION. Fall term. See ANIMAL NUTRITION.
16. LABORATORY WORK IN NUTRITION. Fall term. Laboratory course. See ANIMAL NUTRITION.
17. ADVANCED LIVESTOCK FEEDING AND APPLIED ANIMAL NU. TRITION. Spring term. Credit two hours. Prerequisites, a course in livestock feeding and course in animal nutrition. Professor Morrison. Lectures and discussions, T Th 9. Wing E.

A presentation and discussion of recent developments in the feeding and nutrition of farm animals, study of experimental methods, and critical analysis of published data.
120. PROBLEMS IN ANIMAL BREEDING. Fall term. Prerequisite, Animal Husbandry 20 or Plant Breeding 101. Professor Salibsury. T Th 11. Wing E. Given in alternate years.
A consideration of the problems involved in the improvement of the larger farm animals and the application of genetics in their solution.
125. PHYSIOLOGY OF REPRODUCTION. Spring term. Credit two hours. Prerequisite, a course in human or veterinary physiology. Professor Asdell. M W 10. Wing A.
An advanced course in reproduction, principally in mammals.
126. APPLIED ANIMAL PHYSIOLOGY. Fall term. Credit one hour. Professor Asdell. T 9. Wing B.
The application of physiological methods to growth, reproduction, and lactation in farm animals.
127. ELEMENTARY ENDOCRINOLOGY. Fall term. Credit one hour. Professor Asdell. Th 9. Wing B.
A general course in the physiology of the endocrine system.
150. ADVANGED DAIRY PRODUCTION. Spring term. Credit three hours. Prerequisite, course 50. Professor Spielman. Lecture, T Th 11. Discussion and practice, T 2-4:30. Wing E.
Analysis of breeding and management programs in successful herds. Evaluation of the programs of dairy cattle breed associations. Emphasis is placed on the application of the principles of dairy breeding, feeding, and management to the development and operation of a successful dairy farm.
151. MILK SECRETION. Fall term. Credit three hours. Prerequisites, courses 50 and 127 and and a course in physiology. Professor $\longrightarrow$. Lectures, T Th 9. Laboratory, W 2-4:20. Wing B. Given in alternate years (not given in 1947-1948).
Anatomy, development, and functioning of the mammary gland of dairy cattle and hormonal control of lactation.
214. SPECIAL TOPICS IN ANIMAL NUTRITION. Spring term. See ANIMAL NUTRITION.
215. HISTORY OF NUTRITION. Fall term. See ANIMAL NUTRITION.
219. SEMINAR IN ANIMAL NUTRITION. Fall term. See ANIMAL NU. TRITION.
220. SEMINAR IN ANIMAL BREEDING AND PHYSIOLOGY. Spring term. Credit one hour. Registration by permission. Professors Asdell, Salisbury, and Bratton. T 4:15. Wing E.
Informal reviews of developments of interest to those working with domestic animals.
200. RESEARCH. Fall and spring terms. Hours by arrangement. Professors Morrison, Miller, Salisbury, Turk, and J. P. Willman, Asdell, Loosli, Maynard, McCay, and Spielman.
201. SEMINAR IN ANIMAL HUSBANDRY. Fall term, to be repeated in spring term. Required of all graduate students taking either a major or minor subject in Animal Husbandry. Professor Turk and departmental staff. M 11.

## DAIRY SCIENCE

Professors J. M. Sherman, A. C. Dahlberg, B. L. Herrington, E. S. Guthrie, R. F. Holland, W. E. Ayers, V. N. Krukovsky, J. C. White, and F. V. KosiKOWSKY.

APPROVED MAJOR AND MINOR SUBJECTS (key to symbols on p. 47)
Dairy Science 1, 2, 3, 4
Dairy Chemistry 1, 2, 3, 4
Biochemistry 1, 2, 3, 4
Before taking up graduate work in dairy science, it is desirable that the student have general chemistry, qualitative and quantitative analysis, organic chemistry, college physics, and general bacteriology, in addition to the elementary courses in the particular field in which he wishes to do his graduate work.

Formal courses open to undergraduate and graduate students are given in the following subjects:

1. Introductory Dairy Science. Fall term. Credit three hours a week.
2. Technical Control of Dairy Products. Second term. Two hours a week.
3. MARKET MILK. Spring term. Credit five hours. Prerequisites, course 1 , and Bacteriology 1 or its equivalent. Professor Holland. Lectures, M W 11; laboratory, M W 2-5:30. Dairy Building 119 and 146.

The scientific, technical, and sanitary aspects of the fluid milk industry.
103. MILK-PRODUCTS MANUFACTURING. Fall term. Credit five hours. Prerequisite, course 1. Professor Guthrie and Associate Professor Ayres. Lectures, recitations, and laboratory practice, T Th 11-4:30. Dairy Building 120.

The principles and practice of making butter, cheese, and casein, including a study of the physical, chemical, and biological factors involved.
104. MILK-PRODUCTS MANUFACTURING. Spring term. Credit five hours. Prerequisite, course 1; should be preceded or accompanied by course 5. Associate Professor Ayres. Lectures, recitation, and laboratory practice, F 12-5, S 8-1.
The principles and practice of making condensed and evaporated milk, milk powders, ice cream, and by-products, including a study of the physical, chemical, and biological factors involved.
111. ANALYTICAL METHODS. Spring term. Credit four hours. Prerequisite, quantitative analysis. Professor Herrington. Lectures, T Th 11. Laboratory practice, T 1-5. Dairy Industry Building 120.

An advanced course in the chemical analysis of products and materials important in the dairy industry.
113. CHEMISTRY OF MILK. Fall term. Credit two hours. Prerequisites, qualitative and quantitative analysis and organic chemistry; must be preceded or accompanied by course 1 or its equivalent. Professor Herrington. Lectures, M W 8. Dairy Building 119.

A consideration of milk from the physico-chemical point of view.
DAIRY BACTERIOLOGY. (See Bacteriology 191.)
[220. CHEMISTRY OF MILK PRODUCTS. Spring term. Credit four hours.

Must be preceded by course 113. Professor $\longrightarrow$. Lectures, M T W Th 8. Dairy Building 218. Not given in 1947-1948.]
An advanced consideration of the scientific and technical aspects of milk products.
252. SEMINAR. Throughout the year. Without credit. Required of graduate students specializing in the department. Professor Sherman. Hours to be arranged. Dairy Building.

## FOR GRADUATES

Graduate students may elect research problems in any of the various fields of dairy science and in related fields of bacteriology and biochemistry.

## FLORICULTURE AND ORNAMENTAL HORTICULTURE

Professors L. H. MacDaniels, Kenneth Post, J. P. Porter, A. M. S. Pridham, W. E. Snyder, and J. F. Cornman.

## APPROVED MAJOR AND MINOR SUBJECTS (key to symbols on p. 47)

Floriculture and Ornamental Horticulture 1, 2, 4
Studies in the propagation, nutrition, culture, and improvement of ornamental plants may be undertaken. Also monographic studies of ornamental groups and their adaptability to use are suitable problems.
Most of the problems in this field are basically those of plant response with relation to environment and thus the student majoring in the department should have adequate preparation in Botany, Plant Physiology, Genetics, Biometry, Agronomy, Plant Pathology, Entomology, Chemistry, and elementary Floriculture and should have had experience in the growing and handling of horticultural material. Minor subjects should be chosen in the above-named basic science fields. A candidate for the doctor's degree may find it expedient to arrange a joint major in Floriculture and one of the basic science departments. Under these circumstances the problem would be worked out with horticultural material under the joint supervision of committeemen from the two departments.
The greenhouse, nursery, plant materials, and laboratory facilities of the department are adequate for research in practically any phase of the field. This, with the strong departments in the basic sciences, gives an outstanding opportunity for graduate work with ornamental plants at Cornell.

1. General Floriculture and Ornamental Horticulture. Fall term. Two lectures and one laboratory period a week.
2. Introduction to Landscape Design. Spring term. Three lectures a week.
3. Flower Arrangement. Spring term. One lecture and one laboratory period a week.
4. Taxonomy of Cultivated Plants. Fall term. One lecture and two laboratory periods a week.
5. Herbaceous Plant Materials. Spring term. Two lectures and one laboratory period a week.
6. Woody Plant Materials. Spring term. Two lectures and two laboratory periods a week. -
7. Elementary Landscape Planning and Planting of Small Properties. Fall term. One lecture and two laboratory periods a week.
8. WOODY-PLANT MATERIALS, ADVANCED COURSE. Fall term. Credit two hours. Prerequisite, course 13. Laboratory, T Th 1:40-4. Plant Science 29. Assistant Professor Cornman.

A continuation of course 13 for students in the landscape nursery service. An opportunity for the more intimate study of important groups of ornamental plants, particularly their adaptability to landscape use. A trip is taken to the Rochester parks.
114. TURF. Spring term. One lecture and one laboratory period a week.
115. PLANT PROPAGATION. Fall term. Credit three hours. Prerequisite, courses 12 and 13 and Botany 31 or their equivalent. Lectures, T Th 11. Plant Science 37. Laboratory, Th 2-4:30, S 9-11:30. Greenhouses and nurseries. Assistant Professor Snyder.

A study of the principles and methods involved in the propagation of woody and herbaceous plants by seeds, division, layers, cuttings, budding, and grafting. The class visits nurseries at Geneva and Newark, New York.
[125. Flower Store Management. Spring term. One lecture and one laboratory period a week. Not given in 1947-1948.]
123. COMMERCIAL GREENHOUSE PRODUCTION. Fall term. Credit four hours. Prerequisites, courses 115, Botany 31, Agronomy 1, and the practice requirement. Professor Post. Lectures and recitation. M W F 9. Plant Science 37. Laboratory, W 1:40-4. Greenhouses.

A comprehensive study of the application of basic science to the culture of ornamental plants.
124. COMMERCIAL GREENHOUSE PRODUCTION. Spring term. Credit three hours. Prerequisite, course 123. Professor Роst. Lectụres, M W 9. Plant Science 37. Laboratory, W 1:40-4. Greenhouses.

A course supplementary to course 123 dealing with the study of the commercial production of florists' crops with emphasis on the practical problems concerned. A trip made to nearby commercial greenhouses.
[117. COMMERCIAL NURSERY MANAGEMENT. Spring term. Credit three hours. Prerequisite, course 115. Lectures, T Th 11. Plant Science 37. Laboratory, T 1:40-4:30. Greenhouses and Nurseries. Associate Professor Pridham. Not given in 1947-1948.]

A course supplementary to course 115 dealing with the problems of commercial propagation and management of nursery plants.
119. PLANTING AND MAINTENANCE OF ORNAMENTAL PLANTS. Fall term. Credit three hours. Prerequisite, Floriculture 115. Associate Professor Pridham. Lectures, T Th 11. Plant Science 37. Laboratory, T 1:4-4.
A study of the principles and practices employed in the maintenance of plants used as landscape materials.
132. LaNDSCAPE PLANNing and planting of small properTIES. Both terms. Credit four hours a term. Prerequisites, courses 12, 13, 32,
and Drawing 10 and 15. Associate Professor Porter. Lecture, T 10. Plant Science 37. Laboratory, T Th 1:40-4:30. and one additional three-hour period.

An advanced course in the design of small properties to follow course 32.
134. CONSTRUCTION AND PLANTING OF SMALL GARDENS. Fall term. Credit three hours. Intended for advanced students specializing in landscape service. Prerequisite, course 132. Associate Professor Porter. Lecture, Th 10. Plant Science 433. Laboratory, F 1:40-4:30 and one additional three-hour period. Plant Science 433.

A study of the design, construction, and planting of intimate garden areas with special attention to plant and flower combinations and the construction of landscape features.
241. SEMINAR. Fall and spring terms. One hour to be arranged. Required of all graduate students in the department and recommended for senior majors. Plant Science 37.

## FORESTRY

## Professors C. H. Guise and E. F. Wallihan.

# APPROVED MAJOR AND MINOR SUBJECTS (key to symbols on p. 47) 

Forest Conservation 2, 4
Forest Ecology 2, 4
Instruction and research in forestry on the graduate level leading to advanced professional degrees in forestry have been discontinued.

Graduate students, candidates for the degrees Master of Science or Doctor of Philosophy, may elect to do work of non-professional character in forestry. Prospective graduate students should correspond with the Dean of the Graduate School in order to ascertain whether the work desired is available.

## POMOLOGY

Professors A. J. Heinicke, M. B. Hoffman, R. M. Smock, Damon Boynton, F. W Southwick, and L. J. Edgerton.

## APPROVED MAJOR AND MINOR SUBJECTS (key to symbols on p. 47)

Pomology 1, 2, 4
The large experimental and varietal orchards of different fruits at Ithaca and at Geneva are available for graduate use. Representative varieties of all domesticated species that grow in this climate may be found in these orchards. Each year a large collection of exotic fruit is brought together at the College; herbarium and preserved material is also available. The important pomological literature required for research is found in the libraries at Cornell and at the State Station. Modern apparatus for research work on pomological problems involving chemical, histological, and physiological technique is available in the departmental laboratories. Opportunity for investigation of fruit storage problems is afforded by a modern cold storage plant which is equipped for experimental purposes.

Special facilities for research work in fruit breeding, nursery stock investigations, and other phases of pomology are also available to graduate students at Geneva. (For further information, see page 253.)
In order to enter upon graduate work in Pomology, the student should have the equivalent of the following courses: General Botany, Elementary Plant Physiology, Economic Entomology, Elementary Plant Pathology, Introductory Inorganic and Elementary Organic Chemistry, Elementary Pomology, and Systematic Pomology. In addition, students are required as part of their graduate work in Pomology to take advanced courses in Plant Physiology and Chemistry, unless minors are chosen in those subjects. They are urged, however, to choose a minor in some phase of Botany, particularly Plant Physiology.

On account of the nature of the work, it is very desirable that graduates studying for the Master's degree should spend one summer at Ithaca or Geneva or in the field investigating their special subject. This is expected of graduates working for a Doctor's degree.

1. General Pomology. Spring and fall terms. Credit three hours.
2. Fruit Varieties. First term. Credit three hours.
3. Handling, Storage, and Utilization of Fruit. Fall term. Credit three hours.
4. Advanced Laboratory. Second term. Credit two hours.
5. ECONOMIC FRUITS OF THE WORLD. Professor Boynton. Lectures, T Th 12. Laboratory, F 1:40-4. Plant Science 107.
A study of all species of fruit-bearing plants of economic importance, such as the date, the banana, the citrus fruits, the nut-bearing trees, and the newly introduced fruits, with special reference to their cultural requirements in the United States and its insular possessions. All fruits not considered in other courses are considered here. The course is designed to give a broad view of world pomology and its relationships with the fruit industry of New York State.
[131. ADVANCED POMOLOGY. Credit four hours. Prerequisites, Pomology 1 and 2 and Botany 31. Professor Heinicke. Lectures, M W F 10. Conference, W 11. Plant Science 141. Given in alternate years. Not given in 1947-1948.]

A systematic study of the sources of knowledge and opinion as to practices in pomology. The results of experiences and research pertaining to pomology are discussed with reference to their application in the solution of problems in modern fruit growing.
231. SPECIAL TOPICS IN EXPERIMENTAL POMOLOGY. Fall term. Credit three hours. Prerequisite, Pomology 131. Professors Heinicke, Hoffman, Boynton, and Smock; and Assistant Professors Southwick and Edgerton. Conference periods, M W F 10. Plant Science 141. Given in alteŕnate years.

In this course the student is expected to review critically and evaluate the more important original papers relating to pomological research. Interpretation of the literature will be made on the basis of the fundamental principles of plant biology. Modern experimental methods applicable to the field of pomology are fully considered.
201. RESEARCH PROBLEMS IN POMOLOGY. Fall and spring terms. Professors Heinicke, Hoffman, Smock, Boynton, Southwick, and Edgerton.
200. SEMINAR. Members of the staff. T 11. Plant Science 404.

## POULTRY HUSBANDRY

Professors J. H. Bruckner, R. K. Cole, G. O. Hall, G. F. Heuser, F. B. Hutt, L. C. Norris, A. L. Rómanoff, M. L. Scott.

## APPROVED MAJOR AND MINOR SUBJECTS (key to symbols on p. 47)

Animal Genetics 1, 2, 3, 4<br>Animal Nutrition 1, 2, 3, 4<br>Chemical Embryology 1, 2, 3, 4<br>Poultry Husbandry 2, 4

The department provides excellent facilities for research in the genetics, physiology, incubation, embryology, nutrition, and behavior of domestic birds. A flock of over 6000 birds of various breeds of domestic fowl and turkeys is maintained, and ducks, geese, and game birds can be obtained when needed. The equipment includes the usual facilities for hatching, brooding, and rearing poultry, together with laying houses and pens for experimental work. There is a well-equipped chemical laboratory and complete facilities for work in poultry nutrition, equipment for studies of incubation and facilities for various kinds of histological and physiological work.
Students for the Ph.D. degree in this department may elect Animal Genetics, Animal Nutrition, or Chemical Embryology as the major field of study. They may also be elected as major or minor fields of study for the M.S., or M.S. in Agriculture degree. For requirements and courses in Animal Nutrition see p. 93.
Poultry Husbandry may be elected as a major or minor for the M.S., or M.S. in Agriculture degree, and as a minor for the Ph.D. degree when the major is taken in a field of study other than Animal Genetics, Animal Nutrition, or Chemical Embryology.
The prerequisites for graduate students electing a major subject in this department include some undergraduate training in poultry husbandry, some experience in that field, courses in zoology or animal biology, physiology, and chemistry, as well as permission of the major adviser.

1. Farm Poultry. Fall term. Credit three hours.
2. Poultry Breeds, Breeding, and Judging. Fall term. Credit three hours.
3. Poultry Incubation and Brooding. Spring term. Credit three hours.
4. Marketing Poultry Products. Spring term. Credit two hours.
5. Poultry Nutrition. Spring term. Credit three hours.
6. Animal Genetics. Spring term. Credit three hours.
7. Anatomy of the Fowl. Fall term. Credit two hours.
8. Poultry Hygiene and Disease. Fall term. Credit two hours.
9. POULTRY GENETIGS. Spring term. Credit three hours. Prerequisites, Zoology 2, Plant Breeding 101, or equivalents, and permission of the instructor. Professor Hutt. M W F 9. Given in alternate years.
A survey of inherited characters in domestic birds, cytology, linkage, inbreeding, hybrid vigor, resistance to disease, genetic principles in poultry breeding, physiology of avian reproduction, infertility, embryonic mortality, and avian endocrinology.
10. SEMINAR IN POULTRY BIOLOGY. Throughout the year. Members of departmental staff. F 4:15. Rice 201. Required of all graduate students in the department.

A survey of recent literature and research in poultry biology.
210. EXPERIMENTAL METHODS IN POULTRY NUTRITION. Fall term. For details see Animal Nutrition.
219. ANIMAL NUTRITION SEMINAR. Fall and spring term. For details see Animal Nutrition.
229. SEMINAR IN ANIMAL GENETICS. Fall and spring terms. Credit one hour each term. Registration by permission. Professors Hutt, Asdell, and Cole. Th 4:15. Rice 201.

Review of current literature and consideration of topics of interest to workers in the fields of animal genetics and physiology and reproduction.
P.H. 230. AVIAN EMBRYOLOGY. Spring term. Given in alternate years with the Course 235. Credit two hours. For graduate students. Undergraduates by special permission. Prerequisite, Biology 1, or Zoology 1, or the equivalent. Lecture and laboratory demonstration, Th 1:40-4, or hours to be arranged. Rice Hall. Associate Professor Romanoff.

The principles of embryonic growth and development, with specific emphasis on various manifestations of biochemical phenomena. The study, in general, is designed to provide basic facts for natural and artificial propagation of birds.
[P.H. 235. THE AVIAN EGG. Spring term. Credit two hours. Given in alternate years with the course 235. For graduate students and qualified juniors and seniors. Prerequisite, Biology 1, or Zoology 1, or the equivalent, and permission of the instructor. Lecture and laboratory, Th $1: 40-4$, or hours by arrangement. Rice Hall. Associate Professor Romanoff. Not given in 1947-1948.]

Biological constitution and physicochemical properties of the egg as a reproductive cell, and as an article of food.
P.H. 239. SPECIAL TOPICS IN CHEMICAL EMBRYOLOGY. Fall term. Credit one hour. Registration by permission. Rice Hall. Associate Professor Romanoff.

A critical review of current literature.

## VEGETABLE CROPS

Professors H. C. Thompson, Paul Work, E. V. Hardenburg, Ora Smith, Hans Platenius, G. J. Raleigh, A. J. Pratt, R. D. Sweet, and H. M. Munger; at Geneva, Professors C. B. Sayre and W. T. Tapley.

APPROVED MAJOR AND MINOR SUBJECTS (key to symbols on p. 47)
Vegetable Crops 1, 2, 4
Opportunity is offered for research in such lines of vegetable growing and handling as the student may select. There are excellent opportunities for original work on this subject.

The facilities available include the usual classrooms and laboratories; research laboratories with equipment for chemical, physiological, and anatomical work; cold storage and common storage rooms; greenhouses (about 7500 square feet)
with heat and light controls; about 30 acres of land at Ithaca devoted to research and teaching and an additional 30 acres devoted to research on Long Island. Special equipment is obtained as needed for students majoring in this field.
In order to enter upon graduate work in this field the student should have the equivalent of the following courses: Botany 1 and 31, Plant Pathology 1, Entomology 12, Agronomy 1, Vegetable Crops 1, 2, 112. These courses are outlined in the Announcement of the College of Agriculture. In case a student has not had all of these courses, he should take them early in his period of graduate study. Students taking either a major or a minor in vegetable crops are required to take the courses $101,113,225$, and to attend the seminar.
Students majoring in vegetable crops will ordinarily find it necessary to spend at least one summer in Ithaca, in order to grow and study plant materials used in their research work.

1. Vegetable Crops. Spring term. Credit four hours.
2. Special Cash Crops. Spring term. Credit three hours. Botany 1 should precede or accompany this course.
3. ADVANCED VEGETABLE CROPS. Fall term. Credit three hours. Prerequisites, course 1 and Botany 31. Professor Thompson. Lectures, M W F 9. East Roberts 223.

This course is devoted to a systematic study of the sources of knowledge relating to problems involved in vegetable production. Results of research are studied with reference to their application in the solution of problems in vegetable growing.
112. GRADING AND HANDLING VEGETABLE CROPS. Fall term. Credit three hours. Prerequisite, Vegetable Crops 1 and Botany 31. Lectures, T Th 8. East Roberts 222. Laboratory, T or W 1:40. East Roberts 223, greenhouses or gardens. Professor Platenius.

Geography of vegetable production and distribution. Factors of environment, culture, and handling as affecting quality, condition, and marketing of vegetable crops. Principles and practices concerned in harvesting, grades and grading, packing, shipping-point and terminal-market inspection, transportation, refrigeration, and storage are discussed with reference to the various crops. A two-day trip is required; maximum cost $\$ 10$. This course with Pomology 111 and Agricultural Economics 142 afford training in marketing of vegetables and fruits.
[113. Types and Varieties of Vegetables. Credit three hours. Prerequisite, course 1 or 2 or permission to register. Professor Work. Given in alternate years. Not given in 1947-1948.]

This course deals with the taxonomy, origin, history, characteristics, adaptation, identification, classification, exhibition, and judging of kinds and varieties of vegetables; the characteristics, production, and handling of vegetable seeds. The leading varieties of the vegetable crops are grown each year. The value of the course depends to a great extent upon gaining an acquaintance with the plant material as it grows.
225. SPECIAL TOPICS IN VEGETABLE CROPS. Spring term. Credit three hours. Prerequisites, course 101 and Botany 31. It is recommended that Botany 231 and 232 precede or accompany this course. Professors Thompson, Raleigh, and Smith, and Associate Professor Platenius. Discussions, M W F 9. East Roberts 223. Given in alternate years.

In this course, intended primarily for graduate students, the student is expected to review critically and to evaluate the more important research publications that deal with vegetable production, handling, and storage problems. In the discussions, attention will be given to research methods and technique.
231. RESEARCH. Members of the staff are prepared to direct investigations in the various lines of vegetable production and handling.
232. SEMINAR. Fall and spring terms. Members of the department staff. Recent literature is taken up for general study and discussion. All graduate students in vegetable crops are required to take part in this seminar. Time to be arranged. East Roberts 223.

## RESEARCH AT THE NEW YORK STATE EXPERIMENT STATION

Research work in vegetable crops is also available at Geneva. For further information see page 253 .

# SCHOOL OF EDUCATION 

EDUCATION AND RURAL EDUCATION

Professors Lucile Allen, T. L. Bayne, J. E. Butterworth, L. A. Emerson, F. S. freeman, E. R. Hoskins, M. L. Hulse, M. Hutchins, J. E. King, P. J. Kruse, C. B. Moore, A. G. Nelson, R. A. Olney, E. L. Palmer, H. I. Patterson, V. E. Schmidt, W. A. Smith, F. M. Thurston, A. L. Winsor, and A. D. Woodruff.<br>\section*{APPROVED MAJOR AND MINOR SUBJECTS FOR A.M., M.S., M.S. IN AGR., AND PH.D. (key to symbols on p. 47)}

## Agricultural Education 1, 2, 3, 4

Curriculum 1, 2, 3, 4
Education 3, 4
Educational Administration 1, 2, 3, 4
Educational and Mental Measurement (including Statistics) 2, 3, 4
Educational Method 3, 4
Educational Psychology 1, 2, 3, 4
Guidance and Personnel Administration 1, 2, 3, 4
History of Education 2, 3, 4
Home Economics Education 1, 2, 3, 4

Industrial Education 1, 2, 3, 4
Nature Study 1, 2, 3, 4
Rural Education 1, 3, 4
Rural Secondary Education 1, 2, 3, 4
Science Education 1, 2, 3, 4
Secondary Education 1, 2, 3, 4
Social Studies Education 1, 2, 3, 4
Supervision 1, 2, 3, 4
Theory and Philosophy of Education 1,2,3,4
Vocational Education 1

There are two types of advanced degrees for which students in Education may become candidates, as follows:

1. The degrees of Master of Arts, Master of Science, Master of Science in Agriculture, and Doctor of Philosophy, administered by the Graduate School.
2. The degrees of Master of Science in Education and Master of Education, administered by the School of Education under the jurisdiction of the Graduate School.

## ADMISSION

A student may be admitted to candidacy for any of the degrees, Master of Arts, Master of Science, Master of Science in Agriculture, or Doctor of Philosophy, with a major or minor or both in some phase of Education.

The requirements for admission to candidacy for Master of Science in Education are the same as for Master of Arts or Master of Science, except that there is no requirement in foreign language.

Persons interested in becoming candidates for these degrees should address inquiries to the Director of the School of Education. Formal application for admission should be sent to the Dean of the Graduate School.

## THE DEGREE OF MASTER OF EDUCATION

The student who enters the University with the intention of preparing for secondary school teaching will be expected to complete a five-year program. He will register in one of the undergraduate colleges and at the end of four years will normally receive a Bachelor's degree. Upon the satisfactory completion of the five-year program, the professional degree, Master of Education, will be awarded.

## THE DEGREE OF MASTER OF SCIENCE IN EDUCATION

The various programs leading to this degree are planned primarily for those who, having had experience in teaching or other type of educational work, wish to prepare themselves for such specialized forms of service as supervision, counseling, or the administration of an elementary, secondary, vocational, or technical school. For the present, teachers of industrial arts and of industrial and technical subjects should also ordinarily seek this degree. Information regarding requirements for admission to candidacy for this degree will be found in the Announcement of the School of Education.

For information regarding rooms in which classes will be held see the Announcement of the colleges concerned.

## PRE-PROFESSIONAL AND PROFESSIONAL COURSES FOR SECONDARY SCHOOL TEACHERS

Introduction to Social Science, A, B. A two-term course: Fall and spring terms. Credit three hours a term.
Human Growth and Development, A, B. A two-term course: Fall and spring terms. Credit three hours a term.
100. Educational Psychology (Ed. and R.E.) Spring term. Credit three hours.
190. Social Foundations of Education (Ed. and R.E.) Fall or spring term. Credit three hours.
130. The Art of Teaching (Ed. and R.E.) Throughout the year. Credit five hours a term.
131. Introduction to Teaching in Vocational Agriculture (R.E.) Fall term. Credit three hours.
132. The Teaching of Agriculture in the Secondary School (R.E.) A two-term course: fall and spring terms, in two sequences beginning in either term. Credit four hours during the fall term, three hours during the spring term.
R.E. 133. Directed Teaching of Students in Agricultural Education. Fall or spring term. Credit to be arranged.
R.E. 135. Directing Extra-curricular Activities by Teachers of Agriculture. A two-term course. Credit one hour each term.
[200. APPRENTICE TEACHING. (Ed. and R.E.) An eight-week period offcampus to be arranged. Credit six hours. Members of the staff. Required of all candidates for the M.Ed. degree. Prerequisite: satisfactory completion of the first four years of the five-year program, or the equivalent, or special permission.
Students will be assigned to cooperating schools so selected as to provide the most favorable conditions for this type of experience. They will be expected to carry a half-time teaching program including the usual related responsibilities
of the teacher. Preparation for teaching and work on special problems under the direction of University instructors will occupy the remainder of the student's time. Each student will be under the immediate supervision of the principal, of a competent local teacher, and of a member of the staff of the School of Education. Not given in 1947-1948.]
210. SPECIAL PROBLEM IN TEACHING. (Ed. and R.E.) Fall or spring term. Credit two hours. Members of the staff.

A critical study of some phase of teaching undertaken during the period of apprentice teaching.
[220. PHILOSOPHY OF EDUCATION. (Ed. and R.E.) Credit two hours Offered for an eight-week period during the spring term at such time as will not interfere with the student's apprentice teaching. Time and place of meeting to be arranged.

For fifth-year students in preparation for secondary school teaching under the five-year program. A coordinating course in the professional sequence designed chiefly to develop a critical appreciation of teaching enterprise. It centers, therefore, upon the question of values in education and calls for examination and judgment of aims and content from that standpoint. Every student is required to undertake a study in valuation of the teaching enterprise in his own field of specialization. Not given in 1947-1948.]

Ed. 675. SEMINAR IN HUMAN DEVELOPMENT AND BEHAVIOR. Spring term. Credit two hours. Primarily for graduate students. Professor Freeman. M 4-6. Goldwin Smith 248. Recent experimental and clinical materials and theories. Educational implications.

## EDUCATIONAL PSYCHOLOGY

R.E. 10. Psychology: An Introductory Course. Fall or spring term. Credit three hours.
R.E. 112. Psychology for Students of Education. Fall or spring term. Credit three hours.
R.E. 117. Psychology of Childhood and Adolescence. Spring term. Credit three hours.
Ed. 608. EXPERIMENTAL EDUCATIONAL PSYCHOLOGY. Fall or spring term. Credit and hours to be arranged. For undergraduate and graduate students. Consent of the instructor is required. Prerequisite, Education 607 or its equivalent. Professor Freeman.
The application of psychological and statistical methods to problems in education.
Ed. 618. INDIVIDUAL DIFFERENCES. Spring term. Credit three hours. Prerequisite, Education 607 or equivalent, or consent of instructor. For undergraduate and graduate students. Professor Freeman. T Th 2-3:15. Goldwin Smith 248.
The nature, causes, and implications of individual differences in abilities and behavior. Study and observation of atypical groups.
R.E. 211. PSYCHOLOGY FOR STUDENTS OF EDUCATION. Fall term. Credit three hours. Professor Kruse. M F 11-12:20.
R.E. 214. EDUCATIONAL PSYCHOLOGY. Spring term. Credit two hours. For members of the staff. Professor Kruse. T 4:15-5:45. Stone 309.

The field of psychology in relation to education, teaching, and learning; motivation; the learning process; individual differences; behavior adjustment: in relation to the problems of the college teacher.
[R.E. 212. PSYCHOLOGY OF LEARNING. Spring term. Credit two hours. Professor Kruse. Th 4:00-5:30. Not given in 1947-1948.]
R.E. 213. PSYCHOLOGY OF LEARNING IN THE SGHOOL SUBJECTS. Fall term. Credit two hours. Associate Professor Bayne. S 9-10:30. Stone 309.
R.E. 216. SEMINAR IN HUMAN MOTIVATION. Fall term. Credit three hours. Associate Professor Woodruff. M 4-6. Stone 309.

The development, nature, and operation of the dynamic and directive factors in human behavior, with analysis of the identifiable aspects of adjustive behavior.
R.E. 218. SEMINAR IN EDUCATIONAL PSYCHOLOGY. Spring term. Credit two hours. Professor Kruse. Th 4-5:30. Stone 309.
R.E. 223. SEMINAR IN EXTENSION TEACHING. Fall term. Credit two hours. T 4:15-5:45. Stone 309. Professor Kruse.
R.E. 219. SEMINAR IN PERSONNEL ADMINISTRATION. Spring term. Credit two hours. Prerequisite, a course in Personnel Management or equivalent experiences. Professor Winsor. Th 7-9. Stone 309.

## METHOD

[R.E. 121. Method and Procedure in Secondary School Teaching. Fall term. Credit three hours. Not given in 1947-1948.]
[R.E. 127. Visual and Auditory Aids in Teaching. Fall term. Credit two hours. Not given in 1947-1948.]
R.E. 134. Special Education for Out-of-School Youth. Spring term. Credit two hours. Associate Professor Hoskins. Th 4:15-5:45.

Designed for advanced seniors in training and leaders of rural youth. A consideration of objectives and trends in educational and social-economic problems; also, cooperative relationships with other youth groups.
R.E. 226. RESEARCH IN SCIENCE TEACHING. Fall or spring term. Credit one or two hours a term. Professor Palmer, Assistant Professor Schmidt, and Miss Gordon. M 12:30. Fernow 8.

Special problems in science teaching.
[R.E 247. SEMINAR IN ELEMENTARY EDUCATION. Spring term. Credit two hours. Professor Moore. Not given in 1947-1948.]
R.E. 228. SEMINAR IN CHILD GUIDANCE (Child Development and Family Relationships 350). Spring term. Credit two hours. Professor Waring. F 4-6. Martha Van Rensselaer G-58.
R.E. 232. EVALUATION AND PROGRAM PLANNING IN AGRICULTURAL EDUCATION. Spring term. Credit two or three hours. Associate Professor Hoskins. M 4:15-5:45 and special trips to be arranged.

The evaluation of programs of vocational education in agriculture in actual situations as a basis of more effective planning.
R.E. 233. PROBLEMS IN SECONDARY AGRICULTURE. Hours and courses to be arranged. Extramural. Staff in Agricultural Education.

## HOME ECONOMICS EDUCATION

Home Ec. Ed. 437. ADULT Homemaking EDUCATION. Credit two to six hours. Fall or spring term. Assistant Professor Patterson.

Designed for teachers, nutritionists, extension agents, health and social workers and other leaders in adult homemaking education.
a. Gives attention to philosophy, organization, program planning, promotion, leadership and evaluation of adult education. Two or three hours. M 4 and other hours to be arranged.
b. Deals with desirable learning experiences for adults and provides opportunities for experimentation in various methods and materials. Two or three hours, Sat 9 and other hours to be arranged.

Home Ec. Ed. 448. TEACHER EDUCATION IN HOME ECONOMICS. Credit two hours. Fall term. Professor Hutchins.
Planned for experienced teachers who desire to prepare for positions of leadership in the field of teacher education. See Announcement of the College of Home Economics.

Home Ec. Ed. 449. SEMINAR IN PROBLEMS OF HOME ECONOMICS EDUCATION with special emphasis upon Curricula. Fall and spring terms. Credit two or three hours either term. Hours to be arranged. Field work is required. Students must consult the instructor before registering. Professor Thurston.

Home Ec. Ed. 459. SEMINAR IN EVALUATION. Prerequisite or parallel H. Ec. Ed. 449. Spring term. Credit two or three hours. Hours to be arranged. Field work is required. Students must consult the instructor before registering. Professor Therston.
Home Ec. Ed. 479. SEMINAR IN STUDIES AND RESEARCH IN HOME ECONOMICS EDUCATION. This course can be used to develop the student's study or thesis. Fall term. Credit two or three hours. Hours to be arranged. Field work is required. Students must consult the instructor before registering. Professor Thurston.
Home Ec. Ed. 469. THE SUPERVISION OF HOME ECONOMICS EDUCATION. Spring term. Credit two hours. Students must consult the instructor before registering. Time to be arranged. Professor Thurston.

For persons who are now engaged in supervision and in the education of teachers in service and for those who wish to prepare for such work. Field work is required.

Home Ec. Ed. 400. SPECIAL STUDIES. Credit as arranged. Members of the staff.
Students working on theses or other research projects may register for this course. The staff members concerned must be consulted before registration.
300. SPECIAL PROBLEMS. Fall and spring. Credit and hours to be arranged individually. For students who wish to do independent advanced work on a problem not dealt with by other courses in the department.

## PREPARATION OF TEACHERS FOR NORMAL SCHOOLS AND COLLEGES

[R.E. 241 THE PREPARATION OF TEACHERS FOR NORMAL SCHOOLS AND COLLEGES. Spring term. Credit two hours. Professor Moore. Not given in 1947-1948.]
[R.E. 235. THE TECHNICAL AND PROFESSIONAL PREPARATION OF TEACHERS OF AGRICULTURE FOR THE SECONDARY SCHOOL. Spring term. Credit three hours. Should follow course 211a or its equivalent. Not given in 1947-1948.]

## MEASUREMENT AND STATISTICS

Ed. 607. MENTAL MEASUREMENTS. Fall term. Credit three hours. For undergraduate and graduate students. Prerequisite, a course in psychology and a course in statistics or consent of instructor. Professor Freeman. T Th S 9. Goldwin Smith 234.

Development of individual and group tests of intelligence and personality; principles underlying their construction and use; their use in schools, psychological clinics, the armed services, and in other fields. The nature of mental abilities. Demonstration in administering and interpreting tests.
R.E. 251. EDUCATIONAL MEASUREMENT. Spring term. Credit three hours. Candidates for the principal's certificate may register for two hours' credit. Prerequisite, a course in educational psychology. Associate Professor Bayne. S 1112:30 and an additional hour to be arranged. Roberts 492.

The use of aptitude and achievement tests and other measuring instruments in the classification and guidance of pupils, improvement of instruction, and other activities of the teacher and school officer. Those class members who wish may make a study of their own aptitudes and achievements.
R.E. 253. INTRODUGTION TO EDUCATIONAL STATISTICS. Fall term. Credit three hours. Associate Professor Bayne. T Th 10 and an hour to be arranged. Stone 309.

A study of common statistical procedure in relation to critical reading of technical studies, research, and writing reports of studies. As far as possible the work is related to the problems of the individual student.
R.E. 254. STATISTICAL INSTRUMENTS IN EDUCATION. Spring term. Credit two hours. Prerequisite, a first course in statistics and permission of the instructor. Associate Professor Bayne. T 10 and a period to be arranged. Stone 309.

INDUSTRIAL AND TECHNICAL EDUCATION
(See under Industrial and Labor Relations, page 239)

## ADMINISTRATION AND SUPERVISION

[R.E. 260. THE SECONDARY SCHOOL PRINCIPALSHIP. Spring term. Credit two hours. Assistant Professor King. T Th 2-3:30. Stone 309. Not given in 1947-1948.]

A consideration of the problems of high school administration; intended primarily for persons interested in secondary principals' certificates.

## R.E. 261. FUNDAMENTALS OF EDUCATIONAL ORGANIZATION AND ADMINISTRATION. Fall term. Credit three hours. Professor Butterworth. T Th 11-12:30. Stone 309.

A consideration of the main problems in organizing and administering the school program, including the services provided when school and community cooperate in meeting educational needs.
R.E. 264. SCHOOL FINANCE. Fall term. Credit two hours. Prerequisite, R.E. 261 or equivalent. Professor Butterworth. T 4:15-5:45. Stone 309.

Typical problems: how local school funds are levied, collected, and disbursed; cost accounting; budget making; bonding; sources of state funds and their distribution. The discussion is based upon actual problems; prospective members of the class are urged, therefore, to bring with them financial data regarding their schools.
R.E. 265. THE SCHOOL PLANT. Spring term. Credit two hours. Prerequisite, R.E. 261 or equivalent. Professor Butterworth. T 4:15-5:45. Stone 309.

The planning and utilization of the school building to serve community needs. Each student will work on a project for his community.
R.E. 243. PROCEDURES AND TECHNIQUES IN SUPERVISION. Fall term. Credit three hours. Professor Moore. M W F 10. Stone 309.

Designed for superintendents, supervisors, and principals. Students taking this course must be prepared to spend four full days or more in observing supervisory procedures in various school systems.
R.E. 268. SEMINAR IN RURAL SCHOOL ADMINISTRATION. Spring term. Credit two hours. Professor Butterworth. S 11-12:30. Stone 309.

Topic to be announced.
R.E. 269. SEMINAR IN CITY SCHOOL ADMINISTRATION. Spring term. Credit two hours. Special lecturer. S 9-10:30. Stone 309.

Current problems in the organization and administration of a city school system.
R.E. 245. SEMINAR FOR PRINCIPALS. Fall term. Credit two hours. Required of all graduate students who are candidates for a principal's certificate. Professor Moore. S 9-10:40. Stone 309.
R.E. 246. THE SUPERVISION OF THE ELEMENTARY* SCHOOL. Spring term. Credit three hours. Candidates for a principal's certificate may register for two hours' credit. Professor Moore. T Th S 2-3:30. Stone 309.

A course designed for supervisors, elementary school principals, and superintendents.
R.E. 236. THE ORGANIZATION AND ADMINISTRATION OF VOCATIONAL AGRICULTURE IN THE PUBLIC SCHOOLS. Spring term. Credit three hours. Should follow or accompany course 261. Professor Olney. T Th 11-12:30. East Roberts 223.

Designed for persons on the state, county, and local levels, who will be responsible for organizing and administering agricultural education in the public schools.
[231. THE SUPERVISION OF VOCATIONAL AGRICULTURE IN THE SECONDARY SCHOOL. Fall term. Credit two hours. Open to teachers, super-
visors, principals, district superintendents, and other educational leaders responsible for supervision in this field. Hours to be arranged. Associate Professor W. A. Smith. Not given in 1947-1948.]
R.E. 298. SEMINAR IN RURAL EDUCATIONAL LEADERSHIP. Spring term. Credit three hours. Professor Butterworth and others. T Th 11-12:30. Stone 309.

A consideration of problems especially significant in the rural areas. Planned for superintendents, principals, extension specialists, social workers, and others preparing for leadership responsibilities in rural education.
R.E. 276. PRINCIPLES OF CURRICULUM building. Fall term. Credit three or four hours. Assistant Professor King. T Th 2-3:30 and an additional hour to be arranged for those wishing to carry further the study of curriculum problems.

A consideration of major problems, principles, and techniques in determining educational objectives and curriculum content and organization in elementary and secondary schools in the light of modern theory and practice.
[R.E. 237. COURSES OF STUDY IN VOCATIONAL AGRICULTURE. Spring term. Credit two hours. Associate Professor Hoskins. Not given in 1947-1948.]
R.E. 278. SEMINAR IN RURAL SECONDARY EDUCATION. Spring term. Credit two hours. Assistant Professor King. Monday 4:15-6:00. Stone 309.
R.E. 263. SEMINAR IN THE SOCIAL AND ECONOMIC PROBLEMS OF THE SCHOOL ADMINISTRATOR. Fall term. Credit two hours. S 11-12:30. Stone 309. Professor Butterworth and specialists from the fields of economics and sociology.

An analysis of the social and economic characteristics of the community that affect the work of the school, and a consideration of as many specific problems as is practicable in the time available. Among these problems are: racial and national composition of the population; occupational pattern; standards of living; delinquency; welfare; income and its distribution; taxation; labor, agricultural, and business groups in relation to education.

## EDUCATIONAL THEORY

R.E. 194. PRINCIPLES OF VOCATIONAL EDUCATION. Fall term. Credit two hours. Open to graduate students and others who have permission to register. Associate Professor W. A. Smith. Hours and room to be arranged.
The meaning and significance of vocational education and the concepts basic to its organization and administration.
R.E. 290. RURAL SECONDARY EDUCATION. Fall term. Credit three hours. Assistant Professor King. M W F 9. Stone 309.

A consideration of some of the more basic problems in the functions, nature, organization, curriculum, and extension of secondary education in its adaptations to rural and village needs and conditions.
R.E. 291. THE EDUCATIONAL PROGRAM IN UNDEVELOPED COMMUNITIES. Spring term. Credit two hours. Assistant Professor King. M 10-11:30. East Roberts 223.

Using the Casa del Pueblo of Mexico as one type of school suitable for undeveloped communities, attention is focused upon the principles that should govern the planning and the implementation of educational programs for situations of this type. Several different countries will be called upon for illustrations.
R.E. 244. PHILOSOPHY OF EDUCATION. Spring term. Credit two hours. Professor Moore. S 9-10:40. Stone 309.
[R.E. 295. COMPARATIVE EDUCATION. Fall term. Credit two hours. Professors Butterworth and Moore. Not given in 1947-1948.]

## NATURE STUDY

R.E. 106. Outdoor Living. Fall term. Credit two hours.
R.E. 107. The Teaching of Nature Study and Elementary School Science. Spring term. Credit two hours.
R.E. 108. Field Natural History. Fall and spring terms. Credit two hours a term. Professor Palmer.
[R.E. 202. NATURE LITERATURE. Fall term. Credit two hours. Alternate years. Not given in 1947-1948.]
R.E. 205. THE TEAGHING OF CONSERVATION. Spring term. Credit two hours. Professor Palmer. T Th 10. Fernow 8.

Consideration of the principles, materials, and methods of conservation education useful to teachers and others engaged in teaching wise use of the resources of the nation.
R.E. 207. METHODS AND MATERIALS FOR THE TEACHING OF SCIENCE IN SECONDARY SCHOOLS. Spring term. Credit two hours. Assistant Professor Schmidt. F 10-11:40. Fernow 8.

A consideration of problems of selection and organization of subject matter, of choice and use of materials, and of methods of teaching science at the secondary level.
R.E. 209. THE DEVELOPMENT OF NATURE AND SCIENCE EDUCATION in the united states. Fall term. Credit two hours. Miss Gordon. M W 10. Fernow 8.

A survey of origins and developments in nature and science education, both in and out of schools, with emphasis on leaders and their philosophies.

## GUIDANCE

Ed. 680. PROCEDURES IN CLINICAL CHILD GUIDANCE. Fall term. Credit three hours. Primarily for graduate students. Prerequisite, Education 607 or equivalent. All students must have consent of the instructor. Professor Freeman. M W 4-6 and conferences.

Procedures and instruments used in case studies of psycho-educational problems of learning and adjustment. Study of case materials. Occasional participation in making actual case studies of pupils.
R.E. 255. USE AND ADMINISTRATION OF TESTS IN GUIDANCE AND PERSONNEL ADMINISTRATION. Fall term. Credit three hours. Open to stu-
dents in guidance or personnel administration. Professor Winsor. Th 7-9. Stone 309.

This course deals with the development, use, and interpretation of aptitude tests as a basis for guidance and selection.
R.E. 282. EDUCATIONAL AND VOCATIONAL GUIDANCE. Fall term. Credit two hours. Primarily for graduate students who wish to be certified as counselors. Th 4:20-6. Warren 125. Assistant Professor Nelson.

Principles and practices of educational and vocational guidance. Historical and theoretical background of the guidance movement; educational, vocational, and community information needed; the study of the individual; group methods; counseling; placement and follow-up; the organization, administration, and appraisal of guidance programs.
R.E. 283. COUNSELING METHODS. Spring term. Credit four hours. Prerequisite, course 282 or its equivalent. Assistant Professor Nelson. T Th 4:20-6. Warren 140.
Techniques for counseling with individuals concerning various types of educational, social, and vocational adjustment problems. Case studies and field work.
R.E. 284. THE TEACHING OF OCCUPATIONS AND ORIENTATION CLASSES. Spring term. Credit two hours. Assistant Professor Nelson. M 4:20-6. Warren 140.
Methods and materials for presenting occupational and orientation information to students. Deals with classes in occupations, orientation groups, field trips, clubs, work-experiences programs, and other group methods.
R.E. 285. OCCUPATIONAL AND EDUCATIONAL INFORMATION. Fall term. Credit four hours. Assistant Professor Nelson. T Th 1:00. Stone 309. Field trips on Wednesday afternoons or as arranged.

Survey and appraisal of occupations and training opportunities; study of sources of educational and vocational information; job analysis; vocational trends. Field trips to places of employment.
R.E. 289. SUPERVISED PRACTICE IN TESTING AND COUNSELING. Spring term. Credit three hours. Prerequisites, $255,282,283$ (or their equivalents), and the permission of the instructor. Assistant Professor Nelson. W 5:00. Hours for observation and practice to be arranged.

Practice in the administration, scoring, and interpretation of psychological tests. Observation and supervised practice in counseling at the Cornell Guidance Center. Case conferences and assigned readings.
R.E. 280. SEMINAR: STUDENT PERSONNEL ADMINISTRATION. Fall and spring terms. Graduates only. Credit two hours. Additional hours for laboratory work. Prerequisite, Sociology, psychology, Economics, Political Science, or practical field experience such as teaching, administration or other kinds of personnel work. Limited enrollment. Students will be admitted upon consultation with the instructor. Professor Lucile Allen, Miss Isabel Peard assisting.
Study in administration areas, organization and administration of personnel programs, including counseling and counseling techniques. This course is designed primarily for students expecting to become assistant deans or personnel workers in colleges.

## INFORMAL STUDY AND RESEARCH

R.E. 199. INFORMAL STUDY IN EDUCATION. Maximum credit, three hours each term. Members of the staff.
R.E. 300. SPECIAL STUDIES. Credit as arranged. Members of the staff.

Students working on theses or other research projects may register for this course. The staff members concerned must be consulted before registration.
R.E. 310. SEMINAR IN SCIENTIFIC METHOD IN EDUCATION. Fall term. Credit two hours. Recommended for graduate students preparing for or engaged in research in education. Associate Professor Smith and members of the staff. Tuesday, 7-8:30. Stone 309.
An analysis and evaluation of types of research used in education. Special attention given to appropriate techniqques, instruments, and devices.

# THE ENGINEERING DIVISION 

## S: C. Hollister, Chairman; W. R. Cornell, Secretary.

The Engineering Division of the Graduate School consists of all professors, associate professors, and assistant professors of the College of Engineering, the Dean of the Graduate School, and such other members of the Faculty of the University as have supervision of the work of Graduate Students in the Division.
The Executive Committee of this Division has general supervision of the graduate work falling within its jurisdiction, and its chairman and secretary are the same as for the Division.
Each of the main branches (Aero.E., Chem.E., C.E., E.E., and M.E.) of the division has a Committee on Graduate Work which has direct charge of the following: examining engineering credentials of applicants for admission, which, however, must first be sent to the Dean of the Graduate School*; corresponding with applicants for the purpose of giving or receiving information or of giving advice concerning the availability of facilities for the graduate work desired in Engineering; the registration of students in the subdivision, after they have registered in the Graduate School; giving advice and approval regarding the student's program and the selection of his Special Committee, which has direct charge of his work; looking after the completion of undergraduate shortages; and making final review of the student's records to check the fulfillment of all scholastic requirements for the degrees. The membership of the Committees on Graduate Work in the four subdivisions is as follows:

## COMMITTEES ON GRADUATE WORK IN THE ENGINEERING DIVISION

Aeronautical Engineering - W. R. Sears, Chairman, 208 Sibley Annex; J. M. Wild, Secretary, 206 Sibley Annex.
Chemical Engineering - F. H. Rhodes, Chairman, 124 Olin Hall; C. C. Winding, Secretary, 228 Olin Hall; C. W. Mason, 318 Olin Hall.

Civil Engineering - W. L. Malcolm, Chairman, 122 Lincoln Hall; R. Y. Thatcher, Secretary, 308 Lincoln Hall; E. W. Schoder, 206 Lincoln Hall.

Electrical Engineering - C. R. Burrows, Chairman, 107 Franklin Hall; J. G. Tarboux, Secretary, 105 Franklin Hall; E. M. Strong, 103 Franklin Hall.

Mechanical Engineering - W. J. King, Chairman, 18 West Sibley; W. R. Cornell, Secretary, 304 West Sibley; F. S. Erdman, Mechanical Laboratory.

Division Representative on the General Committee of the Graduate School, and Chairman of Group E-E. M. Strong.

## GRADUATE STUDY IN ENGINEERING

The instructing staffs and the laboratories, libraries, and other facilities of the various departments of the College of Engineering and those of the other departments of the University are available for students desiring to pursue graduate

[^10]study and research in engineering and allied fields. Graduate students in engineering will also find among the regular and elective courses given in the College and in mathematics, physics, chemistry, and in other departments of the University, many suitable for advanced study. For the courses offered, and for the laboratory, library, and other facilities in Engineering, see the Announcement of the College of Engineering.
Many of the courses described below are to be given in only one of the two terms. Information regarding the availability of any course may be obtained from the office of the School concerned.

## ADVANCED DEGREES OFFERED

The degrees of Master of Chemical Engineering (M.Chem.E.), Master of Civil Engineering (M.C.E.), Master of Electrical Engineering (M.E.E.), Master of Mechanical Engineering (M.M.E.), Master of Science in Engineering (M.S. in Engineering), Master of Science (M.S.), and Doctor of Philosophy (Ph.D.) are granted in the field of engineering. For the professional degrees, Chem.E., C.E., M.E., E.E., and M.Aero.E., see the Announcement of the College of Engineering.

## THE DEGREES OF M.CHEM.E., M.C.E., M.E.E., M.M.E., AND M.S. IN ENGINEERING

Subject to certain general regulations of the Graduate School, ${ }^{1}$ the rules governing admission to candidacy for, and graduation with, one of the engineering degrees (M.Chem.E., M.C.E., M.E.E., M.M.E., and M.S. in Engineering) are established and administered by the Engineering Division of the Graduate School.

For purposes of administration, the Engineering Division of the Graduate School has created five Committees on Graduate Work, one for each of the subdivisions (Aero. Eng., Chem.E., C.E., E.E., and M.E.).

## THE DEGREE M.AERO.E.

The degree Master of Aeronautical Engineering (M.Aero.E.) is administered by the Faculty of the Graduate School of Aeronautical Engineering. Candidates for this degree are not admitted to the Graduate School of the University. Information regarding the requirements for this degree will be found in the Announcement of the College of Engineering.

## THE DEGREES OF M.S. AND PH.D.

The rules governing admission to candidacy for, and those for graduation with, the degrees of Master of Science (M.S.) and Doctor of Philosophy (Ph.D.) are established and administered by the faculty of the Graduate School. ${ }^{2}$

## FELLOWSHIPS AND SCHOLARSHIPS

See above in this Announcement.

[^11]
## ADMISSION TO GRADUATE STUDY IN ENGINEERING*

(1) All applications for admission to the Graduate School and all applications for Graduate Fellowships and Scholarships must be sent to the Office of the Graduate School. Obtain the necessary blanks and instructions from that office.
(2) If the applicant wishes to become a candidate for one of the advanced Engineering Degrees his credentials should include not only information requested on page 9, but in addition, (a) a statement showing, if possible, his relative standing in his class, (b) a catalogue of the institution from which he was graduated, with each subject that he has completed clearly marked therein, and (c) a detailed statement concerning his practical experience, together with letters from his employers.
(3) In all cases, the applicant should designate as definitely as possible his chosen field of study, both major and minor, so that he may be advised concerning the facilities and personnel available in those fields. See paragraphs 13 and 19 below.
(4) A prospective graduate student is urged to write to the office concerned (Aeronautical, Chemical, Civil, Electrical, or Mechanical Engineering) for advice or information.
(5) Candidacy for M.Chem.E., M.C.E., M.E.E., or M.M.E., presupposes the substantial equivalent of the corresponding first degree at Cornell University. In the evaluation of a candidate's credits, however, the quality of his previous work, his practical experience if any, and his chosen fields of advanced study will be considered in making adjustments if the candidate's undergraduate work has not been the exact equivalent of that required for the corresponding undergraduate degree at Cornell.
Candidacy for the degree M.S. in Engineering presupposes graduation from a school or college of recognized standing, with work, either prior to or subsequent to the bachelor's degree, which is equivalent to a recognized curriculum in engineering and which is adequate preparation for the field chosen for graduate work.
(6) A shortage, which does not exceed six university credit hours, may be made up as extra work. If an applicant's total shortage is more than six hours, he may be required, and if more than eighteen hours he will be required, to enter an undergraduate school, and pay the undergraduate fees. See paragraph 12 below.
(7) The Committees on Graduate Work will recommend for admission to the Graduate School only those applicants who show promise of outstanding ability to pursue graduate study and research, judged by previous record and training.
No applicant will be admitted to the Graduate School for work in Engineering unless he is in at least the upper half of his class. Exception may be made when an applicant can present further evidence which would demonstrate his fitness to carry on graduate work.
(8) When a student's Special Committee considers that a reading knowledge of French or German or both is essential for satisfactory progress in his particular fields of study, the student will be required to demonstrate such knowledge before proceeding with this study.
(9) An applicant who does not care to meet the requirements either for entrance to candidacy for or graduation with an advanced degree may arrange for a program of work as a "non-candidate," provided only that he has had previous

[^12]training which is adequate for advanced study in the fields of engineering in which he desires to work.
(10) A student whose mother tongue is other than English may be required by the Committee on Graduate Work to furnish satisfactory evidence of his ability to speak, write, and read English to a degree sufficient for satisfactory progress in his graduate work. The Committee may lengthen the minimum time of residence and prescribe some study of English when a student's deficiency in this respect is deemed to place an undue burden upon him and upon the faculty members with whom he is to come in contact.

## REGISTRATION

A graduate student in engineering must, at the beginning of each term of residence, register first in the Graduate School and then at the office of the Engineering School of whose faculty his major professor is a member.

## RULES GOVERNING GRADUATE STUDY LEADING TO MASTERS' DEGREES IN ENGINEERING*

(11) A Master's Degree is engineering shall be awarded only after the candidate has spent at least one full academic year, or the equivalent, in residence and study at the University.
(12) In general, a graduate student should remove his shortages before he enters his chosen fields of graduate work. Since it is not always practicable to do this, the student may receive permission from the Committee on Graduate Work to make up his shortages while doing his graduate work.
Arrangements can sometimes be made for making up deficiencies in the Summer Session preceding admission to the Graduate School. Sometimes graduate work may also be done in the summer, either in the Summer Session or by special arrangement under "personal direction." To be allowed to work under "personal direction," a student is expected to have spent one year in graduate study, here or elsewhere.

In making up shortages, a student is under the general supervision of the Committee on Graduate Work.
(13) (a) A student shall select a major field of study to which he shall devote not less than one-half nor more than three-fourths of his time. He must also select one or more secondary fields of study to which he shall devote the remainder of his time.
(b) A student shall select one Professor ${ }^{1}$ who shall supervise his work in his major field. For each secondary (or minor) field to which he intends to devote not less than one-fourth of his time, he shall select one Professor to supervise his work in that field. The Professor or Professors thus selected shall be known as his Special Committee. The Professor in charge of the major field shall be Chairman of the Special Committee. If the student selects a secondary field to which he intends to devote less than one-fourth of his time, he shall in that field be under the supervision of the Committee on Graduate Work.

[^13](14) A student shall select his program of study and his Special Committee with the advice and approval of the Committee on Graduate Work in that subdivision (M.Aero.E., Chem.E., C.E., E.E., or M.E.) in which his major subject falls. No change in the program of study or in the personnel of the Special Committee shall be made without the written approval of the appropriate Committee on Graduate Work and the advice of the student's Special Committee.
(15) When a candidate for an advanced degree in Engineering takes a course specified by the Committee on Graduate Work or approved by his Special Committee, he must register in that course and must conform to all the requirements of that course, including the examinations.
(16) If, in the opinion of the Special Committee, a candidate at any time during his residence shows insufficient preparation in any subject or subjects, he may be required to register in and take the work of specified undergraduate courses. His residence requirements will be increased accordingly.
(17) A candidate for a Master's degree in Engineering must present a thesis on a subject in his major field. The thesis must show initiative and originality and must conform to the general requirements of the Graduate School. It may take one of the following forms:
(a) An analytical or interpretative discussion of results already in existence.
(b) A design or construction or both, of sufficient importance and originality to demonstrate thoroughly a knowledge of the principles involved and of their applications.
(c) A dissertation based upon his own original investigation, analytical or experimental.
(18) When a student has satisfied all the requirements set by his Special Committee, including a satisfactory final examination, the Special Committee will so certify to the Committee on Graduate Work. The Committee on Graduate Work will then review the student's record and if the student has fulfilled all scholastic requirements imposed upon him, he will be duly recommended for his degree.

## FIELDS OF GRADUATE INSTRUCTION IN ENGINEERING

(19) A candidate for the Master's degree (M.Chem.E., M.C.E., M.E.E., M.M.E., or M.S. in Engineering) must select his major field in Engineering. He will be allowed considerable latitude in the selection of his minor field or fields, and any field may be chosen which includes a sufficient amount of graduate work, and provided his entire program shows a unified purpose. For instance, a student might select some phase of structural engineering as his major field and economics as his minor field if he could show that his study of economics had a definite purpose consistent with a well-rounded training as an engineer. The major and minor fields available in the College of Engineering are listed below. Graduate courses in engineering are described in the following pages. For opportunities in other fields of graduate study, see elsewhere in this Announcement.

## APPROVED MAJOR AND MINOR SUBJECTS (key to symbols on p. 47) <br> IN CHEMICAL ENGINEERING

Chemical Engineering 1, 2, 4
(Candidates for the degree of Master of Chemical Engineering will be expected to be thoroughly familiar with the general field of Chemical Engineering. Candidates for this degree will be required to select a minor in some other field of engineering or in a related science.)

## IN GIVIL ENGINEERING

Astronomy
Geodetic Astronomy 2, 3, 4
Geodesy 1, 2, 3, 4
Highway Engineering 1, 2, 3, 4
Hydraulic Engineering 1, 2, 3, 4
Hydraulics
Theoretical 1, 2, 3, 4
Experimental 1, 2, 3, 4
Management Engineering 1, 2, 3, 4
Materials of Engineering 2, 3, 4
Mechanics 1, 2, 3, 4

Railroad Engineering
Railroad Maintenance 1, 2, 3, 4
Railroad Location 1, 2, 3, 4
Railroad Operation and Management 1, 2, 3, 4
Sanitary Engineering 1, 2, 3, 4
Sewage Treatment 2, 3, 4
Water Purification 2, 3, 4
Soil Mechanics 1, 2, 3, 4
Structural Engineering
Structural Engineering 1, 2, 3, 4
Theory of Structures 1, 2, 3, 4

Surveying
Geodetic Engineering 1, 2, 3, 4
Topographic Engineering 1, 2, 3, 4
IN ELECTRICAL ENGINEERING
Communications Systems Engineering 1, 2, 3, 4
Economics of Communication Services 2, 3, 4
Electromagnetic Theory 1, 2, 3, 4
Radio Wave Propagation 1, 2, 3, 4
Wire Transmission 2, 3, 4
Radio Engineering 1, 2, 3, 4
Microwave Engineering 1, 2, 3, 4
Acoustical Engineering 1, 2, 3, 4
Carrier Systems 2, 4
Electric Power Generation and Distribution 1, 2, 3, 4
Electric Power System Stability 1, 2, 3, 4
High Voltage Engineering 1, 2, 3, 4
Economics of Public Utilities 2, 4
Electrical Control and Relaying 1, 2, 3, 4

Industrial Control and Applications 1, 2, 3, 4
Servomechanisms 1, 2, 3, 4
Industrial Electronics 1, 2, 3, 4
Illumination Engineering 2, 4
Electric Equipment and Machine Design 2, 4
Electric Circuit Analysis 1, 2, 3, 4
Electrical Measurements and Testing 1, 2, 3,4
Materials in Electrical Engineering 1, 2, 3, 4
Electric Machine Theory 1, 2, 3, 4

## in mechanical engineering

Administrative Engineering 1, 2,3, 4
Automotive Engineering 1, 2, 4
Experimental Mechanical Engineer-
ing 1, 2, 3, 4
Fluid Mechanics 1, 2, 3, 4
Heat-Power Engineering 1, 2, 3, 4

Industrial Engineering 1, 2, 3, 4
Machine Design 1, 2, 3, 4
Materials of Engineering 1, 2, 3, 4
Mechanical Processing 1, 2, 3, 4
Mechanics 1, 2, 3, 4
Metallography $1,2,4$

## IN AERONAUTICAL ENGINEERING

-Aeronautical Engineering 1, 3, 4

## AERONAUTICAL ENGINEERING

Application for admission to candidacy for the degree M.Aero E. should be made directly to the Director of the Graduate School of Aeronautical Engineering, College of Engineering, Cornell University. A special application blank for this purpose can be obtained from the office of the Director. This degree is awarded upon satisfactory completion of a required curriculum of studies and an acceptable thesis. For further details, see the Announcement of the College of Engineering.
Students who desire to work for the Ph.D. degree with Aeronautical Engineering as their major subject must be admitted to the Graduate School of the University in the usual manner. They should make application to the Dean of the Graduate School. Such candidates will be expected to complete courses and original research in the scientific fields that constitute the background of aeronautics, such as mechanics, fluid dynamics, and structural theory.

Close contact is maintained between the Graduate School of Aeronautical Engineering at the University and the Cornell Aeronautical Laboratory in Buffalo, N. Y. Certain periods of employment at the Laboratory are usually offered to aeronautical engineering students - ordinarily during their summer vacations. It is also possible that certain experimental equipment of that Laboratory will occasionally be available to graduate students in connection with their original
research.

The Graduate School of Aeronautical Engineering is equipped with a fluid mechanics laboratory on the campus for fundamental scientific research in fluid mechanics and aerodynamics.

## UNDERGRADUATE COURSES

7001. Introduction to Aeronautical Engineering. Each term. Credit three hours. Assistant Professor Ocvirk.
An introductory course for students in all branches of engineering.

## GRADUATE COURSES

7101. AIRPLANE MECHANICS I. Fall term. Credit three hours. Prerequisite: Engineering Mechanics. Associate Professor Wild.
Introduction; the nature of fluid forces; characteristics of airfoils; airplane performance.
7102. AIRPLANE MECHANICS II. Spring term. Credit three hours. Prerequisite: 7101. Associate Professor Wild.

Airplane stability; airplane dynamics; control surfaces.
[7103. AIRCRAFT PROPELLER DESIGN. Credit three hours. Prerequisite: 7101. Not given in 1947-1948.]

The aerodynamics of propellers and fans.
7204. MECHANICS OF JETS. Spring term. Credit three hours. Dr. Kuo.

Intended primarily for graduate students in Chemical Engineering. Dimensional analysis, Bernoulli's theorem, nozzle and channel flow, sound waves, shock waves.
7205. GASDYNAMICS. Spring term. Credit four hours. Prerequisites: Physics 15 and 16, 7601, or equivalents. Associate Professor Kantrowitz and Dr. Kuo.
Aero-thermodynamics and kinetic theory in relation to fluid dynamics. Onedimensional steady flow of a compressible fluid; addition of heat. Shock waves, nozzle and channel flow with shock waves. Method of characteristics for stationary and non-stationary channel flow.
7203. AERODYNAMICS OF POWER PLANTS. Spring term. Credit three hours. Prerequisites: 7101, 7201, Physics 15 and 16. Associate Professor Wild.

Engine-supercharger characteristics at altitude; characteristics of turbojets, ramjets, etc.; aerodynamics problems of cooling, cowling, and combustion. Principles of aerodynamic design of compressors and turbines.
7301. THEORETICAL AERODYNAMICS I. Fall term. Credit three hours. Prerequisites: 7601, 7602, Engineering Mechanics or equivalent. Professor Sears.
Introduction to theoretical hydrodynamics; the theory of ideal fluids; potential flows, conformal transformation.
7302. THEORETICAL AERODYNAMICS II. Spring term. Credit three hours. Prerequisite: 7301. Professor Sears.

Wing theory; thin-airfoil, two-dimensional airfoil theory, Prandtl wing theory, lifting surfaces, general multiplane theory, non-stationary wing theory.
7303. THEORETICAL AERODYNAMICS III. Fall term. Credit three hours. Prerequisites: Same as for 7301, plus 7201, 7202, and enrollment in 7301. Professor Sears.

The aerodynamics of compressible fluids: equations of motion, small-perturbation theory (subsonic and supersonic), Janzen-Rayleigh theory, the hodograph methods, the limiting line, the methods of characteristics, Prandtl-Meyer flow.
7304. THEORETICAL AERODYNAMICS IV. Spring term. Credit three hours. Prerequisite: 7301. Dr. Kuo.
The aerodynamics of viscous fluids, the boundary layer, heat transfer, fundamentals of boundary-layer stability; turbulence, the fundamentals of isotropic turbulence.
7401. AIRPLANE DESIGN I. Fall term. Credit two hours. Prerequisite: Enrollment in 7101 and 7403. Professors Wild and Ocvirk.
Stress analysis; the fundamentals of load determination and distribution, load factors, design conditions, critical study of existing design requirements.
7402. AIRPLANE DESIGN II. Spring term. Credit two hours. Prerequisite: 7401. Professors Wild and Ocvirk.

Stress analysis continued.
7403. AIrplane design ili. Fall term. Credit one hour. Professor Sears.

The airplane and its components; the philosophy of airplane design; orientation.
7404. AIRPLANE DESIGN IV. Spring term. Credit one hour. Prerequisite: 7403. Professor Sears.

Orientation in airplane design (continued). Aircraft materials and processes.
[7405. AERO-ELASTIC PROBLEMS. Not given in 1947-1948. Credit three hours. Prerequisites: 7101, 7102, 7601, 7602.

Flutter, divergences, and aileron reversal; control-surface vibration at high speeds.]
7503. EXPERIMENTAL METHODS IN AERONAUTICS. Fall term. Credit four hours. Associate Professors Wild and Kantrowitz.

Wind tunnels and allied techniques, flight-test methods, hot-wire anemometer, schlieren and spark photography, strain gages, vibration pickups and vibrators, other instruments and experimental techniques. Lectures and demonstrations.
[7601. MATHEMATICS IN AERONAUTICS I. Not given in 1947-1948; Substitute C.E. 224b or Phys. 405. Credit three hours.

An introduction to the mathematics used in the solution of advanced engineering problems.]
[7602. MATHEMATICS IN AERONAUTICS II. Not given in 1947-1948; Substitute Ma. 201 or Phys. 405. Credit three hours. Prerequisite: 7601. A continuation of 7601.]
7801. RESEARCH IN AERONAUTICAL ENGINEERING. (Credit hours to be arranged.) Prerequisite: Admission to the Graduate School of Aeronautical Engineering and approval of the Director.

Independent research in a field of aeronautical science. Such research must be under the guidance of a member of the staff, and must be of a scientific character.
7901. AERONAUTICAL ENGINEERING SEMINAR. Credit one hour. Prerequisite: Admission to the Graduate School of Aeronautical Engineering.

Lectures by staff members, graduate students, personnel of Cornell Aeronautical Laboratory, and visiting scientists on topics of interest in aeronautical science, especially in connection with new research.
7902. ADVANCED SEMINAR IN AERONAUTICS. Credit two hours. Prerequisites: 7301 or 1163 or approval of the Director.
Same as 7901, but devoted to topics of advanced scientific interest.

## AGRICULTURAL ENGINEERING

See above under Agriculture.

## AUTOMOTIVE ENGINEERING

Professor L. L. Otro.
Special problems related to Automotive Engineering may be selected for advanced study. Laboratory facilities of the Department of Mechanical Engineering Laboratory are available for research on internal combustion engines, or on the chassis dynamometer; and arrangements may be made for investigations on other automotive topics. Students desiring to take a minor in this field may find courses $3741,42,43$ and 44 suitable as a foundation.

3742, 3743. AUTOMOTIVE DESIGN. Professor L. L. Otro. Two lectures and two computing periods a week. Offered if conditions permit.
General study of automotive road vehicles and their functioning; driving, braking, steering, springing, power required for operation.
3742, 3744. AUTOMOTIVE DESIGN. Professor L. L. Otro. Two lectures and two computing periods a week. Offered if conditions permit.

Power plants of automotive field, particularly internal combustion types. General design and functioning, lubrication, mechanical efficiency, volumetric efficiency, valving, balancing, carburation, ignition, performance.
3750. ADVANCED AUTOMOTIVE ENGINEERING. For qualified graduate students and seniors. Professor L. L. Otro.

## CHEMICAL ENGINEERING

Professors F. H. Rhodes, M. S. Burton, P. E. Kyle, C. W. Mason, J. C. Smith, R. L. Von Berg, C. C. Winding.

To qualify for admission as a candidate for the degree of M.Chem.E., a student must hold the degree of B.Chem.E., or the equivalent thereof, and must have completed satisfactorily a course substantially equivalent to the course leading to the degree of B.Chem.E. at Cornell University.

The work for the thesis may be in the specific fields of:

## UNIT OPERATIONS <br> CHEMICAL ENGINEERING ECONOMICS CHEMICAL PLANT DESIGN <br> UNIT PROCESSES

## METALLURGY

1255. Materials of Construction. Fall term. Credit three hours. Lectures. Professor Mason. Primarily for undergraduates.
1256. Materials of Construction. Spring term. Credit three hours. Lectures. Professors Mason and Winding. Continuation of course 1255.
1257. CHEMICAL ENGINEERING THERMODYNAMICS. Fall term. Credit three hours. Prerequisite course Chemistry 405b. Assistant Professor Von Berg. For undergraduates and graduates.

Lectures. The development of the fundamental principles of thermodynamics, with special reference to their applications in chemical engineering processes.
5104. CHEMICAL ENGINEERING THERMODYNAMICS. Spring term. Credit two hours. Prerequisite course Chemical Engineering 5103. Assistant Professor Von Berg. For undergraduates and graduates. Lectures. Continuation of course 5103.
5203. Chemical Engineering Technology. Fall term. Credit two hours. Lectures. Professor Mason. Primarily for undergraduates.
5204. Chemical Engineering Technology. Spring term. Credit two hours. Lectures. Assistant Professor Von Berg. Continuation of course 5203.
5303. Unit Operations of Chemical Engineering. Fall term. Credit three hours. Lectures. Professor Rhodes. Primarily for undergraduates.
5304. Unit Operations of Chemical Engineering. Spring term. Credit three hours. Lectures. Professor Rhodes. Continuation of course 5303.
5353. Unit Operations Laboratory. Fall term. Credit three hours. Lectures and laboratory. Professor Rhodes and Assistant Professor Smith. Primarily for undergraduates.
5354. Unit Operations Laboratory. Spring term. Credit three hours. Lectures and laboratory. Professor Rhodes and Assistant Professor Smith. Continuation of course 5353.
5501. Chemical Engineering Stoichiometry. Each term. Credit two hours. Lectures. Professor Rhodes. Primarily for undergraduates.
5503. CHEMICAL ENGINEERING COMPUTATIONS. Fall term. Credit two hours. Conferences and lectures. Prerequisite course 5303. Professor Winding. For undergraduates and graduates.
Advanced problems in chemical engineering unit operations.
5504. CHEMICAL ENGINEERING COMPUTATIONS. Spring term. Credit two hours. Conferences and lectures. Prerequisite course 5304, Professor Winding. For undergraduates and graduates.

Continuation of course 5503.
5505. ADVANCED PROBLEMS IN HEAT TRANSFER. Fall term. Credit three hours. Conferences and lectures. Prerequisite courses 5503 and 5504. Professors Rhodes and Winding and Assistant Professor Smith. Primarily for graduates.
Heat transfer to fluids in streamline flow, heat transmission under unsteadystate conditions, heat transfer in mixed-flow exchangers, and other special problems in heat flow.
5506. ADVANCED PROBLEMS IN DIFFUSIONAL OPERATIONS. Spring term. Credit three hours. Conferences and lectures. Prerequisite courses 5503 and 5504. Professors Rhodes and Winding, and Assistant Professor Smith. Primarily for graduates.
Advanced and special topics in distillation, gas absorption, liquid-liquid extraction, crystallization, and drying.
5603. CHEMICAL ENGINEERING EQUIPMENT DESIGN. Fall term. Two hours credit. Lectures. Prerequisite course 5504. Assistant Professor Smith.

Details of design of chemical engineering equipment.
5604. CHEMICAL ENGINEERING EQUIPMENT DESIGN. Spring term. Two hours credit. Lectures. Prerequisite course 5504. Assistant Professors Smith and Von Berg. For undergraduates and graduates. Continuation of course 5603.
5605. CHEMICAL ENGINEERING PLANT DESIGN. Fall term. Two hours credit. Professors Rhodes and Winding and Assistant Professors Smith and Von Berg. For undergraduates and graduates.

Individual problems in the design of complete chemical plants, with estimation of costs of construction and operation.
5606. CHEMICAL ENGINEERING PLANT DESIGN. Spring term. Two hours credit. Professors Rhodes and Winding and Assistant Professors Smith and Von Berg. For undergraduates and graduates. Continuation of course 5605.
5701. PLANT INSPECTIONS. Spring term. One hour credit. Prerequisite course 5504. Professors Rhodes and Winding. For undergraduates and graduates.
Supervised inspection trips to representative chemical manufacturing plants. A critical and comprehensive report is required.
5711. Library Use and Patents. Spring term. One hour credit. Professors Rhodes and Mason. Primarily for undergraduates.
5721. Chemistry of Explosives. Fall term. Two hours credit. Lectures. Professor Rhodes. Open to officers of the U. S. Navy only.
Manufacture of primers, propellants, and high explosives.
5731. Interior Ballistics. Fall term. Two hours credit. Lectures. Professor Rhodes. Open to officers of the U. S. Navy only.
5732. Exterior Ballistics. Spring term. Two hours credit. Lectures. Professor Rhodes. Open to officers of the U. S. Navy only.
5741. PETROLEUM REFINING. Fall term. Three hours credit. Lectures, Prerequisite course 5304. Professor Winding. For undergraduates and graduates.

Processes and equipment used in refining petroleum.
5742. SYNTHETIC RESINS AND PLASTICS. Spring term. Three hours credit. Lectures. Prerequisite or parallel course 5304. Professor Winding. For undergraduates and graduates.

Polymerization reactions; manufacture and properties of synthetic resins, plastics, and rubbers.
5851. CHEMICAL MICROSCOPY. Either term. Three hours credit. Lectures and laboratory. Prerequisite or parallel course Chemistry 405 or 406 and Physics 17 or 18 or special permission. Professor Mason and assistants. For undergraduates and graduates.
The use of microscopes and their accessories in chemical and technical investigations.
5853. MICROSCOPICAL QUALITATIVE ANALYSIS (INORGANIC). Either term. Credit two or more hours. Laboratory practice. Prerequisite course Chemical Engineering 5851. Professor Mason. For undergraduates and graduates.

The analysis, by microscopical methods, of inorganic substances containing the more common elements.
5854. MICROSCOPICAL METHODS IN ORGANIC CHEMISTRY. Either term. Credit two or more hours. Laboratory practice. Prerequisite course Chemical Engineering 5851. Professor Mason. For undergraduates and graduates.

Application of microscopical methods in the examination of organic substances. 5859. ADVANCED CHEMICAL MICROSCOPY. Either term. Credit one or more hours. Laboratory practice. Prerequisite course 5851 and special permission. Professor Mason and assistants. For undergraduates and graduates.
Special methods and special applications of chemical microscopy.
6111. Metal Working. Either term. One hour credit. Laboratory. Professor Kyle and assistants. Primarily for undergraduates.
6112. Casting Processes. Either term. One hour credit. Laboratory. Professor Kyle and assistants. Primarily for undergraduates.
6113. Materials Processing. Second term. One hour credit. Laboratory. Professor Kyle and assistants. Primarily for undergraduates.
6811. INTRODUCTORY METALLOGRAPHY. Second term. Three hours credit. Lecture and laboratory periods. Prerequisite courses 1255 and 1256 or 1231 and 1232 or special permission. Professor Mason and assistants. For undergraduates and graduates.

Microstructure of alloys as related to composition, thermal history, and physical properties, and as explained in terms of general crystallographic phenomena. Preparation of specimens, and principles and use of metallographic microscopes.
6813. ADVANCED METALLOGRAPHY. Fall term. Credit three or more hours. Two lectures and one or more laboratory periods a week. Prerequisite course 6811 and permission of the instructor. Professor Mason and assistants. For undergraduates and graduates.

Heat treatment and structures of ferrous and non-ferrous alloys, or minor research problems.
6814. ADVANCED METALLOGRAPHY. Spring term. Credit three or more hours. Two lectures and one or more laboratory periods a week. Prerequisite course 6811 and permission of the instructor. Professor Mason and assistants. For undergraduates and graduates.

Heat treatment and structures of ferrous and non-ferrous alloys, or minor research problems.

## DESCRIPTIVE GEOMETRY AND DRAWING

in civil engineering
Professor H. T. Jenkins.
2052. Drawing. Sophomore. Any term. Credit two hours.
2002. Descriptive Geometry. Sophomore. Any term. Credit three hours.
2004. ADVANCED DRAWING. Credit three hours. Associate Professor Jenkins.

Perspective drawings, rendered in pencil, ink, and washes, of buildings, concrete bridges, dams, and other engineer work; building details of window frames, doors, stairs, and other simple units, to give the student some insight into detailing parts of plans, and further to familiarize him with reading working drawings.
Problems in concrete, structural, topographical, highway, and sanitary drafting:
engineering drawings, rendered in color, to enable the student to supplement ordinary working drawings with artistic representations so portrayed as to be readily intelligible to non-technical persons.

## IN MECHANICAL ENGINEERING

Professors C. E. Townsend and S. F. Cleary.
3111. Drawing and Descriptive Geometry. Any term. Credit three hours.
3112. Mechanical Drafting. Any term. Credit three hours.

TOPICS SUGGESTED FOR ADVANCED WORK
SPECIAL APPLICATIONS OF DESCRIPTIVE GEOMETRY. ECONOMIC ORGANIZATION OF GEOMETRIC STRUCTURES. DRAFTING TOOLS AND EQUIPMENT.

## ELECTRICAL ENGINEERING

Professors C. R. Burrows, W. C. Ballard, L. A. Burckmyer, Jr., R. F. Chamber. lain, M. G. Malti, T. Mclean, B. K. Northrop, E. M. Strong, J. G. Tarboux; Associate Professors W. W. Cotner, C. L. Cottrell, A. B. Credle, H. B. Hansteen, W. E. Meserve, H. G. Smith, S. W. Zimmerman;-Assistant Professors P. D. Ankrum, J. Baird, W. H. Erickson, R. E. Osborn, M. M. Peterson, S. L. Schauss, C. L. Seeger, J. H. Smith.
The School of Electrical Engineering has the following laboratories suitable for graduate work:
Advanced Electrical Machinery Laboratory
Electrical Measurements and Standardization Laboratory
Basic Electronics Laborafory
Radio and Communications Laboratory
Industrial Electronics Laboratory
Electronics Apparatus and Project Laboratory
Servomechanisms Laboratory
High-Vacuum and Tube-Construction Laboratory
High-Voltage Testing and Development Laboratory
Special equipment for experimental research is provided through a fully equipped and manned machine shop.
Graduate Courses and Topics: In addition to the formal courses listed below, members of the faculty are prepared to guide individual students in special topics. Seminars are conducted by members of the faculty for groups of graduate students interested in closely related lines of study and research.

## RADIO AND COMMUNICATIONS

## 4121. Electron Tubes and Circuits. Three hours.

4126. Electronics Laboratory. Two hours.

## 4122. Electronic Circuit Elements. Four hours.

4131. Basic Communications Systems. Two hours.
4132. RADIO AND COMMUNICATION THEORY. Three hours. Associate Professor Credle. Two lectures and one recitation or computing period each week. Prerequisite, 4112 and 4122.
Intensive studies of the various components of radio receivers, broadcast studios, and broadcast transmitters constitute the course. The topics studied are: amplifiers with compensation, feed-back, and of class C; double-tuned transformer circuits; oscillators; modulation and detection; frequency modulation; microphones; and loud speakers.
4133. RADIO AND COMMUNICATION THEORY. Three hours. Professor
McLean. Two lectures and one recitation or computing period each week. Must be preceded or accompanied by 4511 .

This course is a study of communication circuits with distributed constants and also a study of production and propagation of electro-magnetic radiation.

The topics included are: transmission line theory and applications; impedance matching; ultra-high-frequency generation; introduction to vector analysis and electromagnetic theory; propagation phenomena; and antenna characteristics and radiation.
4513. COMMUNICATION NETWORKS. Three hours. Professor McLean. Three recitations each week. Must be preceded or accompanied by 4511.
4516. RADIO AND COMMUNICATION LABORATORY. Three hours. Associate Professor Credle. One recitation and one lecture-laboratory or computing period each week. Must be preceded or accompanied by 4511.
This course consists of a series of experiments closely paralleling the work of the accompanying course.
4517. RADIO AND COMMUNICATION LABORATORY. Three hours. Professor Mclean. One recitation and one lecture-laboratory or computing period each week. Must be preceded by or accompanied by 4512.
A series of experiments for this course has been selected following the outline of theoretical material in 4511 and 4512. The experiments are detailed studies of the characteristics of selected pieces of communication equipment, or experimental studies of measurement methods.
After a review of fundamental principles dealing with linear networks, a study is made of two-terminal networks, reciprocal structures, ideal reactance structures, and balancing networks. A generalized analysis of the four-terminal transmission network is made. There is an introductory study of filter characteristics and design, and of amplitude- and delay equalizers. The course includes: general equivalence theorems; analogies between lumped networks and smooth lines; continuous and concentrated loading of lines; use of line segments as network elements.
4521. RADIO BROADCASTING. Three hours. Associate Professor H. G. Smith. Two lectures and one lecture-laboratory or computing period each week. Prerequisite, 4511. Must be preceded or accompanied by 4512.

The course deals with the engineering aspects of radio broadcasting, including the following topics: studio equipment, and problems of studio operation; transmitting equipment, and problems of operation; determination of coverage; station
interference, allocation of channels, and use of directional radiating systems; performance tests and maintenance procedures; network interconnections; purpose and policy of governmental regulating bodies.
The alternate laboratory and computing periods offer an opportunity to gain practical knowledge through the facilities of the University broadcasting station and through inspection of other near-by stations.
452, TELEPHONE AND TELEGRAPH SYSTEMS. Two hours. Professor ballard. Two recitations each week. Prerequisite, 4131.
This course continues in greater detail the study begun in the prerequisite course. The methods of machine switching in telephone systems are studied. Consideration is given to the relative advantages of the several systems, and to the proper choice of system as influenced by the size of the community. Carrier telephony in both cable and open-wire circuits is given some attention.
Modern telegraphic methods, such as multiplex printing and facsimile transmission are studied.
Inspection trips to nearby telephone and telegraph exchanges will be arranged.
4526. DESIGN AND CONSTRUCTION OF VACUUM TUBES. Three hours. Professor Ballard. Two lecture-recitations, and one laboratory period each week. Prerequisite, 4511.
The purpose of this course is two-fold; first, to acquaint the student with methods by which an electron tube may be designed and its performance predicted, and second, to give a practical insight into the methods and problems of electron tube manufacture.
The conformal transformation of the electric field in certain simple tubes and its aid in the determination of tube parameters, effects of auxiliary grids, focusing structures, equivalent diode and other related topics will be considered in some detail. In connection with the consideration of gas and vapor tubes the fundamental principles of the conduction of electricity through gases with particular stress upon their application to practical tube design and construction will be reviewed.

The laboratory exercises will be devoted to the actual construction of several forms of simple tubes of both high vacuum and vapor types, in which the student will assemble the elements, complete the necessary glass working and evacuation, and check the performance with that predicted.
4531. Television Systems. Three hours. Associate Professor Credle. Two recitations and one computing period each week.
The objectives of the course are to demonstrate the application of physical principles in the field of television engineering, and to acquaint the student with modern practice in the design and operation of television studios, transmitters, and receivers.
Basic work in optics, illumination, cathode-ray tubes, vacuum-tube amplifiers, pulse shaping, modulation, and antenna characteristics, serves as a background for further study of television problems. In addition, such problems as scanning, synchronization, blanking, and shading are considered.

Computations involving the design of various units required for transmission and reception are carried out in the computing periods. An inspection of nearby television facilities serves to emphasize practical aspects.
4541. APPLIED ACOUSTICS. Two hours. Professor McLean. One recitation and one lecture-laboratory period each week.

A review of the laws of ideal gases, the thermo-dynamic properties of air, and the laws of the propagation of compressional waves precedes a study of the transmission of sound through tubes, horns, and unbounded media. The design of sound sources, microphones, loudspeakers, and disc recorders in keeping with acoustical principles is considered. The phenomena of reflection, absorption, and reverberation, and the limitations which these phenomena impose upon architectural design, are studied. There are laboratory experiments on absolute-pressure calibration and free-field directivity characteristics of microphones and loudspeakers, the measurement of reverberation time, and the measurement of reflection coefficients and absorption coefficients of typical materials for acoustic treatment.

## 4551. RADIO AIDS TO NAVIGATION. Two hours. Professor McLean. Two recitations each week. Prerequisite, 4131.

Analysis of the principles of directive antennas is followed by discussion of long-wave and medium-wave direction finders and radio beacons. Atmospheric effects and limitations on the accuracy of determinations made by such equipment is considered. Attention is also given to medium-frequency pulsed transittime systems and to high-frequency return-signal systems.
4561. ULTRA-HIGH FREQUENCY SYSTEMS. Two hours. Professor Ballard. One recitation and one laboratory period each week. Prerequisite, 4565 or the equivalent.
This course consists of a theoretical and laboratory study of electrical equipment particularly applicable to ultra-high frequency operation, such as magnetrons, klystrons, and other similar generators, measuring devices, transmission systems, wave guides, coaxial lines, radiators, cavity resonators, etc.
4565. ELECTROMAGNETIC WAVES. Three hours. Professors Burrows and Ballard. Three lecture-recitations each week. Prerequisites, 4512 and 4517 or their equivalent.

This course is a study of the fundamental Maxwell's Equations and their application in electrical engineering problems. The topics considered include: wave propagation in free space, reflection, refraction and guided propagation in wave guides, cavity resonators, horns, and other radiators.
4566. ELECTROMAGNETIC WAVES. Three hours. Professor Burrows. Three lecture-recitations each week. Prerequisite, 4565 or the equivalent.
This course is a continuation of course 4565 . It includes a study of radio wave propagation over considerable distances, radiation from double antennas, power transfer between antennas, propagation over plane and spherical earth, ionosphere reflection, guide propagation in atmospheric ducts, and kindred topics.

## POWER UTILIZATION

[^14]4321. electrical machine theory. Two hours. Professor Tarboux. Two recitations each week. Prerequisite, 4221.

This course extends the analysis of certain subjects of the prerequisite course. Among its topics are: analysis of magnetomotive force and of air-gap flux in synchronous and in induction machines for harmonics in time and in space; effects of such harmonics on induced voltage and on torque; two-reaction analysis of salient-pole synchronous machines; analyses of single-phase induction motors and commutator alternating-current motors.
4326. POWER LABORATORY. Two hours. Professor Burckmyer. One lecture and lecture-laboratory period each week. Prerequisites, 4226 and 4311.
This course continues the study of basic principles of alternating-current magnetization, and the exemplification of these principles under the favorable conditions provided by selected transformers. Salient-pole synchronous-machine principles are examined from the standpoint of the two-reaction theory. The reactances are measured by several methods and the theory is applied to the analysis of torque-angle relations, steady-state stability, and the voltage regulation of generators. The measurement and the significance of the transient reactances are briefly studied. The special combinations of conditions that arise in commutating alternating-current motors are analyzed for a selected machine. The course includes circuit studies applied to selected alternating-current bridges and to symmetrical-component analysis of faults on transmission lines.
4331. ELECTRICAL DESIGN ECONOMICS. Three hours. Professor Burckmyer. Two recitations and one computing period each week. Prerequisites, 4211 and 4221.

The object of the course is to acquaint the student with technical and economic problems encountered in the design of resistors, electro-magnets, cables, condensers and condenser bushings, transformers, and rotating electrical machines.
4341. MOTOR CONTROL. Two hours. Associate Professor Meserve. One lecture and one recitation each week. Prerequisites, 4211, 4216, 4221, and 4226.

The course is a study of the design and the functioning of typical controllers and protective devices for direct-current and for alternating-current motors. Among the topics are: problems of manual and automatic acceleration, dynamic braking, power regeneration, plugging, and voltage control for direct-current motors, design of resistors and magnetic contactors; interpretation of controller diagrams.
4342. APPLICATION OF MOTORS. Three hours. Associate Professor Meserve. One lecture, one recitation, and one computing period each week. Prerequisites, 4326 and 4341.

Characteristics of motors and requirements of typical loads are analyzed and correlated so that the motor selected for the load is of the proper type and rating. The course includes a study of motor duty cycles, adjustable-speed alter-nating-current drives, coordinated-drive systems, and "synchro" systems.

Inspection trips may replace several of the computing periods.
4343. AIRCRAFT AND MARINE ELECTRIC POWER AND CONTROL systems. Two hours. Associate Professor Meserve. Two recitations each week. Prerequisites, 4321 and 4341.

Modern developments in aircraft electric systems are studied, with attention given to meeting the special requirements imposed by rapid and extreme changes
in temperature, pressure, and humidity. Selected topics include: relative advantages of alternating-current and direct-current systems; selection of voltage and of frequency; methods of driving generators; reliability of operation; saving of weight.
After outlining the problems and principles of ship propulsion, a study is made of the relative advantages of available main drives, the design of power-distribution systems, and the selection of motors and control equipment.
4351. LOW-FREQUENCY HEATING AND INDUSTRIAL DISTRIBUTION systems. Three hours. Associate Professor Meserve. Two lectures and one computing period each week. Must be preceded or accompanied by 4311.

The first part of this course deals with the construction, characteristics, and application of all varieties of electric heating apparatus commonly employed in industry except those based on high-frequency dielectric heating. Principal emphasis is given to arc furnaces and to low-frequency induction furnaces.

The remainder of the course is devoted to current practice and to the apparatus employed in the design of electric-power distribution systems in industrial plants.

## POWER GENERATION AND DISTRIBUTION

## 4121. Electron Tubes and Circuits. Three hours.

4122. Electronic Circuit Elements. Four hours.
4123. Electronics Laboratory. Two hours.
4124. Direct Current Machinery. Three hours.
4125. Electrical Machinery Laboratory. Four hours.
4126. Alternating Current Machinery. Three hours.
4127. Electrical Machinery Laboratory. Four hours.
4128. ADVANCED CIRCUIT ANALYSIS. Three hours. Professor Malti.

Two lectures and one computing period each week. Prerequisite courses. Alternating-Current Machinery, 4221; Differential Equations, Math. 200.
This course treats of typical circuits by which electric energy is transmitted. The physical meaning of the parameters which are used in describing transmission circuits is considered. A review of single-energy transients precedes a detailed analysis of double-energy transients. Ladder networks are viewed as approximate equivalents of circuits having distributed parameters. The behavior of polyphase circuits on which there are faults or unbalanced loads is analyzed by the method of symmetrical components.
4321. MAChine theory. Two hours. Professors Tarboux and Meserve.
4326. POWER LABORATORY. Two hours. Professor Burckmyer.
4361. POWER SYSTEMS. Three hours. Professor Tarboux. Two recitations and one computing period each week. Prerequisite, 4221.
The function and the form of the electrical apparatus included in modern power systems are studied. Among the power-system components considered are generators, switchgear, protective devices, power transformers,, converters, trans-mission-line towers and conductors, and voltage-regulating devices.
Inspection trips to near-by power stations are planned to supplement classroom discussions.
4334. ECONOMICS OF PUBLIC UTILITIES. Three hours. Professor Tarboux. Prerequisite, a course in Economics.

The course is a study of the following topics: the development of public utilities and governmental regulatory bodies; principles of capitalization and depreciation of utility property; the capital structure of power companies; analysis of costs, and principles of rate-making; long-term trends of size of plant, efficiency, costs, and rates; the relation of the industry to other segments of the economic system.
4362. TRANSMISSION OF ELECTRIC ENERGY. Three hours. Professor Tarboux.

Two recitations and one computing period each week. Prerequisite courses, 4311 and 4361.
The performance of transmission lines is analyzed through the following sequence of topics: evaluation of transmission-line parameters from the physical dimensions of the circuit; expressions for voltage and for current at sending and at receiving ends; classification of lines as short, moderately long, and long; equivalent $\pi$ and T networks; development of circle diagrams to facilitate calculations of performance.
4363. STABILITY OF ELECTRIC POWER SYSTEMS. Two hours. Professor Tarboux. Two lectures each week. Must be preceded or accompanied by 4371.

The conditions of stability of synchronous machines and of electric power systems under both steady and transient loads are investigated by mathematical analysis.
4364. PROTECTION AND RELAYING ON POWER CIRCUITS. Two hours. Professor Tarboux. Two lectures each week. Must be preceded or accompanied by 4371 .

The principles of the operation of typical relays and of the application of relaying systems are considered. The course includes a study of telemetering and supervisory-control equipment.
4365. SYMMETRICAL COMPONENTS. Three hours. Professor Tarboux. Three lectures and three recitation periods each week. Prerequisites, 4311, 4321, and 4361.

Review of the fundamental concept followed by its application to three, four, and two phase systems. Application to transmission lines, with a study of line impedance, mutual impedance, and capacitance. Application to two and three winding transformers. The three phase and single phase induction motor and other unsymmetrical motor windings. The synchonous machine and power networks.

## 4371. High voltage phenomena. Three hours. Associate Professor Zimmerman.

Two lectures and one laboratory period each week. Prerequisite course, 4362.
The course is a study of the problems encountered in the normal operation of electric-power systems at very high voltages, of the abnormal conditions imposed by lightning, of the methods employed to assure proper operation of power systems and apparatus under high-voltage conditions, and of the devices available for laboratory testing of equipment under actual or simulated conditions.

A considerable portion of the laboratory work is done in the High-Voltage Research Laboratory, located in East Ithaca.

## INDUSTRIAL ELECTRONICS

## 4112. Alternating Current Circuits. Four hours.

4121. Electron Tubes and Circuits. Three hours.
4122. Electronic Circuit Elements. Four hours.
4123. Electronics Laboratory. Two hours.
4124. Direct Current Machinery. Four hours.
4125. Alternating Current Machinery. Three hours.
4126. Electrical Machinery Laboratory. Four hours.
4127. ADVANCED CIRCUIT ANALYSIS. Three hours. Professor Malti.
4128. MACHINE THEORY. Two hours. Professor Tarboux.
4129. POWER LABORATORY. Two hours. Professor Burckmyer.
4130. ELECTRONIC CONTROL EQUIPMENT. Three hours. Professor Northrop.

Two lectures and one laboratory period each week. Prerequisite course, 4122.
The course deals with the principles of electronic instrumentation and electronic control systems. A study is made of the methods of interpreting electronically a stimulus appearing in the form of heat, light, sound, or mechanical movement; and of typical electronic circuits through which such electrical effect causes the controlled device to make the desired response.

Among the subjects of laboratory experiments are timing circuits, welder controls, motor controls, voltage regulators, frequency-varying circuits, and frequencydiscriminating circuits.
4341. MOTOR CONTROL. Two hours. Associate Professor Meserve.
4415. ELECTRONIC CONTROLS. Three hours. Professor Northrop.

Two recitations and one computing period each week. Prerequisite course, 4421.

This course is an intensive study of the theory and the operating characteristics of electronic circuits and equipment used to control and regulate welders, motors, generators, and other machines. These circuits are generalized, compared, and analyzed rigorously. Methods of precise control of time intervals, voltage, current, and frequency are included.
4421. ELECTRONIC POWER CONVERTERS. Three hours. Professor NorthROP.

Two lectures and one laboratory period each week. Prerequisite course, 4411.
This course continues the study of the characteristics and the applications of some of the electronic power-converting devices that were considered in introductory courses; such as power amplifiers, oscillators, single-phase and polyphase rectifiers, X-ray equipment, and welders. Laboratory work includes inspection and testing of typical equipment, with an analysis of performance.

## 4422. ELECTRONIC INVERTERS. Three hours. Professor Northror.

Two lectures and one computing period each week. Prerequisite course, 4421.
After a survey of electronic inverter circuits of series and of parallel types, the course proceeds to the problems of inversion from high direct voltage to
alternating voltage; combined conversion changing 60 -cycle alternating voltage to alternating voltage of higher frequency; and feed-back inversion. The operation of the parallel inverter is analyzed mathematically. Theoretical and laboratory studies are analyzed and coordinated to determine the effects of loads, supply voltage, and circuit components upon wave form, frequency, and output voltage.
4451. HIGH FREQUENCY HEATING. Three hours. Professor Northrop.

Two lectures and one laboratory period each week, Prerequisite course, 4421.
The course develops the theory of high-frequency heating of dielectrics of high and of low power factor; and of induction heating, with some consideration of unusual coil forms required for surface heating or other special applications. A study is made of the operation and the adjustment of oscillators of the types usual for these purposes.

## ILLUMINATION

## 4611. Introductory Illumination. Four hours. Professor Strong.

Two recitations, one laboratory period, and one computing period each week. Prerequisite course, Elementary Optics, such as Physics 18.
The course is intended to acquaint the student with the general nature of the field of illuminating engineering. Introductory study in several basic aspects of the subject is sufficiently pursued to provide an appreciation of the problems commonly encountered and of the methods of solution.

The following topics are considered: sources of light; visual perception and illusion; light control, both spectral and directional; the units and the measurement of the strength of light sources and of the intensity of illumination; general illumination design; perception, production, and mixing of colors; shadows, desirable and undesirable; architectural objectives.
4612. ILLUMINATING ENGINEERING. Three hours. Professor Strong.

Two recitations and one laboratory period each week. Prerequisite course, 4611.

This course extends the study of some of the topics introduced in the prerequisite course. Study of current literature supplements the text. Computation of light-flux distribution and study of more difficult lighting problems are pursued. Emphasis is placed on industrial lighting problems more specialized than the problems of general lighting.
4615. ILLUMination Seminar. Two hours. Professor Strong.

One two-hour period each week. Prerequisite course, 4611.
Reports on selected topics of current interest in illuminating engineering are presented and discussed.
Physics 135. OPTICS. Three hours. Professor Collins.
Three lecture-recitations each week. Prerequisite course, Elementary Physics.
The course includes the following topics: Geometrical optics, lens systems, Gauss points, aberrations, stops, photometry of optical systems; interference, applications of various forms of interferometers; diffraction, Fresnel and Fraunhofer diffraction patterns; polarized light; reflection and transmission at optical boundaries; emission and absorption spectra; color temperatures.

Psychology 1la. PHYSIOLOGICAL PSYCHOLOGY OF VISION. Three hours. Professor Dallenbach.

Two recitations and one laboratory period each week. Prerequisite courses, Elementary Psychology and General Physics.

The course is a study of the total process of visual perception. Among the topics are: structure and functioning of the eye; sensitiveness of the eye to light of various wave lengths; effects of spatial and temporal patterning; (contrast and adaptation); color mixture; discrimination of color and of brightness; theories of color vision; space perception; problems of visual fatigue; psychological studies of reading.
Public Speaking 45a. DRAMATIC PRODUCTION; STAGE LIGHTING, Two hours. Professor Stainton.

One laboratory period each week.
The course is a laboratory study of the problems encountered in lighting dramatic productions, and of the principles applied to the solution of such problems. (The course is suggested for its applicability to problems of show-window and display lighting.)

## ELECTRIC CIRCUIT ANALYSIS

## 4311. ADVANCED CIRCUIT ANALYSIS. Three hours. Professor Malti.

4035. OPERATIONAL ANALYSIS. Three hours. Professor Malti.

Two recitations and one computing period each week. Prerequisite course, Advanced Circuit Theory, 4311.

Among the topics of the course are: functions of real and of complex variables; infinite series; integral equations; Laplace and Fourier transforms; generalized expansion theorems for differential equations and difference equations. The course concludes with analyses of ladder networks and of transients in circuits with lumped and with distributed parameters.
SEMINAR IN CIRCUIT ANALYSIS. Throughout the year. One period of two hours each week. Prerequisites, a general knowledge of Circuit Analysis and of the principles of electric machines. Professor Malti.

This seminar reviews the developments in the fields of circuit analysis and electrical machinery and provides opportunity to discuss the research work of graduate students in these fields.

## ELECTRICAL MEASUREMENTS

4326. Power Laboratory. Two hours. Professor Burckmyer.

GRADUATE TOPICS. Design of special types of meters and the characteristics of the exponential response meter, development of methods of measurement, characteristics of measuring instruments.

## HIGH VOLTAGE TECHNIQUE

4371. High Voltage Phenomena. Three hours. Associate Professor Zimmerman.
4372. High Voltage Practice. Credit to be assigned. Associate Professor Zimmerman.

Insulation tests of apparatus and insulators. Low frequency and impulse tests, wet and dry. Corona measurements. Radio interference.

The new high voltage laboratory has unexcelled facilities for research in the field of high voltage phenomena. Individual graduate students may be assigned special problems by the professor in charge.
GRADUATE TOPICS. Behavior of insulating materials under electrical stress. Dielectric strength of solid, liquid, and gaseous insulating materials. Partial and complete breakdown and corona. Lightning studies with models.

## MATERIALS OF ELECTRICAL ENGINEERING

4037. Solid Dielectrics. Professor Malti. Prerequisite, 4311.

A study of anomalous behavior of solid dielectrics under varying conditions of e.m.f., time, frequency, temperature, pressure, humidity, and ionizing radiation.
4381. Research in Magnetic Materials. Professor Burckmyer. Prerequisite, 4311 and 4326. Credit three or more hours.
A study of the properties of magnetic materials; the relation between crystal structure, cold working, heat treatment, and magnetic properties.
4386. electrical testing. Professor Burckmyer. Prerequisites, 4311 and 4326. Credit two hours or more.

The testing of engineering materials for determining their magnetic and electrical properties.
4711. SERVOMECHANISMS AND AUTOMATIC CONTROL SYSTEMS. Associate Professor Meserve. Three hours. Two lecture-recitations and one laboratory or computing period each week. Must be preceded or accompanied by 4311, 4321, and 4326.
The basic principles of servomechanisms and of the application of those principles in typical devices. A study of elementary forms of electrical, hydraulic, and electro-hydraulic servo-control systems of both the open-cycle and the closedcycle type; differential devices, discontinuous and continuous controls, and followup links. Attention is given to the factors influencing error, damping, and speed of response.
The subject of the transfer function or frequency analysis of servomechanisms is introduced. The systematic procedure followed in the design of practical servomechanisms is demonstrated.
4712. ADVANCED SERVOMECHANISMS. Associate Professor Meserve. Three hours. Two lecture-recitations and one laboratory or computing period each week. Prerequisite course, 4711.
This course is a continuation of Course 4711. Servomechanism theory is approached from an advanced analytical point of view which includes the use of transfer functions. Error-rate stabilization networks and forms of integral control are considered. The design of several automatic control systems is investigated quantitatively, and quantitative performance tests of typical systems are made in the laboratory.

## EXPERIMENTAL MECHANICAL ENGINEERING

Professors C. O. Magey, V. R. Gage; Associate Professors W. C. Andrae, F. S. Erdman, H. N. Fairchild, D. Dropkin, and L. L. Otto.

The laboratories and the shops of the Department of Mechanical Engineering Laboratory are available for carrying on the many activities of Experimental Mechanical Engineering.
Students contemplating experimental research in mechanical engineering should communicate with the department as far as possible in advance of beginning work in order to arrange for the use of available equipment.
3640. Introductory Mechanical Laboratory. Each term. Two laboratory periods a week and a written report on the work.
3642. Mechanical Laboratory. Each term. One laboratory period and one lecture period a week and a written report on the work.
3651. EXPERIMENTAL ENGINEERING. Each term. Credit depends upon hours of actual work. Recitation and laboratory instruction will be given to a limited number of students to supplement other courses in the field of internal combustion engines, heat transfer, refrigeration, air conditioning, power plants, and engineering instruments.
-3653. TEMPERATURE MEASURING INSTRUMENTS. Two recitations a week.
3654. DIMENSIONAL ANALYSIS. One recitation a week.
3655. AIR CONDITIONING. Two recitations and one laboratory period a week. Advanced study of air conditioning problems and air conditioning apparatus.
3660. AIRCRAFT POWER PLANTS. Each term. Three lectures a week. Operating principles and operating characteristics of reciprocating and rotating types of aircraft power plants.
3661. AIRCRAFT ENGINE DESIGN. Each term. Lectures and design periods. Detailed study of engine design principles.
3741. AUTOMOTIVE ENGINEERING. Three lectures a week.

TOPICS SUGGESTED FOR ADVANCED WORK
AIR CONDITIONING
COMPRESSORS AND PUMPS
FLOW OF FLUIDS
HEAT TRANSFER
INSTRUMENTS
INTERNAL COMBUSTION ENGINES
REFRIGERATION
STEAM ENGINEERING

## HEAT-POWER ENGINEERING

Professors F. O. Ellenwood; Associate Professors W. H. Нook, B. J. Conta, and R. E. Clark; Assistant Professor J. R. Gay.

In each of the many branches of this very extensive field are innumerable opportunities for making advanced studies of interest and value. This advanced
work includes such studies as original investigations in engineering thermodynamics; interpretative studies of available data and other material; investigations in power plant economics; the design, selection, and arrangement of apparatus, and plant layout, to meet specific requirements; analytical and experimental research; to mention but a few of the possibilities. The department and college libraries are liberally provided with reference books, periodicals, transactions of engineering societies, reports, and other material related to this field.

As prerequisite for this graduate work the student should have had the equivalent of the fundamental courses in heat-power engineering that are required of undergraduates in mechanical engineering at Cornell. These courses are described in the Announcement of the College of Engineering. Those lacking the full equivalent of this training may be required to take one or more of these undergraduate courses or to do specially assigned work to make up the deficiency.

The following courses, which are described in the Announcement of the College of Engineering, are open to both undergraduate and graduate students:

3535, 3536. Heat-Power Engineering. Three hours a week. Messrs. Ellenwood, Hook, Clark, Conta, Gay, and Watt.
3543. Heat-Power Engineering. Three hours a week. Two lectures and one laboratory period a week. Mr. Watt.
[3544, 3545. STEAM AND OIL-ENGINE PLANTS. Two hours a week. Prerequisites, $3331,3332,3333,3535,3536$ and must be accompanied or preceded by 3581 and 3582. Assistant Professor Wright. (Temporarily discontinued.)]

Performance characteristics and design features of steam and internal-combustion prime movers, steam generators, condensers, feedwater heaters, evaporators, deaerators, oil engines, pumps, fans, and cooling towers; power-plant piping; automatic control; power plant instruments, fuel-burning equipment; coal-and-ash-handling equipment.
[3546, 3547. POWER PLANT COMPUTING AND DESIGN. Must be accompanied by 3544 and 3545 . Two computing periods a week. (Temporarily discontinued.)]
[3548. HEATING, VENTILATING, AIR CONDITIONING. Credit three hours. Prerequisite, Course 3556. Mr. Mackey. (Temporarily discontinued.)]

Principles and practice in the conditioning of air, including cooling, heating, dehumidifying, humidifying, and ventilating.
[3550. POWER PLANT ECONOMICS; EQUIPMENT SELECTION. Two hours a week. Prerequisite, 3535 or 3536 . (Temporarily discontinued.)]

Costs of equipment and plants; energy costs; load curves, station factors; determining characteristics of equipment; selection of best working pressures, temperatures, and cycles; economic number and size of units. Selection of equipment based on these and other determining considerations. Economic operation. Applications to central stations and to industrial power and heating plants. By-product power. Other similar topics.

[^15][3557, 3558. HEAT ENGINEERING. Prerequisite, 3536. Must be accompanied or preceded by 3582. Mr. Mackey. Two lectures and two computation periods a week. Not given in 1947-1948.]

Properties of mixtures, dimensional analysis, fluid flow, heat transmission, selection of fans and pumps and refrigeration; applications to problems in air conditioning.
3563. ADVANCED THERMODYNAMICS. Two recitations a week. Prerequisites, 3535 and 3536 . Mr. Conta,

The Carnot Principle; temperature scales; entropy; the state properties of a substance; their experimental determination and correlation; equations of state; kinetic theory of gases; mixture of ideal gases; special topics in mathematics will be considered as needed.
3570. ADVANCED HEAT-POWER ENGINEERING RESEARCH. Each term. Work and credit as arranged. Mr. Ellenwood and others of the department.

Advanced analytical and experimental investigations in this field.
Note. The following group offerings for seniors may be used as minors by graduate students:
3581. INTERNAL-COMBUSTION ENGINES. Each term. Credit three hours. Prerequisites, 3535 and 3536 or their equivalent. Messrs. Conta and Gay.

The principles of operation of spark and compression-ignition, internalcombustion engines and their auxiliaries; petroleum fuels and their properties; combustion; detonation and octane rating; engine cooling, rating, and performance; supercharging of aircraft and compression- ignition engines; gas turbine cycles.
3582. STEAM-POWER PLANTS. Each term. Credit three hours. Prerequisites, 3535,3536 or their equivalent. Messrs. Ellenwood, Clark, and Conta.

A review of the thermodynamics of vapor is followed by a further study of combustion and combustion-control equipment, draft apparatus; boilers, condensers, evaporators, feedwater heaters, feed pumps, economizers, and air preheaters; turbines, and plant auxiliaries; performance and cost of steam engines, turbines, and plants.
3588. REFRIGERATION AND AIR CONDITIONING. Repeated each term. Credit three hours. Prerequisites, 3535,3536 or their equivalent. Three periods a week. Messrs. Mackey and Feitner.

The general principles of refrigeration with particular emphasis on the equipment; principles and practice in the conditioning of air, including cooling, heating, dehumidifying, and ventilating; application of refrigeration in cold storage.
3590. GAS-TURBINE PLANTS. Elective for graduate students and seniors in Mechanical Engineering. Second term. Two recitations a week. A fundamental study of the various cycles and apparatus involved in the modern gas-turbine plant. Performances and suitability of this type of power plant for various applications. Mr. Ellenwood.

TOPICS SUGGESTED FOR ADVANCED WORK

ADVANCED ENGINEERING THERMODYNAMICS<br>STEAM ENGINEERING

INTERNAL COMBUSTION ENGINEERING<br>ECONOMIC STUDIES<br>HEAT TRANSMISSION<br>FUELS, COMBUSTION, BURNERS, FURNACES<br>FLOW OF FLUIDS THROUGH CLOSED CONDUITS; POWER PLANT PIPING<br>REFRIGERATION<br>COMPRESSORS AND PNEUMATIC MACHINERY<br>AIR CONDITIONING<br>POWER AND HEATING PROJECTS

# HIGHWAY ENGINEERING 

Professors W. L. Malcolm, Associate Professor D. J. Belcher, Assistant Professor T. D. Lewis.

The laboratories for the examination of non-bituminous and bituminous materials and their utilization, soils, subgrade stabilization problems, etc., are located in the School of Civil Engineering. The other laboratories of the School of Civil Engineering, equipped for examining the properties of engineering materials, and the Ceramic Laboratory of the Department of Geology are also available for graduate work in Highway Engineering.

In addition to the scheduled courses for the graduate student, there is much graduate work of an independent character which requires investigation by the student ảnd frequent conferences with staff members. Occasional field trips are also made.

Note: For courses in design of highway structures such as large bridges, see Structural Engineering.
2610. Highway Engineering. Either term. Credit three hours.
2618. LOW COST ROADS. Either term. Credit three hours. Prerequisite, 2610 or its equivalent.

Study of economic importance of routes and selection of farm to market roads to be improved; location and design; subgrade soils and stabilization of subgrade soils by use of admixtures, chemicals, and bituminous materials; drainage and drainage structures; bituminous treatments and bituminous mats for stabilized subgrades. Survey of the experimental work in the use of materials and design and construction of low cost roads. Design, construction, and maintenance of road mixes, plant mixes, etc.
2612. HIHWAY LABORATORY. Either term. Credit three hours. Prerequisite, 265 or its equivalent; may be taken concurrently with course 2610.

Non-bituminous and bituminous materials are tested. Subgrade soils are sampled and their properties examined; subgrade stabilization admixtures are also tested and studied. Bituminous mixtures are designed and their properties examined.
2613. ADVANCED HIGHWAY LABORATORY. Credit three hours. Prerequisites, 2610 and 2612 . Two laboratory periods a week.

Non-bituminous and bituminous materials are tested and their characteristics studied. Soils are sampled and examined, and investigations made of the behavior of mixtures of soils with bituminous and non-bituminous materials. Special investigations and tests are made to determine the properties of various combinations of materials and the effects of modifications in design.
2614. ADVANCED HIGHWAY ENGINEERING. Credit three hours. Prerequi site, 2610 or its equivalent. This course is conducted as a seminar. Meetings are held once each week at hours to be arranged.
The topics for assignment and discussion include the economics of highway engineering, highway finance, legislation, regulation, traffic, design, construction, and maintenance of highways, the latest research programs and reports, labor and plant organization for various kinds of highway contracts with special emphasis on the economics of contracting, etc.
2615. MODERN HIGHWAY PLANNING AND DESIGN. Credit three hours. Prerequisite, 2610 or its equivalent. Professor Clarke.
Study of geographical, political, and economic divisions of communities with particular reference to highway transportation requirements; analysis of regional plans chiefly concerning the classification of roads and the selection of routes to be abandoned or improved, based upon their economic justification. Design of regional systems of highways, freeways, and parkways, including the consideration of the economic, safety, and aesthetic aspects. Traffic studies, legislation, financing, and zoning. Design of intersections and grade separations. Problems and reports required.
2616. CITY STREETS. Elective. Seniors and graduate students. Credit two hours. Prerequisite 2610. The location and design of streets in cities and villages. One recitation and one long period a week. Professor Malcolm.
2617. AIRPORTS. Elective. Seniors and graduate students. Credit three hours. Prerequisite, 2610 and 2725 . The location, design, construction, and maintenance of airports. Two recitations and one computing period a week. Mr. Malcolm.
2619. BITUMINOUS PAVEMENTS. Elective. Credit three hours. Prerequisite, 2610 and 2612. Part I: Properties of tars; base and liquid asphalts. Weathering and stripping of bituminous films; adhesion. Special uses and applications of individual materials. Part II: Theory and practice in design based on surface area, density, and loading and subgrade conditions. Part III: Design of surface treatment mixes, patches, sheet asphalt, bituminous concrete. Rock asphalt. Control and construction. Bituminous undersealing and maintenance.
2620. TRAFFIC ENGINEERING. Elective. Credit three hours. Prerequisite, 2610. City and highway traffic surveys. Traffic control and routing. Signs and markings. Regulation; truck and bus units as traffic elements. Driver reactions and habit patterns; design of safety features and effectiveness of signs. Also air traffic for those specializing in airports. Three recitations a week.
2621. ENGINEERING INTERPRETATION OF AERIAL PHOTOGRAPHS. Elective. Credit three hours. A study of the soil and rock areas of the United States and the patterns that they present in aerial photographs. Fundamental elements of soil patterns are analyzed to permit determination of soil texture, type of bedrock, and drainage properties. Special emphasis is placed on the interpretation of engineering information dealing with construction, excavation, clearing, water supply, drainage requirements, and foundation problems. Two recitations and one computing period a week. Associate Professor Belcher.
2622. ADVANCED ENGINEERING INTERPRETATION OF AERIAL PHO.

TOGRAPHS. Elective. Credit three hours. Prerequisite, 2621. Engineering interpretation of aerial photographs with special emphasis on engineering construction problems in frozen ground (arctic), the analysis, mapping, and estimating of tropical areas, and the special problems associated with arid regions. Particular emphasis is placed on the significance of vegetation in these three special climatic areas. Two recitations and one drawing room period a week. Associate Professor Belcher.

2641 (b) HIGHWAY ENGINEERING DESIGN. Credit three or more hours. Prerequisites, 2610, 2702, and 2715 . Conferences to be arranged.
The problems are those encountered in the selection, location, design, and construction of highways. They include the following: economic selection of routes, economic location, design of highways, highway intersections, culverts, highway bridges, retaining walls, and other highway structures. Bills of materials and estimates of cost are usually required, also plant layouts and methods of executing work.
' 2642 (b) RESEARCH IN HIGHWAY ENGINEERING. Credit three or more hours. Prerequisites, 2610 and 2612. Hours to be arranged.
Studies of traffic and traffic regulations and legislation may be made. The field of economics of highway engineering offers a wide variety of problems. Laboratory investigations of subgrade soils, subgrade stabilization, and the effects of modifications in design of bituminous and non-bituminous mixtures, provide a wide range of topics for research.

## HYDRAULICS AND HYDRAULIC ENGINEERING

## IN CIVIL ENGINEERING

Major work in Experimental Hydraulics, Theoretical Hydraulics, or Hydraulic Engineering may consist in part (subject to the thesis requirement) of advanced courses, or the entire minor work may consist of such courses accompanied by special work and reports as may be arranged with the members of the special committee.

A candidate for the degree of Master of Civil Engineering (or of Science), or Doctor of Philosophy, who desires to take either a major or minor subject in these fields of study must ordinarily have completed, preliminary to graduate work, courses in Hydraulics (including laboratory), Municipal Sanitation (including sewer design and construction and sewage disposal), and Water Supply, substantially equivalent to these courses as required of all undergraduates in the School of Civil Engineering. If a graduate student lacks one or more of these preliminary courses or considerable portions of any of them, more than the minimum period of residence may be necessary.

## HYDRAULICS

Professor E. W. Schoder; Associate Professor L. Reid; Assistant Professors M. Bogema, M. S. Priest, and M. J; Willis.
For major work in Experimental (or Theoretical) Hydraulics the thesis requirement may be satisfied by individual experimental (or theoretical) investigation and a thesis based thereon. The tendency is to underestimate the time required
for preliminary thesis work and that necessary for a thorough digestion of results. Consequently the work should be begun, if possible, during the first term of residence.
2331. FLUID MECHANICS. Required for students in Mechanical and Electrical Engineering. Credit three hours. Either term. Prerequisite, Mechanics 1131. Properties of fluids, gas laws, viscosity; static pressures, center of pressure on plane and curved surface; gages and manometers; buoyant force and equilibrium of floating and immersed bodies; dynamics of fluids, Bernoulli's theorem; impulse and momentum, open jets, vanes; flow in pipes, Reynolds' number, hydraulic gradient, divided flow; orifices, nozzles, weirs, and gates; open-channel flow; hydraulic similitude and dimensional analyses. Textbook: Fluid Mechanics, Cox and Germano. Two recitations and one laboratory period a week. Messrs. Schoder, Reid, bogema, and Priest.
2303. ADVANCED HYDRAULICS. Credit three hours. Prerequisite, Hydraulics 2351 or the equivalent. Professor Schoder. Lectures, recitations, and problems. Three hours a week.
2351. Hydraulics (including laboratory work). Either term. Credit four hours.

Topics selected from the following list are taken up, subject to changes to suit group requirements: stability of flotation; barometric levelling; flow over weirs and dams, free and submerged; backwater and non-uniform flow in open channels; the hydraulic jump; water hammer; surges in pipes and canals; viscous flow of fluids and flow of air in pipes; hydraulic similitude and flow in models; some introductory elements of hydrodynamics; impulse wheels and turbines; centrifugal pumps.
2304. HYDRAULIC MEASUREMENTS. Credit three hours. Prerequisite, Hydraulics 2351 (including the laboratory) or the equivalent. Professor Schoder. Three periods a week in laboratory or computing room.

Experimental studies involving usually (as time permits): current meters and floats in canal or river; Pitot tubes in pipes; water meters; weirs; the hydraulic jumps; special features of orifices, nozzles, Venturi meters, pipe modern studies; such other occasional experimental measurements as opportunity offers in the laboratory or in the neighborhood of Ithaca; the determination of efficiency, capacity, and characteristics of hydraulic machinery by tests.
2305. HYDRODYNAMICS. Elective. Credit three hours. Prerequisite, 2302 (or 2351 ) and Differential Equations. Physical properties of fluids, equations of motion, circulation, irrotational motion, conformal transformation, laboratory methods for determining flow nets, pressure distribution on submerged surface, vorticity, equations of viscous flow, separation, drag, turbulence, dimensional analysis and similitude. Three recitations a week. Mr. Priest.
2306. PUMPS AND TURBINES. Elective. Credit three hours. Prerequisite, 2302 or 2351. Theory and characteristics of the hydraulic ram, impulse wheel, reaction turbine selection and testing. Two recitations and one laboratory or computation period a week. Assistant Professor Bogema.
2307. FLOW IN OPEN CHANNELS. Elective. Credit three hours. Prerequisite, 2302. Uniform and non-uniform steady flow. Energy criteria, hydraulic pump, surges; transitions, bends; obstructions, effects of improvements; flood rating, tidal flow. Two lectures and one computing period a week. Messrs. Schoder and Rerd.
2308. HYDRAULIC MODELS. Elective. Credit three hours. Prerequisite, 2303. Theory and practical use of models in designing hydraulic structures. One reci-
tation and two laboratory or computing periods a week. Professors Schoder, Reid, Bogema, and Priest.

## 2342. HYDRAULIC RESEARCH.

The subject and scope of the investigations in experimental or theoretical hydraulics should be selected by conference at the beginning of the term if not previously arranged. It is often desirable and is permissible for two students to work together on the same investigation. Written reports are required but the test need not be typewritten in thesis style. These reports are kept by the department. In most cases it is necessary to arrange a definite schedule for work in the laboratory to avoid conflicts. Professors Schoder, Reid, Bogema, and Priest.
2343. HYDRAULICS SEMINAR. One to six hours credit. Elective. Open to specially selected seniors or graduate students: Abstraction and discussion, of technical papers and publications in the hydraulic field.

## HYDRAULIC ENGINEERING

## Associate Professor D. E. Donley.

For the master's degree with major work in Hydraulic Engineering the thesis requirement of the Graduate School may be satisfied by work involving original designs, estimates, or analyses based on actual engineering data, these to be gathered by the student himself as an essential part of advanced work in this field. The requirement may not be satisfied by the so-called descriptive type of thesis with only rather vague design based on assumed data.

Ordinarily a candidate for the Ph.D. degree who elects most of his work in the general fields of hydraulic engineering and hydraulics is required to select his thesis in experimental or theoretical hydraulics. Only when the candidate has an adequate background of practical experience and mature judgment will a doctor's thesis in hydraulic engineering be permitted.
2401. Applied Hydrology. Any term. Credit two hours.
2403. HYDRAULIC CONSTRUCTION. Credit three hours. Prerequisite, 2401 or the equivalent.

This is a computing and designing course dealing with problems of water storage and the design and construction of dams by means of lengthy problems to be solved by graphical and analytical methods and involving the economics of water storage at a given site; the design of a high masonry dam by Wegmann's Method and the tests for safety and stability of design, and the analysis of stresses and stability.
2404. WATER POWER. Credit three hours. Prerequisites, 2401 and 2351, or the equivalent. Three lectures and recitations a week and the working of three lengthy problems during the term.

The subject matter of the course covers the technique of hydraulic turbines, the analysis of test data, study of the adaptation of turbine types to working conditions, unsteady flow and surging in long conduits, governing, and the analysis of the power available at a low head millsite.
2405. HYDRAULIC ENGINEERING. Credit three hours. Prerequisite, 2401 or the equivalent. Professor Donley. Lectures, recitations, and abstracting of references.

Theory of percolating water, ground water development, recent developments in soil technology and the design and construction of earthen dams and levees;
theory of design of gravity and arch masonry dams and distribution of stresses in such structures; spillway design; preparation of dam sites; construction methods and plants.
2406. CONSERVANCY AND RECLAMATION PROBLEMS. Credit three hours. Prerequisites, 2401 and 2351, or the equivalent. Professor Donley. Lectures, recitations, and abstracting of references.

Flood flow estimates; planning for and designing of flood protection structures, irrigation and drainage works. The Miami Conservancy work will be the chief source of material for the course.
2407. WATER POWER. AND PUMPING PLANTS. Credit three hours. Prerequisite, 2404. May be taken concurrently with course 2404. Professor Donley.
This is a computing and designing course devoted to the problems of designing and detailing power and pumping plants.
2408. HARBOR ENGINEERING. Elective. Credit three hours. Study of wave action; currents, tides; shore protection, wharves, bulkhead, jetty design and construction; channel and revetment work; dredging and reclamation of land; cargo handling; transportation in dock areas; storage and warehouse facilities. Three recitations a week.
2441. HYDRAULIC ENGINEERING DESIGN. Credit three hours. Prerequisite, 2401. For best results Hydraulic Design should be preceded by course 2401, but the two may be taken concurrently. Professor Donley.

The purpose of the course is to go more into detail in selected phases of hydraulic engineering and is not to duplicate in large part work regularly given in the scheduled courses in hydraulic and structural engineering.
2443. HYDRAULIC ENGINEERING SEMINAR. One to six hours credit. Elective. Open to specially selected seniors or graduate students. Abstraction and discussion of technical papers and publications in the hydraulic engineering field.

# TOPICS SUGGESTED FOR ADVANCED WORK <br> DRAFT TUBE DESIGN AND PERFORMANCE <br> <br> \section*{HYDRAULIC TURBINES} <br> <br> \section*{HYDRAULIC TURBINES} <br> CENTRIFUGAL PUMPS <br> ECONOMICS OF WATER POWER PLANTS 

## INDUSTRIAL AND ENGINEERING ADMINISTRATION

Professors H. J. Loberg; Associate Professors C. I. Millard, R. S. Schultz, Jr., K. C. White; Assistant Professors M. W. Sampson, C. R. Scott.

The facilities of the department permit a wide range of choice for the student interested in the industrial-management aspects of engineering. For example, in the micro-motion laboratory, 16 mm . motion picture cameras and projectors with necessary auxiliary apparatus are available for motion and process studies as well as the necessary tools and work places for setting up and studying various operations.
3231. Principles of Industrial Accounting and Cost Finding. Each term. Credit three hours.
3235. Industrial Organization and Management. Each term. Credit three hours.
3241. Elementary Industrial Statistics. Each term. Credit three hours.
3242. Statistical Quality Control. Credit three hours.
3232. Personnel Management in Industry. Each term. Credit three hours.
3270. Industrial Marketing. Credit three hours.
3271. Industrial Marketing Research. Credit two hours.
3250. Industrial Engineering and Cost Control. Alternate terms. Credit four hours.
3281. BUSINESS AND INDUSTRIAL RESEARCH. Credit one hour for each forty hours of actual work. Professor Loberg and others. Open to a very limited number of seniors and graduate students who have shown by training and aptitude their ability to carry on original investigations in business and industrial subjects.
3272. Industrial Salesmanship. Credit two hours.
3254. Standard Costs and Management Control. Credit three hours.
3261. Industrial Engineering. Each term. One lecture and two computing periods a week.
3282. ADVANCED INDUSTRIAL ENGINEERING. Each term. Credit one hour for forty hours of actual work. Open to a limited number of seniors and graduates. Associate Professor Millard and Mr. White.

Special problems and investigations which are carried on under the direction of members of the department staff.
3252. INDUSTRIAL AUDITING. Each term. One lecture and one computing period a week.
3262. METHODS OF ENGINEERING. Each term. One recitation and one laboratory period a week. Credit two hours.
3263. PRODUCTION ENGINEERING. Credit three hours.
3264. PRODUCTION MANAGEMENT. Credit three hours.
3265. PRODUCTION CONTROL. Credit three hours. Industrial Marketing Studies.

## TOPICS SUGGESTED FOR ADVANCED WORK

MICRO-MOTION ANALYSIS
INVESTIGATIONS FOR MOTION AND PROCESS ECONOMY
PRACTICAL ECONOMIC AND PRODUCTION INVESTIGATIONS IN NEAR-BY INDUSTRIES
ECONOMIC CONTROL OF QUALITY IN PRODUCTION

## MACHINE DESIGN

Professors F. S. Rogers and P. H. Black; Assistant Professors R. T. Hinkle and H. H. Mabie.

Under this head is included advanced work in kinematics and dynamics, machine design and design methods, and special design problems and investigational work.

There are eight well-equipped drawing rooms and a very complete collection of Kinematic models. The Department Library, the Library of the School of Mechanical Engineering, and the University Library have a very complete collection of books on kinematics, machine design and construction, mechanical technology, structural design, and other books on related subjects.
3325. Kinematics, Recitations. Each term. Credit three hours.
3326. Kinematic Drawing. Each term. Credit two hours.
3327. Kinematics, Recitations. Each term. Credit two hours.
3337. Machine Design, Drawing. Each term. Credit three hours.
3338. Machine Design, Drawing. Each term. Credit two hours.
[3362. Tool Engineering. Each term. Credit two hours. An elective for juniors and seniors in engineering. One discussion and two computing periods a week.
The course deals with the theory and principles of operation underlying the design of punches, dies, jigs, and fixtures and with the application of such tools to the production of parts of appliances and machines in small and in large quantities. (Temporarily discontinued.)]
[3366. ADVANCED KINEMATICS AND KINETICS. Prerequisites, 3325 and 3326. Professor Rogers. Two lecture and discussion periods and one laboratory period a week.
Graphical and semi-graphical treatment of linear and angular velocities and accelerations and of the resulting forces, stresses, and strains due to the form and mass of the moving parts of mechanisms and machines. Vibration and critical speeds and the theoretical basis and use of balancing machines for securing static and running balance of machine parts, will be treated so far as time permits. (Temporarily discontinued.)]
3363. DYNAMICS AND VIBRATIONS OF MACHINERY. Each term. Credit three hours. Prerequisites, 3337 and 1114. Professor Black. Two lecture and discussion periods and one laboratory period a week.
Graphical and analytical treatment of velocities, accelerations, static forces. inertia forces, and combined forces. Balancing of engines. Transverse and torsial vibrations, critical speeds, and balancing machines.
3361. ADVANCED MACHINE DESIGN. Credit three hours. Prerequisites, 1114 and 3337. Professor Black. Three lecture and discussion periods a week.
Advanced problems in stress and analysis of machine and structural members including consideration of fatigue, creep, stress concentration, stability, etc. Vibrations and a few special topics.
3370. SPECIAL INVESTIGATIONS IN MACHINE DESIGN: Credit as arranged. Professors Rogers and Black. Opportunity is offered to qualified students, individually or in small groups, to pursue, under direction, special investigations in machine design and related fields.

## TOPICS SUGGESTED FOR ADVANCED WORK

SPECIAL DESIGN PROBLEMS
VIBRATIONS AND CRITICAL SPEEDS

# MANAGEMENT ENGINEERING 

## IN CIVIL ENGINEERING

Professor R. Y. Thatcher; Associate Professors Carl. Crandall and J. E. Perry.

The study of methods of construction is neglected in some colleges and the graduate student who is not familiar with them may well take course 264. Books and periodicals on construction methods for various types of work, on management of construction work, and laws and practices governing it are available in the Library of the School of Civil Engineering.
2901. Engineering Construction. Either term. Credit three hours.
2902. Engineering Law. Either term. Credit three hours.
2903. Engineering Management. Either term. Credit three hours.
2904. ADVANCED ENGINEERING LAW. Credit three hours. Prerequisite, 2902. Professor Thatcher. Lectures and recitations, three hours a week.

Some of the topics treated in course 290 are here enlarged upon and extended, particularly laws relating to the various phases of construction contracts, em-ployer-employee relationship, workman's compensation, mechanic's liens, patents, copyrights, trademarks, and insurance. Among other subjects covered are suretyship, conditional sales, bailments, trusteeship, and taxation. Actual cases are used for illustrating the above and reference is also made to recent court decisions regarding engineering matters.
2905. VALUATION ENGINEERING. Credit three hours. Prerequisites, 2901 and 2902. May be taken concurrently with course 290. Associate Professor Crandall. Lectures, recitations, and reports.

Theory and practice of valuation or appraisal for purposes of utility rate making, purchase or sale, eminent domain or condemnation cases, mergers or joint ownership, taxation and assessment, issuance of securities, bank loans, insurance, uniform system of accounting and improved management. Topics considered include scientific systems of real estate assessment, federal railroad valuation, rate disputes, court rulings, computation of actual rates for gas, telephone, electrical supply, and street railways, valuation of land, mines, water power, factories, railroads, toll bridges, buildings, and all kinds of property both tangible and intangible. Detailed examples of forms and methods with outline of typical valuation reports.
2941. RESEARCH IN MANAGEMENT ENGINEERING. Any term. Credit three hours or more.

Special problems relating to the economic, legal, and financial aspects of engineering construction projects, management of public works and appraisals.

## MATERIALS OF ENGINEERING

IN CIVIL ENGINEERING
Professor H. H. Scofield.
The library of the School of Civil Engineering is well supplied with reference works of various kinds on the subject of structural materials, their properties,
specifications, and tests. Especial effort is made to add continually the most recent investigations and researches as the results find their way into print.
The laboratory equipment is selected to make all ordinary and many special tests and investigations of the materials of construction. The cement and concrete laboratories are equipped to make all the standard tests upon cement and the various other ingredients entering into concrete. A specialty is made of the tests and investigations of the finished concrete under various conditions as to proportion, manufacture, and design.

## 1225. Materials of Construction. Either term. Credit three hours.

1226. Materials Laboratory. Either term. Credit three hours.
1227. ENGINEERING RESEARCH IN MATERIALS. Either or both terms. Credit one hour for forty hours of actual work. Prerequisites, 1225 and 1226 or their equivalent. Professor Scofield.
Special investigations of an advanced nature of the properties of structural units and the materials of construction. The aim of the course is to secure results by proper investigational methods which are of the caliber and scope deemed essential for publication.
1228. MATERIALS SEMINAR. One to six hours credit. Elective. Open to specially selected seniors or graduate students. Abstraction and discussion of technical papers and publications in the materials field. One one-hour period per credit hour.

## IN MECHANICAL ENGINEERING

Professors J. R. Moynihan, J. O. Jeffrey; Assistant Professors G. W. Ehrhart, J. R. Young, C. R. Otto, and W. J. Purcell.

Experimental problems related to the testing, control of the properties and engineering applications of ferrous and non-ferrous metals and alloys, nonmetallic materials such as plastics, fuels, lubricants, woods, refractories, and cementing materials, may be carried on in this department.

The Materials Testing Laboratory is equipped for tension, transverse, and compression tests with an Olsen 200,000-1b. hydraulic machine, an Olsen $100,000-$ lb . three-screw machine, an Amsler $100,000-\mathrm{lb}$. hydraulic machine, a BaldwinSouthwark $50,000-\mathrm{lb}$. hydraulic machine, together with several small testing machines. The laboratory also contains an Olsen torsion machine of 140,000 inchpounds capacity, two Upton-Lewis fatigue testing machines, an R. R. Moore fatigue tester, and an Amsler-Charpy-Izod impact testing machine. The other equipment includes extensometers, calibrating, hardness testing machines, cupping testing machines, metallographic microscopes, polishing equipment, photographic apparatus, gas and electric furnaces, isothermal quenching baths, magnaflux, radiography, and industrial chilling.

In addition, there is available a fuel laboratory for fuel analysis and calorimetry, an oil laboratory for determining the properties of oils and the behavior of oils in bearings, and a cementing material and concrete laboratory.
1221, 1222. Engineering Materials. Throughout the year. Three lectures a week.
1223. Engineering Materials for Electrical Engineers. Two lectures and one laboratory period a week.
1231. Engineering Materials Laboratory - Metals and Alloys. One lecture period and one laboratory period a week and a written report of the work.
1232. Engineering Materials Laboratory - Non-Metallic Materials. One laboratory period a week and a written report of the work.
1251. ENGINEERING MATERIALS RESEARCH. Each term. Prerequisites, 1231, 1232. Professors Moynihan and Jefrrey. Credit one hour for forty hours of actual work. Open to a limited number of seniors and graduate students who have shown a proficiency in this field. Special problems and investigations are carried on under the general supervision of the members of the department.
1252. APPLIED PHYSICAL METALLURGY. Alternate terms. Credit three hours. Prerequisite, 1231. Professor Jeffrey. This course covers the applications of physical metallurgy to problems in engineering. This will include all processing operations including casting, mechanical working, and heat treatment, and the subsequent inspection and use of ferrous and non-ferrous metals and alloys. The significance and control of mechanical properties will be emphasized.
1253. PHYSICS OF ENGINĖERING MATERIALS. Any term. Credit variable. Open to graduate students by permission. Associate Professor Sack, Engineering Physics.
This course offers opportmity for individual research in the field of physical properties of engineering materials and applications of physical methods to production control.

## TOPICS SUGGESTED FOR ADVANCED WORK

APPLIED PHYSICAL METALLURGY. CONTROL OF PROPERTIES OF ENGINEERING MATERIALS<br>PROPERTIES OF ENGINEERING MATERIALS, METALLIC OR NON-METALLIC<br>PHYSICS OF ENGINEERING MATERIALS<br>FUELS<br>insulating materials<br>LUBRICATION<br>RADIOGRAPHIC EXAMINATION OF METALS AND ALLOYS<br>PROPERTIES OF PLASTICS<br>PROPERTIES OF LUBRICANTS<br>THERMAL QUALITIES OF QUENCHING LIQUIDS<br>LOW TEMPERATURE BEHAVIOR OF ENGINEERING MATERIALS<br>HEAT TREATMENT AND ISOTHERMAL QUENCHING

## MECHANICAL PROCESSING

## Assistant Professor R. L. Geer.

The shops available for graduate research include the following: forge shop, foundry, welding shop, pattern shop, and machine shop. The shops are also available for use in the building of equipment for research in any department. Arrangements for the construction of new equipment should be made in advance with the head of the department.
6111. Metal Working. Any term. One laboratory period a week.
6112. Casting Processes. Any term. One laboratory period a week.
6113. Casting Processes. Any term. Two laboratory periods a week.
3423. Machiné Tool Processes. Any term. Two laboratory periods a week.
3424. Measuring Instruments. Any term. One laboratory period a week.
3450. ADVANCED MECHANICAL PROCESSING. Any term. Work and credit as arranged. Assistant Professor Geer.

## TOPICS SUGGESTED FOR ADVANCED WORK

CUPOLA PRACTICE; FOUNDRY PRACTICE
SELECTION, TESTING, AND HANDLING OF FOUNDRY SANDS
ARC AND OTHER TYPES OF WELDING
MACHINABILITY OF MATERIALS
CUTTING TOOLS; CUTTING AND DYNAMOMETRIC STUDIES
DIES, JIGS, AND FIXTURES
MEASURING AND GAGING

# MECHANICS 

IN CIVIL ENGINEERING

Associate Professor E. V. Howell; Assistant Professors C. M. Antoni and L. T. Cheney.

An extensive departmental library in Lincoln Hall, in addition to the University Library, affords facilities for advanced work in the field of applied mechanics especially in applications such as occur in structural engineering.

The prerequisite training for graduate work in this subject should cover the fundamental principles and applications in mathematics, physics, materials, mechanics, and structural design required for graduation in civil engineering at Cornell University. Many of the advanced treatises are in French and German, and an ability to read technical works in these languages is extremely valuable.
1136. Mechanics of Engineering. Credit five hours.
1137. Mechanics Laboratory and Computations. Gredit two hours.
1138. Mechanics of Materials. Credit four hours.
1139. Mechanics Laboratory. Credit one hour.
1140. ADVANCED MECHANICS. Credit three hours. Prerequisites, 1137 and 1138. Associate Professor Howell. Three recitations a week.

Following a brief general review of fundamental topics in Mechanics of Materials, this course covers: induced stresses, torsion; unsymmetrical bending; torsion of prisms of non-circular section; hoops; flat plates; localized stresses; theory of least work; internal work and its derivatives.

## IN MECHANICAL ENGINEERING

Professor W. R. Cornell; Associate Professor H. C. Perkins; Assistant Professors C. B. Mansky, H. A. Lang.

The libraries of the University are well equipped for students engaged in both analytical and experimental investigation. In addition to the regular laboratories, facilities are available for the construction and accommodation of special apparatus for research and testing. These include a photo-elastic laboratory for investigation of two- and three-dimensional stress.

## 1111. Theoretical and Applied Mechanics. Each term. Five hours a week.

1112. Strength of Materials. Each term. Three hours a week.
1113. Strength of Materials, continued. Each term. Two hours a week.
1114. Applied Mathematics. Each term. Three hours a week.
1115. PHOTOELASTICITY. Any term.* Prerequisite, 1113. Two lectures or laboratory periods and reports a week.

The optics of photoelasticity, the stress-optical effect, plane and circularly polarized light, white and monochromatic. Elements of elasticity required for the analysis of observations and the determination of principal stresses.
1162. MECHANICS OF VIBRATION. Credit three hours. Prerequisite, 1114. or its equivalent.

The characteristic phenomena of mechanical vibrations encountered in engineering, and their quantitative investigation, illustrated by a group of typical vibrating systems. Representation of simple harmonic motion. Combination of several simultancous motions. Simple cases of free and forced vibrations, with damping. Resonance. Principles of transmission and isolation of vibration. Systems of variable mass and variable elasticity. Vibrations of taut wires, bars, beams, rings, membranes, and plates. Relation of vibration and noise. Detection and measuring instruments. Examples of diagnosis and preventive measures.
1163. APPLIED ELASTICITY. Credit three hours. Prerequisite, 1114. Three lectures a week.

General theorems of the elastic solid, reciprocal theorem, sudden loading. Tension, flexure, and torsion of bars of arbitrary section. Castigliano's theorem with application to frames, rings loaded in and normal to plane, spiral, and helical springs. Stress in thick cylinders and discs due to pressure, heating, and rotation. Beams on elastic foundations. Symmetrical deformation of thin tubes. Propagation of stress waves in bars.

In the second term the topics are chosen from: Thermal stress, stress-analysis, stability, and vibration, of plates and shells.
1165. THEORY OF ELASTIC STABILITY. Credit three hours. Prerequisites, 1112,1114 , or equivalents.

Mathematical analysis of the conditions under which columns, beams, rings, tubes, thin plates and thin curved shells may fail by general or local buckling. Applications to mechanical, civil, naval, and aeronautical structures.
1180. SEMINAR IN APPLIED MECHANICS. Credit one hour each term. One discussion period each week. Prerequisites, 1163 and 1164 or equivalents. Professor Goodier.

[^16]Current research papers in applied mechanics reported and discussed by members of the group.

TOPICS SUGGESTED FOR ADVANCED WORK
THEORY OF ELASTICITY
ELASTIC STABILITY
VIBRATION
FLUID MOTION
PHOTO-ELASTIC STRESS ANALYSIS.

## RAILROAD ENGINEERING

Professor R. Y. Thatcher; Associate Professors Carl Crandall, and J. E. Perry.
The library of the School of Civil Engineering contains an excellent collection of books, periodicals, and publications of railway and other technical societies dealing with the location, construction, maintenance, and operation of railroads. Books and other publications on transportation are available either in this collection or in the University Library. Maps and profiles are available for studies of the economics of location, and special plans provide for studies of signal layouts, interlocking, and yard and terminal design. Instrumental equipment is available for securing data for special problems in relocation and for designs of structures.
2601. Route Surveying and Drawing. Credit three hours.
2603. RAILROAD MAINTENANCE OF WAY. Credit three hours. Prerequisite, 2601. Associate Professor Perry. Lectures and recitations three hours a week.

The subjects treated are track materials (with special reference to the section, method of manufacture and composition of steel rails, to the economics of tie preservation and the use of metal ties, and to the effect of quality of ballast upon maintenance); machine and other methods of grading for second track; drainage; track laying by both machine and hand methods; ballasting and bringing new track to line and grade; turnouts and switches; derailing switches; side tracks and yard tracks; sorting and terminal yards; track maintenance; track tools; work trains; action of car wheels on curves; widening of gage; double tracking; separation of grades; and improvement in grades and alinement.
2604. RAILROAD OPERATION AND MANAGEMENT. Credit three hours. Prerequisite, 2601. Associate Professor Perry. Lectures and recitations, three hours a week.

Under organization, the following subjects are treated: general principles underlying organization and the effect of each on efficiency; principal departments of railway service with a brief outline of the work of each; departmental and divisional systems of organization, with examples on various roads and discussion of adaptability of each. The duties of officers and the work of the different departments are taken up in considerable detail. The most important laws affecting railroads are given in discussing the work of the legal department. Freight traffic, freight houses, classification yards, car service rules, accounting, etc., are among the topics considered under operation. Signaling and interlocking and train rules are also considered.

## 2602. TRANSPORTATION. Associate Professor Perry.

A course covering travel and transport agencies with special reference to their facilities, ownership, financing, regulation, and coordination. A brief review of the development of transportation throughout the world is used as a background for an intensive study of the present situation in the various countries and comparison of the policies and practices in use. Particular attention is given to the various proposals to promote more efficient use of the various transportation agencies in the United States by better coordination, pooling of facilities, etc., and economics studies are made of some of the new projects which are under discussion.
2641 (a). RAILROAD ENGINEERING DESIGN. Any term. Credit three or more hours. Associate Professor Perry.

The problems are those encountered in the location and construction of railroads, and include the following subjects: economic location of railroads; culverts; bridges; retaining walls; tunnel and subway design; small depot buildings; freight houses; water supply and coaling plants; icing stations; turntables and enginehouses; gravel washing plants; track layouts with details of signals and interlocking; yard and terminal design; etc. Bills of material and estimates of cost are usually required. The field is so broad that the interest of the student is given consideration in assigning problems.
2642 (a). RAILROAD ENGINEERING RESEARCH. Any term. Credit three or more hours.
Special problems in the economics of location, construction, maintenance, and operation of railroads, comparison of transportation agencies, traffic studies, and economics of various systems of transport.
Note: For the larger railway structures see Structural Engineering.
In addition to the above courses, the student may take courses in other departments if time permits; such as courses in transportation in the College of Arts and Sciences, or in applications of electricity in transportation in the School of Electrical Engineering.

## SANITARY ENGINEERING

## Professor C. L. Walker; Associate Professor H. M. Gifft.

Courses offered to graduate students may be divided into two classes: those fundamental studies in Chemistry, Biology, and Bacteriology, which the undergraduate student in Civil Engineering has not had an opportunity of pursuing; and those dealing with the design, construction, and operation of sewage treatment and water purification plants. The sewage treatment and water purification plants in the city of Ithaca and in neighboring communities offer opportunity for experimental study.

A well-equipped sanitary laboratory established in the School of Civil Engineering provides an opportunity for students to acquire laboratory technique in water and sewage analyses, and also a practical training in interpretation. The Kuichling Library for Hydraulic and Sanitary Engineering, and the main library of the School are well provided with the literature dealing with Sanitary Engineering topics.
2504. Sanitary Biology. Credit three hours.
2505. Sanitary Biology. Credit two hours.
2503. Sewerage and Sewage Treatment. Credit three hours.
2502. Water Supply. Credit three hours.
2506. ADVANCED WATER SUPPLY. Credit three hours. Two recitations and one computation period a week.

This course comprises a comprehensive study of the general principles and methods involved in furnishing safe water supplies of satisfactory quality. The topics studied include the character of surface and underground water supplies; inspection of sources; relation of communicable diseases"to water supplies; standards of quality and safety of supplies; water treatment methods including coagulation, sedimentation, aeration, slow and rapid filtration, tastes and odor control, softening and iron removal, corrosion control, sterilization, and miscellaneous treatment methods. Also some study of the design and operation of water treatment plants is included.
2507. ADVANCED SEWERAGE WORKS. Credit three hours. Prerequisite, 2503 . Two recitations and one computation period a week.

A comprehensive study of principles and methods involved in the design, construction, and operation of sewers and sewage treatment works including reference to existing typical plants. In general, the study includes the determination of capacity and design of sewers; the disposal of sewage by dilution and broad irrigation; stream pollution and self purification; sewage treatment methods including preparatory devices, sedimentation, chemical precipitation, intermittent sand and trickling filters, activated sludge, sludge digestion, sludge dewatering and incineration, and miscellaneous treatment methods.
2508. TREATMENT OF WASTES. Credit three hours. Prerequisite, 2503. Professor Walker. Three lectures or recitations a week.

The treatment of municipal and industrial wastes such as garbage, and the wastes from tanneries, packing-houses, mines, canning factories, textile mills, paper and pulp mills, creameries, cheese factories, condensaries, etc. Flow or process charts are used to show the general character of the waste, and methods of treatment applicable are considered. Special attention is given to experimental studies of waste treatment. Numerous references, bulletins, reports.
2507. PUBLIC HEALTH ENGINEERING. Credit three hours. Lectures, recitations, and readings. Three periods a week.

A study of the position of the engineer in public health work. Organization and operation of Boards of Health, vital statistics, public health laws, and the sanitary code.
2510. RURAL SANITATION. Credit two hours. Professor Walker. Lectures, reports, and recitations. Two periods a week.

A course dealing with the sanitation of rural areas, trailer and other camps, summer hotels, and swimming pools. Attention is given to water supply, sewage and garbage disposal, and to the problem of milk sanitation. Lectures, reports, and recitations.
2511. WATER AND SEW AGE ANALYSIS. Elective for juniors and seniors. First term. Credit two hours. The purpose of the course is to acquaint the student with the standard procedures followed in making physical and chemical analyses of water and of sewage. Textbooks: Standard Methods of Water Analysis, A.P. H.A., Water and Sewage Analysis, Eldrige, Theroux, and Mallman. Two laboratory periods a week with lectures, recitations, and laboratory work. Professors Walker and Gifft.
2512. A LABORATORY COURSE FOR GRADUATES. Professor Walker. Hours to be arranged.

A course devoted to some problems of water or sewage or trade waste, such as the operation of a water filtration plant, a sewage disposal plant, the detection, measurement, and purification of trade wastes, the value of disinfection, etc.
2541. SANITARY ENGINEERING DESIGN. Any term. Credit three hours. This course should be preceded by courses 2502 and 2503 or equivalent courses. Professor Walker and Associate Professor Gifft.

The purpose of the course is to teach methods of determining the capacity basis of design, computations, sketches, and general plans and profiles involved in the design of sewerage works.

Problems such as the design of a separate or combined sewerage system, an intercepting sewer, a municipal or an institutional sewage treatment plant, a plant for the treatment or disposal of an industrial waste, or a plant for the treatment of an industrial, institutional, or municipal water supply, may be elected.
2542. SANITARY ENGINEERING RESEARCH. Any term. Prerequisites for work in this field will depend upon the particular problem to be pursued, but in general will include work in water analysis, bacteriology, and courses in Hy draulics and Sanitary Engineering dealing with the field in which the work is to be undertaken. Professor Walker. Hours, credit for work, prerequisites, and other questions relating to contemplated research in this field will be arranged by conference.
2543. SANIT ARY ENGINEERING SEMINAR. One to six hours credit. Elective. Open to specially selected seniors or graduate students. Abstraction and discussion of technical papers and publications in the sanitary field. One one-hour period a week per credit hour.

# STRUCTURAL ENGINEERING (INCLUDING SOIL MECHANICS) 

Associate Professors E. N. Burrows, H. T. Jenkins, George Winter; Assistant Professors Griset, Antoni, Mains.

In this subject instruction is offered in the determination of loading and stresses and the design of roofs, buildings, bridges, arches, foundations, piers, retaining walls, and other structures of timber, steel, and concrete.

The department is equipped with a Beggs Deformeter for the Mechanical Analysis of structures. The facilities of the testing laboratories are available to graduate students.

The Soil Mechanics Laboratory is fully equipped for work by graduate students. The freezing room and humid room are available for research work in investigating the physical properties, bearing capacity, permeability, and stability of soil, and the flow of water through earth dams. There is also a shop for use in the building of new equipment.

To qualify for graduate work in structural engineering a knowledge of theoretical mechanics, strength of materials, engineering construction, and elementary courses in stress and design in timber, steel, and concrete are required.
2702. Structural Design. Either term. Credit three hours.
2715. Concrete Construction. Either term. Credit three hours.
2720. Foundations. First term. Credit three hours.
2725. Soil Mechanics. Either term. Credit three hours.
2705. ADVANCED STRUCTURAL ANALYSIS. Credit three hours. Prerequisite, 2751. Assistant Professor Griset. Three recitations a week.

Stress analysis of continuous beams, framed bents, and rigid frames. Horizontal as well as vertical loading considered. Redundant structures including the braced two-hinged arch. Displacement diagrams for trusses and arches and analytical computation of deflections of such structures.
2706. STEEL BUILDINGS. Credit three hours. Prerequisite, 2702 or their equivalents. Professor Burrows. Reports and drawings. Three two-hour periods a week

This course comprises the design of the steel framework for buildings of the prevailing type used in power house or shop construction. Dead, snow, and wind stress diagrams are drawn for the roof trusses. Provision is made for an electric crane moving the whole length of the building and the stresses in the framework due to the movement of the crane are determined. The effect of the wind and the eccentric load due to the crane girder are considered in the design of the columns.
2707. BRIDGE DESIGN. Credit three hours. Prerequisite, 2702 or the equivalent. Professor Burrows. Computations and drawings, three two-hour periods a week.

Computations and drawings for the complete design of a railroad bridge of six or seven panels or a heavy highway bridge. The computations to determine the stresses and sections of all members, pins, pinplates, splices, deflection, camber, and other details as well as of connecting rivets are to be written up in the form of systematically arranged reports. The drawings consist of general detail plans showing the location of all rivets as well as the composition and relation of all members and connections. The final report is to give a full list of shapes and plates, and a classified analysis of weight for the span.
2708. INVESTIGATION OF EXISTING BRIDGES. Credit three hours. Prerequisite, 2702 or the equivalent. Professor Burrows.

Inspection of existing structures for the determination of sizes and conditions of plates and shapes. After full data have been obtained in the field, computations will be made to determine either the unit stresses under a specified load, or the safe load or rating according to standard specifications.
2709. RIGID FRAMES IN STEEL OR CONCRETE. Elective. Credit three hours. Prerequisite 2704. Slope deflection and moment distribution applied to rectangular bents, trapezoidal bents, gable bents, and hip bents. Bents with members of variable moment of inertia. Design of joints. Application to design of rigid frame bridge in steel or concrete. Assistant Professor Mains.
2710. ADVANCED STRUCTURAL THEORY. Elective. Credit three hours. First term. Prerequisite 2705. Two- and three-dimensienal stress. Strength theories. Strain energy methods. Impact stresses. Stress concentration. Design for fatigue. Stresses beyond the elastic limit. Ultimate design in steel and reinforced concrete. Three recitations a week. Associate Professor Winter.
2711. ADVANCED STRUCTURAL THEORY. Elective. Credit three hours. Second term. Prerequisite 2710 and Math. 200. Design of structural members involving elastic stability. Columns with initial crookedness and eccentric loading. Columns of variable cross-section and open web columns, Lateral strength of beams. Buckling of plates. Design of thin-walled steel structures. Three recitations a week. Associate Professor Winter.
2712. TANKS AND BINS. Prerequisites, 2705, and Math 200. Theory of plates and shells and applied to the design of reinforced concrete and steel tanks, reservoirs, bunkers, and bins. Three recitations a week. Associate Professor Winter,
2719. REINFORCED CONCRETE BUILDING DESIGN. Credit three hours. Prerequisite, 2715. Seven and one-half hours a week.
Design of a reinforced concrete flat-slab building and investigation of various other types of floor systems for commercial buildings. Complete detail design for one building, including stairway, elevator shafts, penthouses, etc. Working drawings and steel schedules.
2717. FIXED ARCHES. Credit three hours. Prerequisites, 2702 and 2715. Lectures, recitations, and computations. Six hours a week.
Theory of the curved beam; the closed ring; the fixed arch. Influence lines for arches of various forms. Selection of curvature of axis for various loadings. Effect of temperature and rib-shortening; effect of plastic flow on stresses in a reinforced concrete arch. Design of a reinforced concrete arch and its abutments.
2718. HIGHWAY BRIDGES. Credit three hours. Prerequisite, 2715 or the equivalent.

Design of short span bridges and their abutments. Comparison of the economy of steel and reinforced concrete superstructures for bridges of this type. Reports and drawings.
2716. REINFORCED CONCRETE DESIGN. Credit three hours. Prerequisite, 2715. Three two-hour periods a week.

Design of footings: single and multiple columns of reinforced concrete. I-beam grillages. Design of bins and tanks, subsurface and supported on towers. Reports and sketches.
2723. SUSPENSION BRIDGE THEORY. Credit three hours. Prerequisites, 2704 and Math 200 (or equivalent). The elastic theory; stresses in cables, moments and shears in stiffening trusses, temperature effects, and deflections. Fundamental principles of the deflection theory. Three recitations a week.

## 2721. ELASTIC FOUNDATIONS AND THIN STRUCTURAL SHELLS. Credit three hours.

Study of the properties of elastic foundations and the application of the elastic foundation theory to the analysis of large diameter, low head tanks, hemispherical domes, hemispherical headers on large pipes, and thin shell pipes under flexure.

## 2726. APPLIED SOIL MECHANICS. Credit three hours. Prerequisite, 2725 or

 its equivalent.Advanced application of soil mechanics, based on the principles and physical studies of course 2725. The plastic flow theory; the consolidation theory; stability of earth slopes; flow of water through earth structures; theories of earth pressure on retaining walls, caissons, and tunnels. Review of modern soil mechanics research.
2741. STRUCTURAL ENGINEERING DESIGN. Any term. Prerequisites, 2702 and 2715.

The student may select a problem such as the following: (a) an arch bridge of steel, (b) a cantilever bridge, (c) a rigid frame bridge, (d) a special problem in steel or concrete building design, (e) the design of any other structure of particular interest to the student provided he has had the proper preparation for such design. The work is submitted in the form of reports. Drawings of typical details must accompany reports.

## 2742. RESEARCH IN STRUCTURAL ENGINEERING.

Students wishing to pursue one particular branch of bridge engineering further than can be done in any of the regular courses may elect work in the field. The prerequisite courses depend upon the nature of the work desired. The work may be in the nature of an investigation of existing types of construction or theoretical work with a view to simplifying present methods of design or proposing new methods.
2743. STRUCTURAL ENGINEERING SEMINAR. One to six hours credit. Elective. Open to specially selected seniors or graduate students. Abstraction and discussion of technical papers and publications in the structural field.

## TOPOGRAPHIC AND GEODETIC ENGINEERING

Professor P. H. Underwood; Associate Professor L. A. Lawrence; Assistant Professor F. J. Spry.

The preliminary training as a qualification for work in this department should include the equivalent of the regular undergraduate course in civil engineering, including work in General and Practical Astronomy. A thorough training in Mathematics and Physics is desirable.

Graduate work for those interested in Topographic and Geodetic Engineering includes courses in Advanced Topographic Surveying, in Geodesy, Least Squares, Geodetic Astronomy, and in Photographic and Aerial Surveying. The Library of the School of Civil Engineering contains an extensive collection of reference books in the subjects mentioned. The surveying equipment of the School is also available for practice work.
182. Elements of Field Astronomy. Any term. Credit two hours. (Given in Department of Astronomy.)
2102. Advanced Surveying. Credit three hours.
2103. Summer Survey: Topographic, Hydrographic, and Geodetic Survey: Camp. Five weeks during end of summer following sophomore year. Credit four hours.
2104. TOPOGRAPHIG SURVEYING AND MAPPING. Elective for upperclassmen and graduate students. Three hours credit. Prerequisite, course 2103. Methods of making topographic surveys for mapping to large scales. The use of the plane table. Solutions of the three-point problem; the two-point problem; location of details by direction and distance. Mapping, including the construction of a final topographic map of the area covered by the field work of course 2103 during the preceding summer. Lectures, recitation, field work, and mapping. One lecture and two laboratory periods a week. Professor Underwood.'
2105. LEAST SQUARES: ADJUSTMENT OF OBSERVATIONS. Elective for upperclassmen and graduate students. Either term. Credit three hours. Prerequi-
sites, Calculus and Physics. The course is designed for students who have experimental investigations in view. The fundamental principles of least squares with application to the adjustment of typical surveying work, such as leveling, and triangulation. Applications are also made to problems in physics, astronomy, mechanics, etc., with some attention to the derivation of empirical formulae. Textbook: Leland's Practical Least Squares. Lectures, recitations, and laboratory periods, three a week as may be arranged. Professor Underwood.
2106. ADVANCED TOPOGRAPHIC SURVEYING. Elective. Upperclassmen. Second term. Credit two hours. Prerequisite, course 2103. Economics of surveying methods. Surveys for special purposes, such as extensive construction work, and storage distribution of water for irrigation; earthwork on a large scale, lines of communication, topographic reconnaissance, etc.; photographic surveying. Lectures, recitations, and assigned readings. Professor Underwood.
2107. GEODESY AND GEODETIC LABORATORY. Elective for upperclasśmen. Any term. Credit three hours. Prerequisites, course 182 and 2102. A course for the consideration of special problems in geodetic work. Precise leveling, deflection of the plumb line, figure of the earth, use and investigation of geodetic instruments and apparatus such as circles, levels, micrometer microscopes, standards of length, thermometers, pendulums, magnetic apparatus, etc. Subject to arrangement to meet the special needs of students. Lectures, reading, discussions, and laboratory work. Three periods a week. Professor Underwood.
2108. PHOTOGRAPHIC AND AERIAL SURVEYING. Elective for upperclassmen. Any term. Credit three hours. Prerequisite, Advanced Surveying 2102. The principles of photographic surveying; surveys with camera stations on the ground, including stereoscopic methods; aerial surveys and making of maps from such surveys; ground control. Recitations, lectures, and collateral reading. Three hours a week. Professor Underwood.
2109. MAP PROJECTIONS AND MAPPING. Elective for upperclassmen and graduate students. Credit three hours. The theory of map projections. Construction of projections. Plane coordinate systems. Map reproduction. Practice in topographic surveying and in mapping. One recitation and two laboratory periods a week. Professors Underwood and Lawrence.
2142. (a) GEODETIC ASTRONOMY. Any term. Prerequisites, courses Astronomy 186 and 2105. Investigations of instrumental errors; variation of latitude and azimuth; and all questions relating to work of the highest precision connected with astronomical problems and geodetic operations. The field is so broad that the interest of the student is given consideration as to the actual research undertaken. Professor Underwood.
(b) GEODETIC ENGINEERING RESEARCH. Either term. Prerequisites will depend upon the line of work to be pursued. Special problems in least squares, reduction of triangulation, and photographic surveying as may be arranged. Professor Underwood.
2143. SEMINAR IN GEODESY. One to six hours credit. Elective. Open to specially selected seniors or graduate students. Abstraction and discussion of technical papers and publications in the geodetic field.

## HOME ECONOMICS

Courses offered in the College of Home Economics are numbered in accordance with the following plan: courses numbered below 300 are, in general, undergraduate courses; courses numbered 300 to 400 are for seniors and graduate students; courses numbered above 400 are for graduate students. The full description of the undergraduate courses, listed in italic small letters, will be found in the Announcement of the College of Home Economics.

Unless otherwise noted all classes meet in Martha Van Rensselaer Hall.
Attendance for at least one semester during the regular academic year is usually necessary for candidates for the master's degree on the A Plan.

## CHILD DEVELOPMENT AND FAMILY RELATIONSHIPS

Professors Robert H. Dalton, Ethel B. Waring, Lemo R. Rockwood, Helen D. Bull; Associate Professors Katherine Reeves, Mary Ford; Assistant Professor Russell C. Smart, and Dr. Leon T. Yarrow.

APPROVED MAJOR AND MINOR SUBJECTS (key to symbols on p. 47)
Child Development and Family Relationships 1, 2, 3, 4
Child Development 2, 3, 4
Child Guidance 2, 3, 4
Family Relations 2, 3,4
Marriage 3, 4
Family Counseling 3, 4
As a basis for graduate work in Child Development and Family Relationships elementary courses in psychology, sociology and/or child development and family relationships are required. As a background for advanced work some experience in one of the following areas is also desirable: teaching or other experience with young children, school children, adolescents, or adults; social or clinical work; or extension teaching or administration.
In addition to course work the department offers opportunities for field work with families and with young children. Laboratory experience is provided in the department nursery school, in public nursery schools, play groups in the settlement houses, and in other organized groups.
102A. The Individual and the Family. Fall and spring. Credit three hours. This course and 102B must be taken in sequence and credit will not be given for one without the other. Not to be taken by students who have had Family Life 100. Primarily for freshmen and sophomores.
102B. The Individual and the Family. Continuation of course 102A. Fall and spring terms. Credit three hours. Primarily for freshmen and sophomores.
120. Home Nursing. Fall and spring. Credit one hour.
130. Experience with Children. Fall and spring. Credit two hours. For sophomores and second-term freshmen.
140. Creative Play in Childhood. Spring term. Credit three hours a term. For sophomores, juniors, and seniors.
150. Literature for Children. Spring. Credit two hours.
260. Family Relationships and Personality Development. Fall. Credit three hours.
300. SPECIAL PROBLEMS. Fall and spring. Credit and hours to be arranged. Department staff. For undergraduates and graduates.

For students recommended by advisers and approved by the head of the department and the instructor in charge for independent, advanced work not otherwise provided in the department.
302. HEALTH OF THE FAMILY. Fall and spring terms. Credit two hours. Primarily for juniors and seniors.
305. METHODS OF CHILD STUDY. Spring. Credit two hours. Primarily for seniors and graduate students. Limited to ten students. Prerequisite, one of the following courses: Child Development and Family Relationships 260, 310, 360, Psychology I and 2, Human Growth and Development or Rural Education 117. Associate Professor Ford. T Th 9. Room 124.

This course deals with techniques which contribute to the understanding of the preschool child. Methods to be considered are observational records, rating scales, mental tests, and play techniques. The student is expected to gain some understanding of the use and interpretation of various techniques through limited practice in one or more areas.
310. PRINCIPLES FOR CHILD GUIDANCE. Fall and spring terms. Credit three hours. Professor Waring. M W F 8. Room 124. Weekly small group discussions.

Observation in the nursery school includes study of individual children and their guidance; the aspects of their behavior - routine and creative, individual and social - as they are related in their personalities; and the guidance which promotes behavior that gives them social sanction, personal satisfaction, and optimum growth and development. Principles of guidance as the basis for selecting procedures and for predicting and evaluating their outcomes. Application to person-to-person relations at any age; and especially to older children, the sick, convalescent, and handicapped.
315. CHILD DEVELOPMENT. Advanced course. Spring. Credit three hours. Open to juniors, seniors, and graduate students. Prerequisite: Human Growth and Development and two or more credit hours of Child Development and Family Relationships or permission of the instructor. Dr. Yarrow. M W F 3. Room 3M13.

This course deals with the physical, motor, intellectual, social, and language behavior and development of the preschool child. Consideration of relevant research, literature, and planned observation of children in the nursery school.
325. EXCEPTIONAL CHILDREN IN THE FAMILY. Fall. Credit two hours. Open to juniors, seniors, and graduate students. Prerequisite: one of the following courses: Child Development and Family Relationships 102, 260, 310, 360, Psychology 1, Human Growth and Development or Rural Education 117. Associate Professor Ford. T Th 9. Room 121.

This course deals with the personal-social development of exceptional children (gifted, retarded, and physically handicapped); family attitudes and responsibili-
ties in relation to them; and community resources which supplement the family in providing for exceptional children. The primary emphasis is on the exceptional child in relation to his own family group.

## 330. A.B.C. PARTICIPATION IN NURSERY SCHOOL.

A. Junior Nursery School
B. Senior Nursery School
C. Ithaca City Nursery Schools and Child Care Centers

Fall and spring. Credit three or four hours for each section of the course. (Students may register in successive terms but section A or B must precede C.)

Open to qualified upperclass and graduate students who are preparing for nursery-school teaching, secondary-school teaching, extension, social work, or homemaking. Prerequisite, course 310. Principles for Child Guidance, Registration by permission of the instructor. Associate Professor Reeves and Nursery School teachers.

Study of young children in the nursery school group and in their homes. Consideration of the development of nursery education and its relation to Home Economics. Scheduled participation in the nursery school program.
In addition to participation, students will be responsible for the following conferences or discussions:
Students registered for Participation for the first time, $A$ or $B$ : Class discussion. Th 8. Room 124. Conference with teacher of nursery school group; A, T 12. Room G 62, 1st term; Room 124, 2nd term; B, T 8. Room 124.

Some home care of a nursery school child; some observation in the public schools; some attendance at parent group meetings.

Students registered for Participation for the second time, A or B: Same, except that instead of the class discussion Th 8 a period of field or clinical observation will be planned for each week.

Students registered for Section C. Conferences and special problems arranged individually.
360. DYNAMICS OF PERSONALITY. Fall. Credit three hours. Professor Dalton and Dr. Yarrow. M W F 11. Room 124.

A study of the development of the personality. Attention will be given to some of the various ways of studying personality, the basic aspects of growth, and the determinants of personality. Special emphasis will be directed toward an understanding of unconscious processes, and the directive forces in adult behavior.
370. MARRIAGE. Fall term. Credit three hours. Open to juniors and seniors and to graduate students by permission of the instructor. Professors Rockwood and Bull, Assistant Professor Smart. M W F 10 or 11. Each section limited to 50 students. Room 121.
380. THEORY AND TECHNIQUES OF FAMILY COUNSELING. Spring. Credit three hours. Open to graduate students and seniors. Limited to twelve students. Prerequisite, Child Development and Family Relationship 260 or 360 and permission of the instructor. Professors Dalton and Rockwood. Th 2-4. Room 114.

The place of counseling in human relationships - theories underlying its effectiveness. Consideration will be given to some diagnostic procedures and to some techniques utilized in counseling.
405. SEMINAR - RESEARCH METHODS. Fall. Credit two hours. Open to graduate students, and seniors by permission of the instructor. Dr. Yarrow. W 2-4. Room 121.

Introduction to methods and techniques in child development and family relationships. Planning of research; observational, interview, questionnaire, and projective techniques; analysis of data.
[420. PROSEMINAR IN CHILD DEVELOPMENT AND FAMILY RELA. TIONSHIPS. Fall. Credit three to six hours. Open to graduate students only. Required of all students majoring in the Department of Child Development and Family Relationships during their first year of graduate study. Staff. Th 2-4. Room 114. Not given in 1947-1948.]
430. RESEARCH IN CHILD DEVELOPMENT AND FAMILY RELATION. SHIPS. Fall and spring. Credits vary according to the nature of the problem. Professor Waring, Associate Professor Ford, Assistant Professor Smart, and Mr. Yarrow.

For graduate students who are actively engaged in research or in special studies in Child Development and Family Relationships.
[440. SEMINAR - THE FAMILY. Throughout the year. Credit two hours. Not offered in 1947-1948.]
450. SEMINAR-CHILD GUIDANCE. See Rural Education 228. Spring. Credit two hours. Prerequisite, some work in Child Development and Family Relationships. Professor Waring. W 4-6. Room G 58.
[460. FAMILY RELATIONSHIPS AND PERSONALITY DEVELOPMENT. Fall. Credit three or four hours. Professor Rockwood. M W F 10 or 11. Room 121 and T 11-12.30, for those registered for four hours' credit. Room 124. Not given in 1947-1948.]

## ECONOMICS OF THE HOUSEHOLD AND HOUSEHOLD MANAGEMENT

Professor Helen Canon; Associate Professors Ella M. Cushman, Mabel Róllins, and lucille Williamson; Assistant Professor Ann Aikin.

## APPROVED MAJOR AND MINOR SUBJECTS (key to symbols on p. 47)

Economics of the Household and Household Management 1, 2, 4
Students selecting a major in economics of the household and household management are expected to take courses in both phases of the field; for the Ph.D. degree the minor subjects are usually selected to support one phase or the other. Appropriate minor subjects may be chosen from a variety of fields including, besides other branches of home economics, agricultural economics, economics, education, psychology.
As a background for graduate work in this field, a well-rounded undergraduate program in home economics is preferable in general to specialization. Undergraduate courses in mathematics, statistics, economics, history, psychology, physics, chemistry, and bacteriology are also useful.
120. Household Processes. Fall and spring. Credit two hours. Primarily for freshment and sophomores.
130. Economic Conditions in Relation to the Welfare of Families. Fall and spring. Credit three hours. Primarily for freshmen and sophomores.
260. Problems in Providing Consumers' Goods. Fall term. Credit three hours. For undergraduate and graduate students.
300. Special Problems. Fall and spring. Credit to be arranged individually.
308. Management in Homes. Fall and spring. Credit one hour. For sophomores and juniors.
310. Management in Family Living. Fall and spring. Credit three hours. For juniors, seniors, and graduate students.
320. Management in Relation to Household Equipment. Spring term. Credit three hours. For juniors, seniors, and graduate students.
330. Management in Relation to Personal Finances. Fall and spring. Credit three hours. For juniors, seniors, and graduate students.
410. ECONOMIC PROBLEMS OF FAMILIES. Spring. Credit two hours. The instructor should be consulted before registering. Professor Canon. Th 2-4. Room 108.

Analysis of a few outstanding contributions to economic thought related to this field. Examination of methods of research.
415. PROBLEMS IN THE DISTRIBUTION OF CONSUMERS' GOODS. Spring. Credit two hours. Prerequisite, Economics of the Household 260 or the equivalent. The instructor should be consulted before registering. Associate Professor Rollins. F 2-4. Room 124.

Analysis of some of the important problems in distribution. Practice in locating and in using sources of data bearing on marketing problems. Discussion of contributions from research in marketing.
418. PERSONAL FINANCES. Fall. Credit two hours. The instructor should be consulted before registering. Assistant Professor Aikin. F 2-4. Room 133.

Examination of the nature of personal financial problems, and of adjustments in individuals' financial practices under changing conditions. The operation and regulation of financial institutions of importance in personal management. Analysis of teaching materials.
420. SEMINAR. Fall and spring. For graduate students. Department Staff. T 4-5:15. Room 114.

## FOOD AND NUTRITION AND INSTITUTION MANAGEMENT

Food and Nutrition: Professors Catherine Personius, L. A. Maynard, faith feivton, Hazel Hauck, C. M. McCay, Helen Monsch, Marion Pfund; Associate Professors J. K. Loosli, Grace Steininger, Charlotte Young; Assistant Professors Alice Briant, Grace Foster, Frances Johnston.
Institution Management: Professor Katherine Harris; Associate Professor Alice Burgoin.

> APPROVED MAJOR AND MINOR SUBJECTS (key to symbols on p. 47)

Food and Nutrition 1, 2, 3, 4
Nutrition 1, 2, 3, 4

Food 2, 3, 4
Institution Food 2, 4

As a basis for graduate work in food and nutrition, elementary courses in home economics and courses in inorganic and organic chemistry are expected. A knowledge of quantitative chemical analysis, biochemistry, physiology, bacteriology, physics, physical chemistry, and statistics is desirable.

Before applying for admission to the Graduate School a prospective student is advised to communicate with a member of the faculty in the field in which she wishes to do research or with the chairman of the department: Food and Nutrition, Professor Personius; Institution Management, Professor Harris. Animal Nutrition, Professor Maynard.

## FOOD AND NUTRITION

100. Food Preparation in Relation to Meal Planning. Fall and spring. Credit three hours.
101. Elementary Food and Nutrition. Fall and spring. Credit five hours.
102. Nutrition and Health. Fall. Credit two hours. For students outside the College of Home Economics.
103. Food Preparation: Principles and Comparative Methods. Fall. Credit four hours.
104. Science Related to Food Preparation. Fall. Credit five hours.
105. Science Related to Food Preparation. Spring. Credit five hours.
106. Food Preparation: Principles and Comparative Methods. Fall term. Credit five hours.
107. Nutrition. Spring. Credit three hours.
108. Food Preparation: Advanced Course. Fall and spring. Credit three hours.
109. Food Preservation. Summer Session only. Credit two hours.
110. Meal Planning and Preparation. Fall and spring. Credit three hours.
111. SPECIAL PROBLEMS. Fall and spring. Credit and hours to be arranged. Registration with permission of the head of the department and the instructor in charge.

Independent advanced work on a problem not dealt with by other courses in the department.
305. FOOD DEMONSTRATIONS. Fall and spring. Credit one hour. Prerequisites, Food and Nutrition 210, 215, or 225 and a course in elementary nutrition. Registration with permission. Assistant Professor Foster. T Th 2-3:30. Room 361.
Emphasis on the purposes and techniques of demonstration in relation to food preparation and nutrition, with application to teaching, extension, business, and social service.
310. SCIENCE RELATED TO FOOD, ADVANCED COURSE. Fall. Credit three hours. Prerequisites, Food and Nutrition 210, 215 or 225, and 240 or 260, or the equivalent. Registration with permission. Professor Personius. M W F 8. Room 339.

The scientific principles necessary to the understanding of modern theory and practice in the field of food preparation. Historical and current literature is reviewed.
320. EXPERIMENTAL COOKERY. Spring. Credit three hours. Prerequisites, Food and Nutrition 210, 215 or 225, and 240 or 160; Food and Nutrition 310 is
recommended to precede this course. Registration with permission. Professors Personius and Pfund. W F 8-11 or 10-1. Room 426.

Independent laboratory work in the solving of practical problems in food preparation. Study of methods and techniques used in experimental work in food. Judging of food products.
325. SEMINAR - FROZEN FOOD. Spring. Credit one hour. Sponsored jointly with the School of Nutrition. Primarily for graduate and senior students in Agriculture, Home Economics, Hotel Administration, and the School of Nutrition. Registration with permission. Professor Fenton in charge. Th 2. Room 339.

Lectures on each subject will be given by a staff member who is currently engaged in research in that area.

Selection and processing vegetables; selection and processing fruits; selection and processing meats; packaging materials and methods; freezing rates; freezing methods and equipment; storage; precooked or prepared foods; thawing and cooking; economic trends; patron and consumer desires; quality control.
330. DIET THERAPY. Fall. Credit two hours. Prerequisite, Food and Nutrition 230 or the equivalent. Registration with permission. Professor Hauck. T Th 8. Room 426.
Diet in those diseases such as fevers, gastro-intestinal disturbances, and diabetes, in the treatment of which choice of food is important.
340. FAMILY NUTRITION, WITH SPECIAL EMPHASIS ON CHILD FEED. ING. Fall term. Credit two hours. Prerequisite, Elementary Nutrition. Professor T 2-4. Room 339.
Special emphasis on the nutritional needs of the child. Relation of nutrition to physical growth and development.
341. Laboratory in family and community nutrition. Fall term. Credit one hour. Prerequisite or parallel, Food and Nutrition 340 or the equivalent. Professor -. Th 2-4. Room 432.

Problems in community nutrition programs. Practice with low-cost diets and diets for various nationality groups; preparation of illustrative material.
360. SEMINAR IN FOOD AND NUTRITION. Fall. Credit one hour. Primarily for seniors; open to graduate students. Prerequisites, Elementary Nutrition and Food and Nutrition 210, 215 or 225. Professor Fenton and Associate Profzssor Steininger. Th 2. Room 301.

Study of historical and current literature.
401. READINGS IN NUTRITION. Spring. «Credit two hours. Registration with permission of the instructor. Professor Hauck. T Th 9. Room 301.

Critical review of literature on energy metabolism, proteins, fats, and carbohydrates with emphasis on experimental data on which the principles of human nutrition are based.
410. RESEARCH IN FOOD AND NUTRITION. Fall and spring. Credit and hours to be arranged. Registration with permission of the instructor. Professors Personius, Maynard, Fenton, Hauck, McCay, Monsch, and Pfund; Associate Professors Loosli, Steininger, and Young; Assistant Professors Briant and JohnsTON.

Individual research in food, human nutrition, and animal nutrition.
420. ADVANCED SEMINAR IN FOOD AND NUTRITION. Fall and spring. Emphasis on nutrition in fall term, on food in spring term. Credit one hour each term. Department Staff. T 4. Room 301.

Note: The attention of advanced and graduate students is called to the courses offered in other departments, listed in the Announcement of the School of Nutrition.

## INSTITUTION MANAGEMENT

100. Institution Food Service. Fall and spring. Credit three hours. Primarily for freshmen.
101. Food Selection and Purchase for the Institution. Fall and spring. Credit three hours.
102. Quantity Food Preparation: Principles and Methods. Fall and spring. Credit five hours. For juniors and sophomores by permission.

Tea Room and Cafeteria Accounting. (Hotel Accounting 240.) Fall and spring. Credit three hours. For sophomores and juniors.
300. SPECIAL PROBLEMS. Fall and spring. Credit and hours to be arranged individually. For students approved by the head of the department and the instructor in charge for independent, advanced work on a problem not dealt with by other courses in the department.
320. INSTITUTION ORGANIZATION AND ADMINISTRATION. Spring. Credit four hours. Should be taken in the senior year. Advised for all students specializing in institution management or dietetics.
330. QUANTITY FOOD PREPARATION AND CATERING, ADVANCED COURSE. Fall and spring. Credit five hours. Open to seniors and a limited number of juniors majoring in institution or hotel management who have obtained the approval of the Department of Institution Management before registering.
[RESTAURANT COST AND SALES ANALYSIS. (Hotel. Accounting 340.) Spring. Credit two hours. Prerequisite, Institution Management 230. Not given in 1947-1948.]
350. INSTITUTION PRACTICE. Fall and spring. Credit four hours. Open to seniors majoring in institution management, with the permisison of the instructor and the class counselor.
400. RESEARCH IN INSTITUTION ORGANIZATION AND ADMINISTRATION. Throughout the year. For graduate students with training and experience satisfactory to the instructor. Professor Harris and other staff members. Hours to be arranged. Fee determined by the problem.

Individual research in the area in which the student is particularly interested. Food-control procedure, job analyses and specifications, experimentation and development of standardized procedures in food preparation and merchandising as applied to quantity production, determination of factors underlying operation and maintenance costs are suggestive of the fields in which there is vital need for research.
410. SEMINAR IN INSTITUTION ORGANIZATION AND ADMINISTRATION PROBLEMS. Spring term. Credit one hour. For graduate students with adequate training in institution management. Professor Harris.

## HOME ECONOMICS EDUCATION

Professors Flora Thurston and Margaret Hutchins; Assistant Professor Irene Patterson.

For courses in Home Economics Education see p. 166 under School of Education.

## TEXTILES AND CLOTHING AND HOUSING AND DESIGN

Textiles and Clothing: Professor Beulah Blackmore; Associate Professors Muriel Brasie, Elsie Frost, Margaret Humphrey, and Ruth Scott.
Housing and Design: Professor Nancy M. Roman; Associate Professor Dora W. Erway; Associate Professor Virginia True; Assistant Professors Mabel Wilkerson and Helen J. Cady.

## APPROVED MAJOR AND MINOR SUBJECTS (key to symbols on p. 47)

Textiles and Clothing and Housing and Design 2, 3, 4.
Graduate work for the Master's degree is offered in Textiles and Clothing and Housing and Design. Emphasis may be placed upon either Textiles and Clothing or Housing and Design.

## TEXTILES AND CLOTHING

The work in Textiles and Clothing may emphasize either the economic, sociological, educational, or practical aspects of the subject.
100. Clothing Selection and Construction. Fall and spring. Credit three hours.
101. Selection, Purchase, Care. Fall and spring. Credit three hours. Not to be taken by students who have had course 100.
110. Clothing Construction. Fall and spring. Credit two hours. Suggested for sophomores. Prerequisite, Textiles and Clothing 100, 101 or the equivalent.
130. Textiles: Clothing Fabrics. Fall and spring. Credit two hours.
200. Fitting and Pattern Making, Flat Pattern Work, Modeling. Fall and spring. Credit three hours. By permission of the department. Prerequisite, Textiles and Clothing 100, 101, 110, and 210.
205. Clothing of the Family. Spring term. Credit two hours. For upperclass students and graduate students interested in child development and family relationships, teaching, or social work.
210. Dress Selection and Design. Fall and spring. Credit two hours. Prerequisite, Textiles and Clothing 100. For students intending to teach.
220. Commercial Clothing and Advanced Problems in Construction. Fall and spring. Credit three, four, or five hours. Prerequisite, Textiles and Clothing 200.
235. SCIENCE RELATED TO TEXTILES. Fall and spring. Credit two hours. Prerequisites, Food and Nutrition 215 or its equivalent, Textiles and Clothing 130 or 310. Mrs. Norton. W F 8-10. Room 353.

A course concerned with the chemistry involved in the study of fabrics. Laboratory work includes the observation of the chemical properties of the major
fibers used in clothing and household fabrics; analysis of anti-perspirants; stain removal by methods which can be adapted for home use; simple performance tests on fabrics and evaluation of these and standard tests.
300. SPECIAL PROBLEMS. Fall and spring. Credit and hours to be arranged individually. For students approved by the head of the department and the instructor in charge for independent, advanced work on a problem not dealt with by other courses in the department.
310. HOUSEHOLD TEXTILES. Fall and spring terms. Credit two hours. For juniors, seniors, and graduate students. (Graduate students please see Textiles and Clothing 410 and consult with instructor.) Professor Blackmore. T Th 9-11. Room 278.

A study of the range in quality in household textiles and the methods of selecting the quality best suited to specific needs. Buying problems in the area of household textiles.
Technical information necessary for efficient buying. Identification of fibers and physical testing of fabrics for properties which affect satisfactory use. Procedure and performance of standard and other physical tests will be evaluated. A study of specifications set up by various groups. Existing state laws governing the sale of certain household textiles.

A two-day trip to four or more manufacturing establishments to observe designing, weaving, making of certain household fabrics, and methods used in preparing fabrics for the retail market. (If trip is possible in 1947-1948 student will be responsible for transportation and living expenses involved.) Estimated cost of materials, $\$ 2$.
320. PROBLEMS IN BUYING CLOTHING. Spring term. Credit three hours. For juniors, seniors, and graduate students. Associate Professor Brasie.
Spring: M W F 11. Room 213.
The course is planned to develop an appreciation of, and an alertness to the problems in buying clothing; an understanding of some of the problems involved in clothing production and marketing, consumer responsibility in this field, and skill in buying clothes.
Illustrated lectures and discussion of such topics as the relationship of such factors as labeling, design, construction, and fit, to the quality and the cost of similar types of wearing apparel; management problems met by people in choosing clothing best suited to their specific needs and desires; government regulations; trends toward simplification and standardization; services provided by various government and commercial agencies; trends in fashion growing out of current events.
Reference reading and a special problem supplement class discussion. (If trips are possible during 1947-1948 students will be responsible for transportation and expenses involved.)
400. DRESS DESIGN, ADVANCED COURSE. Spring. Credit three hours. Prerequisites, Textiles and Clothing 200 and 220, or their equivalent. For upperclassmen and graduate students. Associate Professor Frost. T Th 2-4:45. Room 216.

A course in advanced dress design with emphasis on the development of originality and beauty of execution. Approaches in design problems are made through
experimental manipulation of fabric combination; use of historic and contemporary design sources; draping; sketching.

The majority of the designs will be draped and fitted in muslin. The development of the designs into finished garments will depend on the needs and interests of the students. Estimated cost of material, $\$ 5$ to $\$ 25$.
410. SEMINAR IN TEXTILES. Fall and spring. Credit one hour. Parallel, Textiles and Clothing 310. For graduate students. Consult the instructor before registering. Professor Blackmore. Hours to be arranged.
430. SEMINAR IN TEXTILES AND CLOTHING. Spring. One hour by arrangement. For graduate students. Department Staff. Room 216.

## HOUSING AND DESIGN

Before entering upon advanced work in Housing and Design the student should have had basic courses in color and design, house planning and house furnishing, family life, and household management. Whether a student's preparation is adequate for advanced study can be determined only by special consideration of each case.
100. Color and Design. Fall and spring. Credit three hours.
110. Applied Design. Fall term. Credit two hours.
130. Hotel Furnishing and Decorating. Fall and spring terms. Credit two hours.
[150. Housing. Credit two hours. Not given in 1947-1948.]
[160. Contemporary Art. Fall. Credit two hours. Not given in 1947-1948.]
170. Growth and Development of Handicrafts. Credit one hour.
200. Studio Course in Advanced Color and Design. Fall, 1947. Credit two hours. Given in alternate years.
216. Applied Textile Design. Fall and spring. Credit two hours. Prerequisite, Household Art 100.
220. Home Furnishing. Fall and spring. Credit three hours. Prerequisite, Household Art 100.
225. Home Furnishings. Fall and spring. Credit three hours. Prerequisites, H D 100 and 220.
235. Home Furnishings. Fall and spring. Credit three hours. Prerequisites, H D 100 and 220 or consent of the instructor.
240. House Planning. Fall and spring terms. Credit three hours. Prerequisite, Household Art 220.
300. SPECIAL PROBLEMS. Fall and spring terms. Credit and hours to be arranged individually. For students approved by the head of the department and the instructor in charge for independent, advanced work on a problem not dealt with by other courses in the department. Members of the staff.
305. FASHION ILLUSTRATION. Spring. Credit three hours. Prerequisites, H D 100 and Arch. 340 or the equivalent. Clothing courses desirable. Associate Professor True. T Th 10-1. Room 327. Minimum cost of materials, $\$ 7$.

A course planned to introduce the student to the requirements of knowledge and skills for the fashion illustrator. Study of layouts for fashion advertisements,
techniques for reproduction processes used in newspaper and magazine fashion illustration, fashion styles, and presentation of work.
320. HISTORIC FURNITURE AND INTERIOR DESIGN. Fall. Credit two hours. Prerequisite, H D 220. Assistant Professor Wilkerson. T Th 11. Room 317.
A course concerned with the developments of furniture and interior design from early forms through the major historic periods to the present showing the recurrence of structural forms adapted and modified according to the taste of the period, which in turn reflects the economic, political, and social aspects of the time.
405. GRADUATE COURSE IN HOUSE FURNISHINGS FOR EXTENSION WORKERS. Spring. Credit six hours. Prerequisite, undergraduate courses in Furnishings, and/or experience in extension furnishings work. Registration by permission of the instructor. M W F 8-12. Room 322. Associate Professor Wright.
A course planned especially for prospective or experienced Extension furnishings specialists or agents. Classwork includes problems in selection and arrangement of home furnishings for color, design, quality; upholstering and refinishing of furniture; selection of fabrics; lighting; use of paint and wall paper; slipcovers; buying. During the course students are expected to prepare demonstration material such as is needed in extension work. Estimated minimum cost of materials, $\$ 25$.

## HOTEL ADMINISTRATION

Professors H. B. Meek, F. H. Randolph, Louis Toth, A. L. Winsor, John Court- ney, C. I. Sayles, and C. E. Cladel.

# APPROVED MAJOR AND MINOR SUBJECTS (key to symbols on p. 47) 

Hotel Management 2, 4 Hotel Accounting 2, 4
Note. A major or minor subject may be selected in the field of Hotel Administration provided the other subject is taken outside the department of Hotel Management and has the approval of the Dean of the Graduate School.
Graduate work for the Master's degree is offered in Hotel Administration. A foundation knowledge of hotel management is required of graduate students majoring in the field. Such students will choose a minor in a related or underlying field such as accounting, statistics, engineering, or one of the social sciences. Students majoring in the latter fields may find in the problems of the hotel industry a fertile field for research.
Through its contacts with the American Hotel Association and its subsidiary associations and with member hotels the University has possession of and access to a wide range of research material.
81 and 82. Accounting. Throughout the year. Credit eight hours.
114. Psychology for Students of Hotel Administration. Fall term. Credit three hours.

181 and 182. Hotel Accounting. Throughout the year. Credit eight hours.
183. Auditing. First term. Credit three hours.
184. Food and Beverage Control. Spring term. Credit three hours.
187. Tax Computation. Fall term. Credit two hours.
240. Tea Room and Cafeteria Accounting. Fall term, to be repeated in spring term. Credit three hours.
282. Accounting Practice. Fall term. Credit three hours.
283. Advanced Accounting. Spring term. Credit three hours.
284. Problems in Food Control. Spring term. Credit one hour.
288. Accounting Machines in Hotels. Fall term, to be repeated in the spring term. Gredit one hour.
340. Restaurant Cost and Sales Analysis. Spring term. Credit two hours.
[151. Hotel Operation. Fall term. Credit two hours. Not given in 1947-1948.]
Special Hotel Equipment (Hotel Engineering 261). Fall term. Credit three hours.

Water Systems (Hotel Engineering 262). Spring term. Credit three hours.
Steam Heating (Hotel Engineering 263). Fall term. Credit three hours.
Electrical Equipment (Hotel Engineering 264). Spring term. Credit three hours.

HOTEL PLANNING (Hotel Engineering 265). Spring term. Credit three hours. Open to seniors and graduate students. Discussion, T Th 9-10:30. East Roberts 223. Professor Randolph.

Planning the layout for a proposed hotel, emphasizing floor plans and the selection and arrangement of the equipment in the various departments, including the kitchen and the laundry.
[HOTEL STRUGTURES AND MAINTENANCE. (Hotel Engineering 266). Spring term. Credit three hours. Lectures, M W F 11. East Roberts 222. Laboratory sections as assigned in alternate weeks; computation period M 9 in alternate weeks. Associate Professor Sayles. Not given in 1947-1948.]
185. HOTEL ACCOUNTING PROBLEMS. Spring term. Credit two hours. Prerequisite, Hotel Accounting 183 or its equivalent. Assistant Professor Тотн. Incorporating the hotel owning and operating companies. Financing bond issues and discounts. Accounting provisions in hotel leases and management contracts. Installation of hotel accounting systems.
186. INTERPRETATION OF HOTEL FINANCIAL STATEMENTS. Spring term. Credit two hours. Prerequisite, Hotel Accounting 183 or its equivalent. Assistant Professor Tотн.

Study and discussion of hotel balance sheets and profit and loss statements. Typical balance sheets and operating ratios of representative hotels.
189. PROBLEMS IN ANALYSIS AND INTERPRETATION. Fall term, to be repeated in the spring term. Credit two or three hours, depending on work done. Registration limited. Assistant Professor Courtney. Martha Van Rensselaer G-1. Fee for materials, $\$ 3$.
A seminar course for graduate students or seniors in hotel administration. Application of statistical methods to problems in analysis and interpretation. Each student will solve one or more problems.
153. SEMINAR IN HOTEL ADMINISTRATION. Fall term, to be repeated in the spring term. Credit two hours. Prerequisite, Hotel Administration 151 or its equivalent. Registration limited. Professor Meek.
A course devoted to the study of specific problems arising in the management of hotels.
119. PERSONNEL ADMINISTRATION IN HOTELS. Spring term. Credit three hours. Prerequisite, Rural Education 114 or its equivalent. Professor Winsor.

Study of the problems of human relations in industry. Methods and problems of recruitment, selection, placement, maintenance, organization, and government of employees are analyzed with particular reference to the hotel industry.
219. SEMINAR IN PERSONNEL ADMINISTRATION. Spring term. Credit two hours. Prerequisite, 119. Professor Winsor.
An analysis of current problems in personnel administration.

# INDUSTRIAL AND LABOR RELATIONS 

Professors C. Kenneth Beach, John M. Brophy, Lynn A. Emerson, Milton R. Konvitz, Vernon H. Jensen, John W. McConnell, Jean T. McKelvey, Royal E. Montgomery, J. E. Morton, Maurice F. Neufeld, Donald J. Shank, and A. L. Winsor.

The New York State School of Industrial and Labor Relations in conjunction with other Schools and Departments of the University offers the following areas of specialization at the graduate level: Collective Bargaining, Mediation, and Arbitration; Human Relations in Industry; Industrial Education; Industrial and Labor Legislation and Social Security; Labor Union History, Organization, and Management; and Personnel Management. Admission to graduate standing is determined by the Graduate School.
In general, undergraduate specialization substantially equivalent to that offered by the School is a prerequisite for admission to the Graduate School. An applicant's work experience and other relevant activities will also be taken into account. Subject to the overall limitation of the number of students which the School may admit, graduates of accredited institutions who are without the necessary undergraduate specialization, may apply for admission as special students. If such students are admitted, a period of from one to three terms is usually required in order to fulfill requirements for admission to the Graduate School.
The School offers an opportunity for candidacy for the degrees of Master of Science in Industrial and Labor Relations (M.S. in I.L.R.) and Ph.D. Students concentrating in the field of Industrial Education will, upon successful completion of the requirements of the Master's Degree, receive a Master of Science in Education. The work toward that degree is planned jointly by the School of Industrial and Labor Relations and the School of Education. Residence, language, and other requirements for each degree will be found elsewhere in this Announcement.
In general, a minimum of two terms of residence for the M.S. and six terms of residence for the Ph.D. degrees are required by the University. (For the Ph.D. degree, a maximum of two terms of work may be done in absentia.) For the M.S. degree, four courses in each term, or their equivalent, in addition to the preparation of a thesis, will usually be required. Courses may be selected in other divisions of the University. A wide range of specialization within the field of industrial and labor relations is, therefore, possible. For the Ph.D. degree, field experience or internship may be included as part of the candidate's research program. Details as to courses, thesis, and examination requirements, and other procedural matters, may be determined by the applicant upon admission to graduate standing in the School.

A candidate for the M.S. and Ph.D. degrees works under the direction of a Special Committee composed of two or three members of the faculty. For the M.S. degree, one major and one minor subject, for the Ph:D. degree, one major and two minor subjects, must be selected from the following list. Except as indicated under two of the subjects, each of the six areas of specialization may be selected by a candidate for either degree as a major or a minor subject.

While the following subjects indicate areas of concentration in major and minor fields, candidates for the M.S. and Ph.D. degrees will be expected to show familiarity with all fields indicated, in addition to those selected as their majors and minors.
A limited number of graduate assistantships is available and awarded annually to graduate students qualified to assist in the research and instruction carried on at the School.

# APPROVED MAJOR AND MINOR SUBJECTS (key to symbols on p. 47) 

Collective Bargaining, Mediation, and Arbitration 1, 2, 3, 4
Human Relations in Industry 1, 2, 3, 4
Industrial and Technical Education 1, 2, 3, 4
Industrial and Labor Legislation and Social Security 1, 2, 3, 4
Labor Union History, Organization, and Operation 1, 2, 3, 4
Personnel Management 1, 2, 3, 4
A student who proposes to take either a major or minor in Industrial and Labor Relations must select one of the above subjects.

As background for their independent research, candidates for the Ph.D. degree are expected to meet certain general requirements in these subjects as follows.*

Collective Bargaining, Mediation, and Arbitration. For a major in this subject, the candidate must show knowledge of: (1) the history, current developments, and issues in collective bargaining practices and procedures; (2) the content of trade agreements in different types of industry; (3) state and federal legislation in the field of collective bargaining, mediation, and arbitration; (4) leading cases in this field of labor law; (5) administrative agencies and their functions.
For a minor, (1), (3), and (5) are required.
Human Relations in Industry. For a major in this subject, the candidate must present: (1) comprehensive knowledge of industrial psychology, the relevant materials of anthropology and sociology as applied to industry especially the fundamentals of individual and group behavior, and the growth of institutions; (2) familiarity with principles and practices of personnel administration; (3) knowledge of labor union organization and activity and collective bargaining techniques; (4) knowledge of community conditions affecting individual and social behavior and available community resources; (5) Knowledge of educational techniques in industrial and labor relations.
For a minor, (1), (2) and (3) are required.
Industrial and Technical Education. For a major in this subject, the candidate must show: (1) comprehensive understanding of industrial and technical education programs in public institutions, private institutions, and industry; (2) ability to develop analyses for instructional purposes and prepare an educational or training program based upon analyses; (3) understanding of economic, social, and scientific factors which may modify industrial and technical education programs; (4) understanding of instructional methods and their application in learning situations; (5) ability to apply administrative and supervisory principles to industrial and technical education programs; (6) detailed knowledge of bibliographies and sources of information in this field.

[^17]For a minor, (1), (2) and (3) are required.
Industrial and Labor Legislation and Social Security. For a major in this subject, the candidate must show; (1) familiarity with the sources and nature of insecurity; (2) a comprehensive knowledge of the origin, development, constitutionality and administration of legislation in such fields as minimum wage, hours, protection of women and children, discrimination, health and safety, workmen's compensation and social insurance; (3) a knowledge of the efforts of labor, industry, and the community to meet these problems on a voluntary basis; (4) familiarity with one special field of legislation, and the administrative and legal experience in that field; (5) knowledge of the past and current proposals for improving and extending legislation.
For a minor (1), (2), and (5) are required.
Labor Union History, Organization, and Management. For a major in this subject, the candidate must present: (1) comprehensive knowledge of the history of the American labor movement and familiarity with the history of labor in other countries; (2) comprehensive knowledge of the organizational structure, problems, and management of American labor unions; (3) specific knowledge of the organizational structure, problems, and management of two labor unions in different types of industries; (4) understanding of the economic and social policies and practices of labor unions in their relation to union organization and management problems and techniques; (5) familiarity with the types of union leadership and rank and file behavior; (6) detailed knowledge of the bibliography and sources of information in this field.

For a minor (1), (3), and (4) are required.
Personnel Management. For a major in this subject, the candidate must present: (1) Comprehensive knowledge of the general principles of personnel organization and operation; (2) knowledge of labor and industrial legislation and social security; (3) knowledge of labor union organization and activity and collective bargaining techniques; (4) acquaintance with current methods and procedures in such fields as job rating and evaluation, systems of wage payment and administration, time and motion study, industrial training and education; (5) a knowledge of industrial psychology, especially testing, placement, and the fundamentals of individual and group behavior.

For a minor, (1) (2) and (3) are required.

## GRADUATE SEMINARS AND COURSES Industrial and Labor Relations

## 100. CASE STUDIES IN INDUSTRIAL AND LABOR RELATIONS.

Group research on specific problems in the field of contemporary industrial and labor relations. The interests of the group will determine the selection of topics to be studied in any one year.

## 102. COLLECTIVE BARGAINING, MEDIATION, AND ARBITRATION.

An analysis of the issues in collective bargaining and the techniques in drafting and administering of labor-management contract, the organization and procedures of unofficial and official mediation and arbitration agencies, and the principles of mediation and arbitration as developed by these agencies.

## 103. BASIC ECONOMIC STATISTICS.

For graduate students who have not taken a course in Statistics or who wish to take a refresher course. Emphasis will be placed on discussion on technical
aspects of statistical analysis, and on initiative in selecting and applying statistical methods to individual research problems. The subjects ordinarily covered will include analysis of frequency distributions, of time series (including index numbers), correlation analysis, and analysis of variance.

## 104. HUMAN RELATIONS IN INDUSTRY.

An examination of the social structure, social processes, and human relations within the mine, mill, or factory unit. Attention will be given to the forces underlying the behavior of management and workers, the behavior patterns which control relationships, the nature of the adjustments made to changing industrial situations, and the personal and group relationships which characterize the activities of workers and management. The impact of social institutions, and the influence of social cleavages arising from racial and national origins of workers, upon the relationships within the production unit will be matters of investigation and discussion.

## 105. INDUSTRIAL AND LABOR LEGISLATION AND SOCIAL SECURITY.

A study of the nature of labor's risks and the origin and development and administration of legislation in fields such as minimum wage, hours, protection of women and children, workmen's compensation, social insurance, discrimination, and working conditions. Voluntary programs and European legislation are examined.

## 106. UNEMPLOYMENT AND THEORY OF EMPLOYMENT.

Consideration of the problem of unemployment with an analytical appraisal of various theories and proposals which look to a solution of the problem.
107. WAGE DETERMINATION AND RELATED PROBLEMS (Econ. 48).

A study of wage-hour and labor market structure; of the determinants of distribution; of the factors commonly involved in collective wage determination; of wage policies and their relation to industrial fluctuations, and other wage, hours, and employment problems.
109. LABOR UNION HISTORY, ORGANIZATION, AND MANAGEMENT.

Specific studies in the organization, administration, and management of labor unions, including such services and functions as education, labor banking, housing, pension systems, health insurance, and labor cooperatives.
110. COMPARATIVE LABOR MOVEMENTS.

The history, development, and trends of labor movements in other countries.
111. PERSONNEL MANAGEMENT (Hotel Adm. 219).

Seminar in Personnel Administration.

## 112. INTERNATIONAL ECONOMIC AND SOCIAL ORGANIZATION.

Studies in such international organization and agencies as The International Labor Office, the Economic and Social Council, and the World Federation Trade Union as they affect the development, attitudes, structure, and problems of the American labor movement.

## 113. SEMINAR IN ECONOMIC STATISTICS.

An analytical appraisal of statistical sources; methods, presentation, and interpretation in the field of industrial and labor relations. Each seminar will be given over to the study of one specific topic, such as: design of complex experiments and sampling in economics, advanced theory and analysis of index numbers, time series, etc.
46. (Econ) LEGAL AND CONSTITUTIONAL ASPECTS OF LABOR PROBLEMS.

A study of the legal aspects of trade union objectives and methods; and an examination of state-labor relationships. Among the topics treated: legal theories underlying labor law; statutory enactments affecting trade unions; injunctions, damage suits, criminal prosecutions, restrictions upon employers; conciliation, arbitration, mediation; and various types of labor legislation.

## 114. CIVIL RIGHTS IN industrial and labor RELATIONS.

The constitutional freedoms of speech, press, and assembly as related to employers and employees; the rights of racial and national minority groups as applied to public and private employment; laws regulating the behavior of public employees in such matters as political activities; membership in labor organizations and collective bargaining; current and pending cases in legislation affecting the civil rights of employers and employees; the legal status of women; and the development in international law of concepts of civil rights in industrial and labor relations.
199. SPECIAL STUDIES.

Directed research in special problems.

## INDUSTRIAL AND TECHNICAL EDUCATION

83. CURRICULUM CONSTRUCTION IN INDUSTRIAL AND TECHNICAL EDUCATION. Spring term. Credit two hours. Th 4:15-5:45.
Deals with principles and procedures of curriculum construction for industrial and technical schools.
84. JOB ANALYSIS TECHNIQUES. Fall term. Credit two hours. Th 4:15-5:45.

Deals with various types of job analysis and their relation to job specifications, job descriptions, training programs, and job evaluations.
80. Industrial and technical education in the united STATES. Fall term. Credit two hours. S 9-10:30.

An overview course dealing with the various types of programs in industrial and technical education. Study will be made of industrial arts education, unit trade programs in vocational high schools, apprentice training, technical high schools, and technical institutes. Some attention will be given to private trade schools diversified occupation programs, and special programs for veterans.
82. INDUSTRIAL PLANT TRAINING FOR WORKERS AND SUPERVISORS. Spring term. Credit two hours. S 9-10:30.
Study of the various types of industrial training programs found in industrial plants. Deals with vestibule schools, on-the-job training, apprentice training, company schools for customer service men, evening classes of supplementary type, and foreman and supervisor training. Consideration will also be given to training methods used in training programs.
132. ADMINISTRATION OF INDUSTRIAL AND TECHNICAL EDU. CATION. Spring term. Credit two hours. W 4:15-5:45.

A course in school administration dealing with the responsibilities of the principal and administrative assistants in industrial and technical high schools, and in technical institutes. Consideration will also be given to the problems of the city director of vocational education.
130. SUPERVISION OF INDUSTRIAL AND TECHNICAL EDUCATION. Fall term. Credit two hours. S 11-12:30.
Principles and practices in the improvement of instruction in all phases of industrial high school, technical high school, and technical institutes.

## LAW

Professors R. S. Stevens, L. P. Wilson, G. J. Thompson, H. E. Whiteside, H. D. Laube, G. H. Robinson, W. H. Farnham, J. W. McDonald, A. J. Keefe, A. E, Sutherland; Associate Professors B. F. Willcox, Arthur Larson, Harrop Freeman, L. W. Morse.
All members of the Law Faculty are expected to be in residence during the coming academic year.
The Division of Law consists of members of the Faculty of Law, representatives of the associate departments of Economics, Government, History, and Philosophy in the College of Arts and Sciences, Professors Donald English, R. E. Cushman, M. L. W. Laistner, and G. W. Cunningham, and such other members of the Graduate School Faculty as for the time being are serving on the special committees of candidates for the graduate degrees in law.

APPROVED MAJOR AND MINOR SUBJECTS (key to symbols on p. 47)

Jurisprudence 1, 2, 3, 4
Legal History 1, 2, 3, 4
Private Law 1, 2, 3, 4
Graduate work in law is organized under the direction of the Division of Law of the Graduate School, in which is vested authority to establish and administer rules for the admission to candidacy for, and graduation with, the degrees LL.M. and J.S.D.

This method of organizing graduate work in law is considered especially advantageous since it offers to graduate students in law an opportunity to correlate their work in law with work in allied fields in other departments of the University, such as those in philosophy, history, government, business, and finance.

Candidates for either of the graduate degrees in law must be in residence not less than one academic year.

The Master's degree is intended primarily for those who desire to increase their knowledge of the law by intensive work in special fields.

Work leading to the Doctor's degree is designed to train legal scholars and to stimulate original investigation in the purpose, administration, history, and progress of the law. It is expected that candidates for the Doctor's degree shall have had some professional practice or teaching experience after obtaining a first degree in law.

As each candidate for a graduate degree in Law is admitted and his program arranged on an individual basis, no courses, except Jurisprudence, are prescribed for all. The content of the program of any particular candidate will depend upon his individual needs. A description of Professor Laube's course in Jurisprudence will be found in the Announcement of the Law School.

Graduate students may pursue work in Administrative Law, Business Regulation, Commercial Law, Constitutional Law, International Law, Jurisprudence, Labor Law, Legal History, Procedure, Property, Taxation, or in any other field of the Law in which they have an interest. Candidates who can not receive the instruction they require in the regular established courses listed in the Law School

Announcement may study under the personal supervision of the appropriate members of the Faculty.

A number of furnished offices are provided in the Law School building, Myron Taylor Hall, for graduate students in Law.
Further information in regard to graduate work in Law can be found in the Law School Announcement.

For the procedure to be followed by a candidate for LL.M. see p. 19 of this Announcement, and for J.S.D. see page 28.

## SPECIAL REQUIREMENTS FOR PROFESSIONAL DEGREES

The following special requirements apply in the case of the professional masters' degrees enumerated.
Master of Laws, LL.M. The degree of LL.M. is intended primarily for those who desire to increase their knowledge of the law by work in special fields. In addition to meeting the general requirements for admission given on page 8 , the candidate must have received the degree of Bachelor of Laws from an approved law school and must have shown a high level of professional ability. To complete the requirements for the degree the candidate (1) must work for a minimum period of two terms under the direction of a Special Committee of three or more, chosen by the candidate, after consultation with the chairman of the Division of Law, from the Faculty in Law and related fields (such as Economics, Government, History, Philosophy, Business and Public Administration, and Industrial and Labor Relations); (2) shall complete with high merit such a program of instruction and investigation as shall be approved by his Special Committee and acceptable to the Division; (3) must demonstrate his ability creditably to pursue research in Law by the submission of articles or reports; and (4) must pass with superior standing a final examination and such other examinations as shall be required by his Special Committee and acceptable to the Division. For further information see page 27 of this Announcement and also the Announcement of the Cornell Law School.

## REQUIREMENTS FOR THE J.S.D. DEGREE

Work leading to this degree is designed to train legal scholars and to stimulate original investigation in the purpose, administration, history, and progress of the law.

Admission. To be eligible for admission to candidacy for J.S.D. the candidate shall have met the general requirements for admission stated on page 8 ; shall have received the degree Bachelor of Laws from an approved law school; shall have had some professional practice or teaching experience after obtaining that degree; and must have shown a high level of professional ability.

Residence and Special Committee. The candidate shall be in residence a minimum period of two terms working under the direction of a Special Committee of three or more chosen by the candidate after consultation with the Chairman of the Division of Law. The chairman of the committee and one other member shall be from the Faculty of the Law School, but the other member or members may be chosen from the Graduate School Faculty in a field or fields appropriate to the candidate's graduate objective, which normally will be in the related fields of Economics, Government, History, Philosophy, Business and Public Administration, or Industrial and Labor Relations.

Program. The candidate shall pursue with distinction a program of study and investigation approved by his Special Committee and acceptable to the Division of Law and shall pass with superior standing such examinations as his Special Committee shall prescribe.
Thesis. The candidate must embody the results of his investigation in a thesis which shall be a creditable contribution to legal scholarship and which shall be presented in a form suitable for publication. He is required to file two bound copies, together with two copies of a typewritten abstract thereof, in the office of the Graduate School. For the procedures to be followed in presenting the thesis see page 25 .
Final Examination. After the thesis has been completed and filed in the office of the Graduate School, as provided on page 28, the candidate is required to present himself for a final examination. A report on each final examination shall be filed by the Special Committee in the office of the Graduate School. By permission of his Special Committee, a candidate who has failed in his final examination may present himself for re-examination but only within a period of from six to twelve months after the failure.
For further information concerning J.S.D. see page 28 of this Announcement and also the Announcement of the Cornell Law School.

# VETERINARY MEDICINE 

## APPROVED MAJOR AND MINOR SUBJECTS (key to symbols on p. 47)

Animal Pathology 1, 2, 3, 4
Animal Physiology 1, 2, 3, 4
Diseases of Large Animals 1, 2, 3, 4
Diseases of Small Animals 1, 2, 3, 4
Immunology 1, 2, 3, 4
Pathogenic Bacteriology 1, 2, 3, 4

Pharmacology 1, 2, 3, 4
Poultry Diseases 1, 2, 3, 4
Veterinary Anatomy 1, 2, 3, 4
Veterinary Obstetrics 1, 2, 3, 4
Veterinary Parasitology 1, 2, 3, 4
Veterinary Surgery 1, 2, 3, 4

ANIMAL BREEDING, HUSBANDRY, NUTRITION

(See under Animal Sciences, above)

## VETERINARY ANATOMY

Professor Malcolm E. Miller.
The laboratories of the department are well equipped for classwork and research. In the regular courses offered, the anatomy of the domestic animals is given.
The following courses are open to graduate students. For details of subject matter, see the Announcement of the New York State Veterinary College.

1. Anatomy. First year, first term. Credit seven hours. Credit hours may be divided into two, one, and three. Covering work in Osteology, Arthrology, and Myology.
2. Anatomy. First year, second term. Credit seven hours. Credit hours may be divided into three and four hours. Covering work in Canine and Bovine anatomy.

## PHYSIOLOGY

## Professors H. H. Dukes, C. E. Hayden, and J. A. Dye.

The laboratories of the department are well equipped for research work in physiology. Adequate facilities are available for work in both the experimental and the chemical fields. The Flower Library, in James Law Hall, provides a good collection of periodicals and books on physiology and related subjects. These may be supplemented by the many works on physiology in other libraries of the University.
Graduate students who plan to do their major work in physiology must have had the basic courses of the department or their equivalents. Graduate students who plan to do minor work in physiology may undertake special problems if they are qualified, or they may, pursue work in the regularly scheduled courses of the department.
10. Animal Physiology. Spring term. Three lectures a week. Primarily for undergraduates.
11. Physiological Chemistry. Spring term. Three lectures and three laboratory periods a week. Primarily for undergraduates.
12. Physiology. Spring term. Three lectures a week. For undergraduates and graduates.
13. Physiology. Fall term. Three lectures a week. For undergraduates and graduates.
14. Experimental Physiology. Fall term. Three laboratory periods a week. For undergraduates in veterinary medicine and graduates.
303. Human Physiology. Fall term, to be repeated in spring term. Three lectures a week. Primarily for undergraduates.
16. ADVANCED EXPERIMENTAL PHYSIOLOGY. Spring term. One laboratory period (four hours) and one conference period (one hour). For graduates,
17. SPECIAL PROBLEMS IN CHEMICAL PHYSIOLOGY. Either term. Credit hours and time to be arranged. Registration by permission. For graduates. Professor Hayden. James Law Hall.

This course will be adapted to the needs of students and will consist of laboratory work, conferences, collateral readings, and reports.
305. ENDOCRINOLOGY AND METABOLISM. Fall term. Credit three hours. Prerequisite, six or more hours each of biology and chemistry. Primarily for graduates. Associate Professor DyE. M W F 8. Moore Laboratory 101.
18. RESEARCH. Throughout the year. Professors Dukes and Hayden, and Associate Professor Dye.

# ANIMAL PATHOLOGY, BACTERIOLOGY, AND IMMUNOLOGY 

(See also Bacteriology, above)
Professors Peter Olafson, W. A. Hagan, P. P. Levine; Associate Professor A. Zeissic.
The laboratories of pathology and bacteriology are well equipped with apparatus for research in pathological anatomy, pathogenic bacteriology, and immunity. The department operates two diagnostic laboratories to which a great deal of pathological material comes. A variety of fresh material is thus made available for study. The Flower Library, in James Law Hall, has a very complete set of current periodicals, and the more important books and monographs dealing with the work of the department is available.
Candidates for advanced degrees, electing pathology or bacteriology as their major subject, must have had at least the corresponding general subjects given in this department, or their equivalents. Candidates electing a minor subject in this department may take up a research problem, if they possess sufficient preliminary training, or may pursue regular undergraduate course work, the courses taken being subject to the approval of the staff member who is in charge of the minor.

The following courses are open to graduate students. For additional information, see the Announcement of the New York State Veterinary College.
40. General Pathology. Two hours. Fall term.

40a. General Pathology Laboratory. Two hours. Fall term.
41. Special Pathology. Two hours. Spring term.

41a. Special Pathology Laboratory. Three hours. Spring term.
42. Infectious Diseases. Two hours. Fall term.
46. Diseases of Poultry. Three hours. Spring term.
48. Food Quality Control. Six hours. Fall term.
149. Pathogenic Bacteriology. Four hours. Spring term.
[151. IMMUNOLOGICAL METHODS. Prerequisites, course 149 or equivalent. Associate Professor Zeissig. Class limited to twelve students. Laboratory fee, $\$ 10$. Not given in 1947-1948.]
152. ADVANCED WORK IN PATHOLOGY AND BACTERIOLOGY. For students who have completed the undergraduate courses in pathology and bacteriology. Professors Olafson, Hagan, Levine, and Zeissig. Special problems or assignments will be given. Hours to be arranged. Laboratory fee, $\$ 2$ a credit hour.
153. Hematology. Spring term. One hour.
154. SEMINAR. Fall term, to be repeated in spring term. One hour, time to be arranged. Required of all graduate students.
(For dairy bacteriology, see Dairy Bacteriology; for soil bacteriology, see Agronomy.)

## DISEASES OF BREEDING CATTLE AND VETERINARY PARASITOLOGY

## Professors R. R. Birch, H. L. Gilman, and D. W. Baker.

The department maintains a herd of cattle to be used in research with diseases that interfere with reproduction. Ample facilities are at hand for the study of the clinical and laboratory aspects of this group of diseases, and special research problems are being worked out at all times. Excellent facilities are also available for investigation of parasitological problems.

The following courses are open to graduate students. For additional information, see the Announcement of the Veterinary College.
62. Animal Parasitology. Fall term. Two hours.

62a. Parasites Laboratory. Fall term. One hour.
63. ADVANCED WORK IN ANIMAL PARASITOLOGY. Either term. Associate Professor Baker. Hours by arrangement.

Special problems with the parasites of animals.

## VETERINARY THERAPEUTICS AND DISEASES OF SMALL ANIMALS

Professors H. J. Milks and H. C. Stephenson.
The laboratories of the department are well equipped for research in veterinary therapeutics and pharmacology. The clinic supplies abundant material for research both in external and internal diseases of small animals.

There is an operating room with modern equipment and facilities for handling approximately sixty animals. The library facilities are good.
20. Therapeutics and Pharmacy. Spring term. Six hours.
22. Diseases of Small Animals. Fall term. Three hours.

22a. Diseases of Small Animals. Fall term. Three hours.
23. ADVANCED WORK. This course will consist principally of the study of the artion of drugs upon well and sick animals, and of the diseases of small animals. This will be supplemented by collateral readings and reports.

## 24. Small Animal Clinic. Six actual hours a week. <br> 25. Elective. Two hours.

## VETERINARY MEDICINE, AMBULATORY CLINIC, AND OBSTETRICS INCLUDING DISEASES OF THE GENITAL ORGANS

Professors M. G. Fincher; Associate Professor S. J. Roberts, and Assistant Professor S. D. Johnson.

Opportunity for the clinical study of internal diseases of animals is afforded by material in the ambulatory clinic. This clinic has gradually developed until it demands a large part of the time of two clinicians. Especially abundant are affections of dairy animals. Students are required to report their observations. Files of notes on completed cases are available for additional information. Special and research students will be given individual instruction to meet their requirements, and may supplement their clinical experience with further study in the various laboratories of the College.

## VETERINARY SURGERY

## Professor J. N. Frost and Professor A. G. Danks.

The laboratory in surgery is well equipped for research and special study along surgical lines especially in connection with diseases of bones, tendons, and tendon sheaths.
Candidates for advanced degrees should have as preliminary preparation, general pathology, physiology, general and special surgery.
32. Special Surgery. Spring term. Five hours. Professor Danks.
research in surgical diseases. Professor Frost.

# THE MEDICAL SCIENCES 

AS PRESENTED• IN THE MEDICAL COLLEGE IN NEW YORK CITY


#### Abstract

The Graduate Faculty of the Medical College (Group F of the Graduate School) at present consists of professors in the preclinical branches of medicine who accept properly qualified students as candidates for the higher academic degrees. The qualifications required of graduate students are in every particular those which are required of students in other divisions of the University. Students desiring to enter the Graduate School for work in the medical sciences can obtain application blanks at the office of the Dean of the Medical College. Professor C. V. Morrill, Chairman of the Group, may be consulted for additional information. Since the number of graduate students who can be accommodated is limited, a personal interview is required of all applicants before the filing of forms. For a description of the work in the Medical College in New York City, see the Announcement of the Medical College.


The Medical College in New York City now occupies a portion of the plant of the New York Hospital-Cornell Medical College Association. This new medical center is located on the bank of the East River north of the Rockefeller Institute for Medical Research. It occupies several city blocks extending from the East River on the east to York Avenue on the west, and from Sixty-eighth Street on the south to Seventy-first Street on the north.
The Medical College group consists of buildings in the western part of the plant, facing York Avenue, opposite Sixty-ninth Street. These buildings from north to south are occupied by the departments of Anatomy, Public Health, Bacteriology, Pathology, Physiology, Biochemistry, and Pharmacology. The library is located in the building of the department of Pathology and at present contains about 25,000 volumes.

## ANATOMY

Professors J. C. Hinsey, J. F. Nonidez, C. V. Morrill, G. n. Papanicolaou, W. A. Geohegan, J. MacLeod, and Doctor C. Berry.

Abundant material and sufficient apparatus are available for advanced study and work in the various branches of anatomy: embryology, histology, descriptive and experimental anatomy, neurohistology, and experimental neurology. Students desiring to pursue graduate work in any of these branches must have had in their college courses preliminary training in general zoology and comparative anatomy. A reading knowledge of German and French is essential.
The courses offered for the medical students appear in the Announcement of the Medical College, and are particularly recommended to those students who have not pursued work of this kind. In addition, the members of the staff offer work in the various phases of anatomy in which they are especially engaged. Technical and practical anatomical work are fully provided.

The requirements for either a major or a minor in anatomy will be determined for each individual case by the department of Anatomy, after consultation with the authorized representative of the other departments involved. As a prerequi-
site for graduate work in anatomy, each student will be expected to have a thorough training in the fundamental sciences of physics, chemistry, and biology such as is required for admission to the Medical College.

## BACTERIOLOGY AND IMMUNOLOGY

Professor James M. Neill, John Y. Sugg, Thomas P. Magill, and Edward J. Hehre.

The course given to second-year students consists of lectures, laboratory work, and group conferences. Emphasis is placed upon the aspects of bacteriology and of immunology that are pertinent to an understanding of the etiology and pathogenesis of infectious diseases. The study of infectious material from patients is included in the laboratory part of the course, not only to acquaint the student with the technical procedures but to illustrate the directness of application of the fundamental principles of the subject to the practical methods used in the examination of clinical material.
Graduate and special students. Opportunities for advanced study and for research will be offered to students particularly interested in bacteriology and immunology. Hours to be arranged.

## BIOCHEMISTRY

Professors V. du Vigneaud, W. H. Summerson, J. P. Chandler, Julian R. Rachele, Donald B. Melville, R. W. Bonsnes, C. G. Mackenzie, and Doctor G. B. Brown.
Opportunity is offered for advanced work and research in various phases of biochemistry. Adequate chemical and physical equipment and fundamental library facilities are provided for the investigation of a considerable variety of problems in the chemistry of the plant or the animal organism or of the human organism in health and disease.

Graduate students expecting to pursue investigations in biochemistry should have adequate preliminary training in inorganic, organic, analytical, and physical chemistry.
Students electing biochemistry as a minor subject are expected to complete the regular medical course in biochemistry, or its equivalent, as a minimum requirement.

## PATHOLOGY

## Professors John G. Kidd, Jacob Furth, Charles T. Olcott, and Curtis M. Flory,

The departmental laboratories are suitably equipped for carrying on graduate study and research problems in Pathology. Since members of the staff are engaged in varied investigations concerning etiology and pathogenesis, the department offers wide opportunity for the experimental study of disease. Adequate facilities for the care of animals are available. There is a small departmental library where some of the current journals and reference books are kept on file. The main library is situated on the floor immediately beneath the department, and is readily accessible. There is a carefully selected collection of mounted museum specimens, in addition to an active file of preserved gross material for study. The
histological collection is likewise rich in material. Autopsies for the entire hospital are performed by the members of the department, and offer an opportunity for the study of fresh pathological tissues.

No regular course of study is offered by the department for graduate students, but applicants in this field are given abundant opportunity for special work under the direct supervision of members of the department. Such work may include the investigation of some problem, and may be credited towards the applicant's graduate degree.

## PHARMACOLOGY

Professors McKeen Cattell, Harry Gold, Maynard B. Chenoweth, and Walter F. Riker, Jr.

Facilities are available for advanced work and research in both the chemical and pharmacodynamic aspects of pharmacology. In addition, arrangement can be made in special cases for correlating laboratory results with clinical studies. Special opportunities are offered for the investigation of the action of drugs on tissue metabolism, the circulation, the autonomic nerves, and muscles. The department is well equipped with special apparatus, including electrocardiographs with amplifying system, and galvanometers with accessories for the measurement of small temperature changes such as are employed for the measurement of heat production in tissues.

An adequate preliminary training in chemistry and physiology is prerequisite for graduate work in pharmacology.

## PHYSIOLOGY AND BIOPHYSICS

Professors Eugene F. Du Bois, Dayton J. Edwards, and James D. Hardy.

Graduate and research training is provided for students who wish to prepare themselves for teaching and research in the physiological aspects of biological science, with special emphasis on the physical and chemical approach; those who desire to prepare themselves more adequately for clinical practice and research by advanced training in some phase of physiology; and those who are entering a career in human biology.
Instruction is at first provided through the medium of formal basic courses in this and other departments of the Medical School, and in the departments of physics and chemistry of neighboring universities. This work is paralleled by similar courses which deal with specialized subjects on a more advanced level. Finally, the student is associated with various members of the staff on a tutorial basis for instruction in special research problems.
The laboratories are equipped for research in most fields of physiology and biophysics with special facilities for investigations in neurophysiology and metabolism. There is an excellent library in the department.

The Russell Sage Institute of Pathology, which houses the calorimeter in the New York Hospital, is under the direction of the head of this department.

## PUBLIC HEALTH AND PREVENTIVE MEDICINE

## PARASITOLOGY

Professors Wilson G. Smillie and Morton C. Kahn.

In this department candidates for the Ph.D. degree may elect Parasitology as a major subject. Members of this department have all carried on investigations in tropical countries, and an excellent collection of living and preserved parasitic material is available for study and research.

The medical school courses in both Public Health and Parasitology are acceptable as minor requirements for students who may desire to major in other departments of the University. The department welcomes graduate students who wish to register in special fields. Each application will be considered on its merits, and the work may be arranged in accordance with the desires and purposes of the candidate after consultation with the members of the department.

The laboratories are well equipped for research in public health, epidemiology, serology, and parasitology. Facilities at the Kips Bay-Yorkville District Health Center are available to a limited number of graduate students for the study of certain social aspects of Preventive Medicine and Public Health.

It is preferred that the candidate for advanced work in Public Health and Preventive Medicine should have a medical degree; he should also possess credit for or the equivalent of the basic course in Public Health given to the third year medical students in Cornell. The Department of Public Health and Preventive Medicine does not offer formal graduate courses in Public Health or in Preventive Medicine, and the University does not grant advanced degrees in Public Health.

# THE AGRICULTURAL SCIENCES 

AS PRESENTED IN THE NEW YORK STATE EXPERIMENT STATION AT GENEVA<br>A. J. Heinicke, Director

Since July 1, 1923, the New York State Experiment Station at Geneva has been under the administration of Cornell University. Research workers on its staff are eligible for membership on the Faculty of the Graduate School, and its facilities for research are available to graduate students.

The station is equipped to care for graduate students in certain specific lines of research, viz., Bacteriology, Chemistry, Economic Entomology, Plant Pathology, Pomology, Seed Investigations, and Vegetable Crops. Ample accommodations are available from the standpoint of laboratory facilities, reference library, etc., for research in the laboratory sciences. Greenhouses and also a farm of approximately 500 acres are available for work with fruits and vegetables.

Certain phases of the investigations now being conducted at the Station and other problems for which the facilities of the Station are suitable may be used as thesis problems by graduate students.

Students who plan to do part of their graduate work at Geneva should correspond with the Dean of the Graduate School concerning special regulations as to residence credit, special committees, etc.

## FOOD SCIENCE AND TECHNOLOGY

Professors E. H. Stotz, R. S. Breed, H. J. Conn, D. C. Carpenter, G. J. Hucker, C. S. Pederson, Z. I. Kertesz, A. W. Hofer, G. L. Mack, G. W. Pearce, F. A. Lee, J. C. Moyer, A. W. Avens, W. B. Robinson, F. G. Smith, J. C. Hening, and R. F. Brooks.

Opportunities for graduate research in fundamental aspects of chemistry and bacteriology, particularly as applied to food problems, are offered: the chemistry and technology of food preservation; food bacteriology; the nutritive values of fruit and vegetable varieties; applied soil bacteriology; physiological and taxonomic studies of bacteria; insecticides and fungicides; protein chemistry; pectin and pectic enzymes; plant metabolism and enzymes.

THE CHEMISTRY OF FRUITS AND VEGETABLES. Professors Kertesz and Stotz.
the preservation of fruits and vegetables. Professors Pederson, Stotz, Lee, Moyer, Hening, and Brooks.

THE TECHNOLOGY OF THE PRESERVATION OF FRUIT JUICES. Professor Pederson.

CLEANING AND STERILIZING TECHNOLOGY. Professors Hucker and Brooks.
nutritive values of foods. Professors Stotz and Robinson.
FOOD POISONING. Professor Hucker.
FOOD PACKAGING. Professor Hucker.
FOOD AND FERMENTATION BAGTERIOLOGY. Professor Pederson.
SOIL BACTERIOLOGY. Professors Conn and Hofer.
TAXONOMY OF BACTERIA. Professor Breed.
BIOLOGICAL STAINS. Professor Conn.
insecticides AND fungicides. Professors Pearce, Mack, and Avens.
PROTEIN CHEMISTRY. Professor Carpenter.
the chemistry of pectin and pectic enzymes. Professor Kertesz.
plant metabolism and enzymes. Professors Stotz, Smith, Kertesz, and Robinson.

## ENTOMOLOGY

Professors H. Glasgow, F. Z. Hartzell, S. W. Harman, P. J. Chapman, E. H. Wheeler, G. E. R. Hervey, F. G. Mundinger, F. L. Gambrell, L. A. Carruth, J. A. Adams, R. W. Dean, J. L. Brann, and E. F. Taschenburg.

The staff of this Division is engaged in research work on a variety of agricultural insect pest problems of the State. Students may obtain, by arrangement, supervision of work on advanced research problems falling within the following fields: insect pests affecting deciduous fruits, vegetable crops, nursery and ornamental plants; biological control of insects, and applications of biometry and ecology in applied entomology.
fruit insects. Professors Chapman, Hartzell, Harman, Mundinger, Dean, Taschenburg, and Brann.
veget able insects. Professors Glasgow, Hervey, and Carruth.
INSECT PESTS OF NURSERY AND ORNAMENTAL PLANTS. Professor Gambrell.

applied ecology. Professor Hartzell.<br>applications of biometry. Professor Hartzell.<br>BIOLOGICAL CONTROL OF INSECTS. Professors Wheeler and Adams.

## PLANT PATHOLOGY

Professors O. A. Reinking, J: M. Hamilton, D. H. Palmiter, W. T. Schroeder, A. J. Braun, and R. E. Foster.

The Division offers opportunities for graduate research in diseases of fruits, vegetables, canning crops, and hops; fungicides; diseases caused by Fusaria; taxonomy of Fusaria; and ecology of plant diseases. Students may select problems as indicated below:
diseases of fruits. Professors Hamilton, Reinking, Palmiter, and Braun, diseases of vegetables. Professors Schroeder, Foster, and Reinking. diseases of Canning crops. Professors Schroeder, Reinking, and Foster. fungicides. Professors Hamilton and Schroeder.
diseases caused by fusaria. Professor Reinking. taXonomy of fusaria. Professor Reinking.
ecology of plant diseases. Professors Schroeder and Reinking.

## POMOLOGY

Professors A. J. Heinicke, R. Wellington, George H. Howe, George L. Slate, G. D. Oberle, John C. Cain, John Einset, N. J. Shaulis, R. W. Bledsoe, and O. F. Curtis, Jr.

This Division is engaged in research in the following fields: genetics of fruit breeding; plant propagation and rootstocks including stock and scion relations; developmental morphology of deciduous fruits; orchard-soil management; orchard management; cytology, applied and theoretical. No formal courses are offered, but students may register for work on problems as indicated below:
fruit breening problems. Professors Wellington, Slate, Howe, and Oberle.

ROOTSTOCK PROBLEMS, INGLUDING STOCK AND SCION RELAtions. Professors Curtis and Bledsoe.
fertilization and nutritional studies with trees. Professors Heinicke, Cain, and Shaulis.
orchard soil technology. Professors Heinicke, Cain, and Shaulis. cytology. Professor Einset.
physiology of fruit plants. Professors Heinicke, Cain, and Curtis.

## SEED INVESTIGATIONS

Professors M. T. Munn and W. F. Crosier.
Seed investigations covering the wide field of seed production, distribution, and control are under way at the Station, By special arrangement qualified students can undertake graduate research in analytical methods, physiology of germination, taxonomy of incidental plant seeds, histology of seed structure, seed-borne microorganisms, seed control and improvement, and a few closely allied fields.
SEED INVESTIGATIONS. Professors Munn and Crosier.

## VEGETABLE CROPS

## Professors C. B. Sayre, M. T. Vittum, C. H. Dearborn, and W. T. Tapley.

Students may obtain, by arrangement, supervision of work on problems in the history and description of varieties, vegetable breeding, plant nutrition, ferti-
lizers, and fertilizer placement for vegetable crops, nutrient solutions for transplants, improved methods of plant growing, comparison of southern and local grown plants, methods of packing transplants for shipment, studies of canning crop rotations and cropping systems, and factors affecting quality of vegetables for canning and freezing. Most of these studies can be undertaken best during the summer.

EFFEGTS OF FERTILIZERS ON YIELD AND QUALITY OF VEGETABLES FOR MANUFACTURE. Professor Sayre.
fertilization and Nutritional studies with vegetables. Professors Sayre and Vit́tum.

VARIETY STUDIES OF VEGETABLES. Professor Tapley.
VEGETABLE BREEDING PROBLEMS. Professor Dearborn.
VEgetable canning crop research problems. Professor Sayre.
CANNING CROP ROTATIONS AND SOIL MANAGEMENT. Professor Vittum.

## FELLOWS AND GRADUATE SCHOLARS IN 1945-1946

## RESIDENT DOCTORS

Samuel Neale Alter, B.A., Grove City, 1917; B.S. Th., Western Theological Seminary, 1920; Ph.D., Edinburgh University, 1922; M.S. Th., Hartford Seminary, 1929.

Francois Bourliere.
Benjamin Julian Kaston, Ph.D., Yale University, 1934.
Margaret H. Stone, Ph.D., Western Reserve University, 1940.
Osmo Turpeinen, M.A., University of Helsingfors, 1929; M.D., University of Helsingfors, 1933; Ph.D., University of Helsingfors, 1936.

Frederick Ludwig Will, A.B., Thiel College, 1929; A.M., Ohio State, 1931; Ph.D., Cornell, 1937.

## ENDOWED AND UNIVERSITY FELLOWS

The Anna Cora Smith Fellowship in Home Economics: Margaret Elizabeth Puffer, A.B., University of Colorado, 1939; S.M., University of Chicago, 1941.

The Clinton DeWitt Smith Fellowship in Agriculture: Clifford Bennett Walberg, B.S., University of Saskatchewan, 1939; A.B., University of Southern California, 1943; M.S., University of Southern California, 1945.

The Cornell Fellowship in English: Esther Kaufman, A.B., Queens College, 1944; A.M., University of Illinois, 1945.

The Erastus Brooks Fellowship in Mathematics: Irma Schocken, A.B., Barnard University, 1944; A.M., Cornell, 1945.

The Fellowships in American History: Barton Bean, III, A.B., University of Buffalo, 1942. Margaret Ruth Beattie, A.B., University of Maryland, 1945.

The Fellowship in Greek and Latin: Alice Sperduti, B.A., Ladycliff College, 1939; A.M., Cornell University, 1943.

The George C. Boldt Fellowship in History: James Everett Seaver, A.B., Stanford University, 1940.

The President White Fellowships in Modern History: Alice Janette Bacon, A.B., Wells College, 1944; A.M., Cornell University, 1943. Charlotte Joanne Erickson, A.B., Augustana College, 1945.

The President White Fellowship in Political and Social Science: Samuel Hsuan Wang, A.B., National University of Peking, 1936.

The Sage Fellowships in Chemistry: Judith Bregman, B.A., Bryn Mawr College, 1942. Liang Huang (Miss) B.S., St. John's University, 1942.

The Susan Linn Sage Fellowship in Philosophy: Richard Henry Popkin, A.B., Columbia University, 1943; A.M., Columbia University, 1945.

The Susan Linn Sage Fellowship in Psychology: Florence Cooper, B.A., Brooklyn College, 1945.

The University Fellowship in Agriculture: Gordon Elsworth Hunt, A.B., Cor nell University, 1944.

## SPECIAL TEMPORARY FELLOWSHIPS

Allied Chemical and Dye Corporation Fellowship: Horace R. Baxman, B.S., Indiana University, 1943.

Cerophyl Fellowship in Poultry Nutrition: Louise Jane Daniel, B.S., University of Pennsylvania, 1935; M.S., Pennsylvania State College, 1936.

Dairymen's League Fellowship: Marjory C. Swisher, B.S.H.E., State Teachers College at Mansfield, Pennsylvania, 1941.

Dow Chemical Company Fellowship: Bert Lear, B.S., Utah State, 1941.
International Minerals and Chemical Corporation Fellowship: Marvin B. Gillis, B.S.A., University of Georgia, 1940.

Nassau County Farm and Home Bureau Association Fellowship: Fred M. Gordon, B.S., Massachusetts State College, 1941.

Tobacco By-Products and Chemical Company Insecticide Fellowship: Martin M. Barnes, B.S., University of California, 1941.

## SCHOLARS

The Allen Seymour Olmstead Scholarships: Elizabeth Margaret Boyd, B.Sc., Edinburgh University, 1930; A.M., Mt. Holyoke College, 1933. Mary Patricia Dolciani, A.B.,-Hunter College, 1944; A.M., Cornell University, 1945.

The Graduate Scholarships in Botany, Geology, or Physical Geography: Katherine H. Heinig, B.S., Northwestern University, 1934; M.S., Northwestern University, 1936. Mary Hickox Mandels, B.S., Cornell University, 1939.

The Graduate Scholarship in Greek and Latin: Albert Sigurdsson, M.A., University of Iceland, 1941.

The Phi Kappa Phi Scholarships: Arline Rae Raskin, B.S., University of Maryland, 1945. Bernita Woodruff, A.B., State College of Washington, 1944.

The Susan Linn Sage Scholarship in Philosophy: Frederick Mitchell Anderson, A.B., Wesleyan University, 1945.

The Susan Linn Sage Graduate Scholarships in Psychology: Thelma Toby Gilman, A.B., Hunter College, 1943; A.M., Clark University, 1944. Joan Sara Menkin, A.B., Hunter College, 1945.

The University Graduate Scholarship in Physics: Nelly Eva Reitlinger, A.B., Smith College, 1945.

## TUITION SCHOLARS

Helmut Aulbach, B.S., Queens College, 1943.
Liesel Bertuch, A.B., Hunter College, 1945.
Portia Billings Foster, B.S., University of California, 1942.

Ross Edwin Graves, S.B., Massachusetts Institute of Technology, 1945.
Dorothy Holt, A.B., Bates College, 1922.
Blanche Luverene Ingram, B.S., Wiley College, 1945.
Hal David Lipsich, A.B., University of Cincinnati, 1942; A.M., University of Cincinnati, 1945.

Stella Marie Pollitz, A.B., Stanford University, 1944; A.M., Stanford University, 1945.

Lorraine Dorine Rosenberg, A.B., Brooklyn College, 1945.
Carl Wilhelm Gottfried Scheerer.
Nora Beate Sigerist, A.B., University of Rochester, 1945.
Janet Stewart, B.A., Goucher College, 1945.
Ann Ruth Willnér, B.A., Hunter College, 1945.

## FELLOWS AND GRADUATE SCHOLARS IN 1946-1947

## RESIDENT DOCTORS

Amiya Bhuson Kar, B.S., Calcutta, 1938; M.S., Calcutta, 1940; Ph.D., Edinburgh, 1946.

Willard Carl Schmidt, A.B., University of Rochester, 1941; M.D., University of Rochester, 1944.

## ENDOWED AND UNIVERSITY FELLOWS

The Allen Seymour Olmstead Fellowships: Mary Patricia Dolciani, A.B., Hunter College, 1944; A.M., Cornell, 1945. Elizabeth Cook, University of Cambridge, 1946.

The Anna Cora Smith Fellowship: Gladys E. Cooper, B.S., Ohio State University, 1945.

The Clinton DeWitt Smith Fellowships in Agriculture: Philip F. Bonhag, B.S., Long Island University, 1944; M.S., Pennsylvania State College, 1946. Desire Marc Eny, B.S., University d'Alger, 1935. Elwood George Fisher, B.S., University of Maryland, 1938.

The Cornell Fellowship in English: Esther Kaufman, B.A., Queens College, 1944; A.M., University of Illinois, 1945.

The Erastus Brooks Fellowships in Mathematics: Albert Gerhard Baum, B.A., McMaster University, 1946. Leila Raines Rubashkin, B.A., Hunter College, 1946.

The Fellowships in American History: David Lindsey, A.B., Cornell University, 1936; M.A., Pennsylvania State College, 1938. Allan George Bogue, B.A., M.A., University of Western Ontario, 1943, 1946.

The Fellowship in American History: Margaret Ruth Beattie, A.B., University of Maryland, 1945.

The Fellowship in Greek and Latin: Alice Sperduti, A.B., Ladycliffe College, 1939; A.M., Cornell, 1943.
The Fellowship in Political Economy: Dorothy Jane Brayley, B.A., University of Toronto, 1946.

The George C. Boldt Fellowship in History: Rose Engelman, B.A., University of Rochester, 1939.

The Goldwin Smith Fellowship in Botany, Geology, or Physical Geography: Shirley Crafts, A.B., Cornell University, 1945.

The McGraw Fellowship in Civil Engineering: Jackson Leland Durkee, B.S., Worchester Polytechnic Institute, 1943.

The Martin Sampson Teaching Fellowship: George Harris Healey, A.B., A.M., West Virginia University, 1932, 1935.

The President White Fellowships in Modern History: Martha Sturtevant Reed, B.A., Wheaton College, 1946. Emily Wait Skillings, A.B., Mt. Holyoke College, 1946.

The President White Fellowship in Physics: William Delany Walker, B.A., The Rice Institute, 1944. Robert Maughan Snow, B.S., M.A., George Washington University, 1940, 1943.
The President White Fellowship in Political and Social Science: Rita Edith Falk, B.A., Washington Square College, 1946.

The Sage Fellowships in Chemistry: Liang Huang (Miss) B.S., St. John's University, 1942. Robert L. Ehrenfeld, A.B., Cornell, 1942.

The Schuyler Fellowships in Animal Biology: Jung Yi Tung Sun, B.S., National Scechuen University, 1939. Barbara Raymond Hough, B.A., Swarthmore College, 1945. Ruthann Hayes, B.A.; University of Colorado, 1946.

The Sigma Xi Fellowship: William Lester Kraushaar, B.S. in E.P., Lafayette College, 1942.
The Simon Henry Gage Fellowships in Animal Biology: Robert Louis Strecker, A.B., Marietta College, 1946. Mary Maxwell Grainger, B.S., Pennsylvania State College, 1945. Da-si Pen, B.S., West China Union University, 1935.

The Susan Linn Sage Fellowships in Philosophy: Richard Lee Cartwright, A.B., M.A., Oberlin College, 1945, 1946. Robert Jean Dowling, A.B., Hofstra College, 1942. Robert Charles Marsh, B.S., M.A., Northwestern University, 1945, 1946. Owen Robinson Orr, B.A., University of Toronto, 1946.

The University Fellowship in Agriculture: Gordon E. Hunt, B.A., Cornell University, 1944.

The University Fellowships in Architecture, Landscape Architecture, Fine Arts, and Regional and City Planning: Dorothy P. Marcuse, B.A., Queen University, 1940; A.M., Cornell, 1942. Donald H. MacDonald, B.A.Sc., University of Toronto, 1945.

The University Fellowships in Germanic Languages: Marlies Kallmann, B.A., Queens College, 1946. Ulrich Karl Goldsmith, B.A., University of Toronto, 1942.

The University Fellowship in Germanic Languages: William August (Viljo) Packer, A.B., A.M., University of Toronto, 1941, 1942.

The University Fellowship in Romance Languages: Harry G. Edwards, B.A., M.A., King's College, Cambridge, 1940, 1944.

The University Fellowship in Romance Languages: John Iwanik, A.B., Syracuse University, 1934; A.M., Cornell, 1944.

## SPECIAL TEMPORARY FELLOWSHIPS

Allied Chemical and Dye Corporation Fellowship: Thomas H. Shelley, Jr., B.S., University of Kentucky, 1941; M.S., University of Kentucky, 1942.

American Nature Association Fellowship: Gilbert Mouser, B.S., Greenville College, 1933.

Cerophyl Fellowship in Poultry Nutrition: Herbert T. Peeler, B.S., Texas Agricultural and Mechanical College, 1940.
Dow Chemical Company Fellowship: Bert Lear, B.S., Utah State, 1941.
DuPont Postgraduate Fellowship in Chemical Engineering: H. Grey Verner, B.S. in Ch. E., University of Pittsburgh, 1940; M.Ch. E., Syracuse University, 1946.

DuPont Pastgraduate Fellowship in Mechanical Engineering: Robert W. Perry, Jr., B.M.E., Cornell, 1943.
G.L.F. Poultry Fellowship: Gerald Fuson Combs, B.S., University of Illinois, 1940.

International Minerals and Chemical Corporation Fellowship: Marvin B. Gillis, B.S.A., University of Georgia, 1940.

Nassau County Farm and Home Bureau Association Fellowship: Fred M. Gordon, Massachusetts State College, 1941.
Philco Fellowship in the School of Nutrition: Saxe Dobrin, B.Chem., University of Minnesota, 1944.

Standard Oil Company Fellowship: Joseph C. Yarze, B.S., Pennsylvania State College, 1944; M.S., Pennsylvania State College, 1945.
Wildlife Institute Fellowship: David Binnie Turner, B.S.A., University of British Columbia, 1933; B.A., University of British Columbia, 1936; M.A., University of British Columbia, 1944.
William S. Merrill Fellowship in Chemistry: Ann Dworkin Holley; A.B., Cornell, 1945.

William S. Merrill Fellowship in Chemistry: Walter A. Gregory, A.B., Cornell, 1941; M.S., Iowa State College, 1942.

## SCHOLARS

The Comstock Graduate Scholarship in Entomology: Philip F. Bonhag, B.A., University of Colorado, 1946.
The Comstock Graduate Scholarship in Nature Study: Dorothy Elsa Alfke, B.S., Cornell, 1941.
The Graduate Scholarship in Civil Engineering: Yiu-Yung Lee, B.S., Chiao Tung University, 1941.
The Graduate Scholarships in Animal Biology: Lucien Auclair, B.S.A., University of Montreal, 1942; M.S., McGill University, 1945. Maxine Ruth Stern, B.A., College of City of New York, 1946.

The Graduate Scholarship in Architecture, Landscape Architecture, Fine Arts, and Regional and City Planning: Miriam Strong, A.B., Oberlin College, 1941.

The Graduate Scholarships in Greek and Latin: Marie Ann Giuriceo, A.B., Hunter College, 1946. George Louis Kustas, A.B., Cornell, 1943.

The Graduate Scholarship in Greek and Latin: Martin Oswald, B.A., University of Toronto, 1946.

The Graduate Scholarship in Greek and Latin: Catherine Mary Cameron, B.A., Mt. Allison University, 1941.
The Graduate Scholarships in History: Eleanor McMichael, A.B., Westminster College, 1946. Betty Lee Wilson, A.B., University of Kentucky, 1944.

The Phi Kappa Phi Scholarships: Louis L. Ferstandig, B.S., University of Illinois, 1944. George Hazzard, B.S., M.S., St. Lawrence University, 1936, 1938.

The Susan Linn Sage Scholarships in Philosophy: John Mansley Robinson, A.B., Middlebury College, 1945. Shih Tsun, B.A., University of Peking, 1938.

## TUITION SCHOLARS

Elizabeth Ainsworth, A.B., Smith College, 1945.
Margaret A. Augst, B.S., New York University, 1945.
Charlotte C. Bernhardt, Dr. der Rechte, University of Hamburg, 1932.
Mildred P. Bowers, B.S., Utah State Agricultural College, 1938; M.S., Columbia University, 1939.
Edith R. Britton, A.B., Cornell, 1923; A.M., Cornell, 1930.
Frances Dunkle, B.A., Wilson College, 1943.
Robert F. Eshleman, B.S., Elizabethtown College, 1939; M.S., University of Illinois, 1944; B.D., Bethany Biblical Seminary, 1945.
Kathleen E. Fetherston, B.A., University of Western Ontario, 1944; M.S., Cornell, 1946.

Richard H. Fillmore, B.A., Acadia University, 1945.
William A. Foster, B.S., University of California, 1942.
Vadakumara T. George, B.A., Madras, 1939; Isc. Ag., Allahabad, 1936.
Juliana K. Glass, B.A., Queens College, 1946.
Maybel Holmes, B.A., Alfred, 1925; M.A., New York University, 1930.
Paul V. E. Hough, B.A., Swarthmore College, 1945.
Mary J. Humphreys, B.A., University of Buffalo, 1939; A.M., Cornell, 1944.
Blanche L. Ingram, B.S., Wiley College, 1945.
William G. Klein, B.A., Princeton University, 1925; B.D., Union Theological Seminary, 1933; M.A., Columbia University, 1933.

Claud Marion, B.S., Florida Agricultural and Mechanical, 1936; M.S., University of Minnesota, 1941.

Sellers J. Parker, B.S., Agricultural and Mechanical College, 1939; M.S. in Agr., Cornell, 1945.

Enid Paskes, B.A., Adelphi College, 1946.
Nelly Eva Reitlinger, B.A., Smith College, 1945.
Edward Rodamaker, B.S., Buffalo State Teachers College, 1944.
Helen B. Ross, A.B., Lebanon Valley College, 1943.
Richard Craig Rover, B.A., Upsala College, 1940; M. Ed., St. Lawrence, 1945.
Bertha J. Spooner, A.B., Wooster College, 1942.
Nicholas Theodorou, B.S., Athens College, 1932; M.S., Cornell, 1946.
James Ella Turnley, B.S., Tuskegee Institute, 1944.
Mary Ann Ullrich, A.B., Southwestern University, 1943.
Suzanne J. Porter Walker, A.B., Albion College, 1945.
Chi-Hwei Wu, B.A., National Central University, 1937.

## ADVANCED DEGREES CONFERRED IN 1945-1946

## MASTERS OF ARTS

## CONFERRED OCTOBER 21, 1945

Ken Claude Baumann, Musicology, German Literature. Thesis: The Change of Style in Verdi's Operatic Work in the Interlude Between "Aida" and "Otello".

Caroline Louise Browne, A.B.; Social Studies.
Theodora Elizabeth Bryce, B.Sc.; Education.
Nai-Wei Chang, A.B.; International Law and Relations, American History. Thesis: The International Minimum Standard of Justice in the Treatment of Aliens.

Edwina Cook Davies, A.B.; Foreign Languages.
Grace Edna Eschenbrenner, B.A.; Social Studies.
Mary Zita Furey, A.B.; Education.
Eleanor Jane Goltz, B.A.; Ancient History, Latin Literature. Thesis: The Political, Economic, and Religious Relations Between Rome and Egypt From 273 B.C. to 51 B.C.

Catherine Hazel Grady, A.B.; English. Thesis: Thoreau and Gandhi: Similarities and Differences.
Anna Marie Hanchouski, A.B.; Foreign Languages.
Grace Fowler Harrison, B.S.; Home Economics.
Constance Rohlff Heiden, A.B.; Algebra, Mathematical Analysis. Thesis: On the Multiplicative Groups of $2 \times 2$ and $3 \times 3$ Matrices $(\bmod p)$.
Harriet Muriel Hodge, A.B.; Modern European History, American History. Thesis: The Interest of Great Britain and France in a Neutralized Belgium During the Nineteenth Century.

Frances Margaret Keefe, B.A.; Social Studies.
Barbara Brigitte Kraft, A.B.; Mathematics.
M. Dorothea Kunz, B.A.; Mathematics.

Margaret Elizabeth Luke, A.B.; English. Thesis: Emerson on Tour in America.

CONFERRED FEBRUARY 22, 1946
Alice Janette Bacon, A.B.; History of Philosophy, English History. Thesis: John Lilburne: From Ecclesiastical Revolt to Democracy.
Laurence Charles Boylan, A.B., Education.
Edith Elsie Cutting, B.S.; English. Thesis: The Douglass Manuscript.
Samuel Hopfer, A.B.; Physics, Theoretical Physics. Thesis: Laue Spot Intensity at the K-absorption Limit of Silver.

Evangeline Anne Jouras, Ph.B.; Psychology, Education. Thesis: Experimental Neurosis and Its Significance in Modern Psychiatry.

Evan Lawn, A.B.; Social Studies.
Pauline Bohan Seibold, A.B.; Speech and Drama.
Lucille Gloria Stein, B.A.; Dramatic Production, Dramatic Literature. Thesis: Epic Theatre and the Living Newspaper.

Elizabeth. Ann Weigel, A.B.; Medieval History, English History. Thesis: Scholastic Benefices in Medieval French Cathedral Schools.

Marianne Schneider Weigel, A.B.; Medieval History, Ancient History. Thesis: Anglo-Saxon Literature in Historical Writing.

## CONFERRED JUNE 21, $1946^{\circ}$

Dorothy Ruth Baisch, B.A., B.L.S.; English. Thesis: A Study of Walt Whitman's "Song of Myself."
Barbara Brooks, A.B.; Biological Sciences.
Frances Jeannette Brown, B.A.; Social Studies.
Harry James Brown, A.B.; American History, Constitutional Law. Thesis: The National Association of Wool Manufacturers, 1864-1867: the Beginnings of a Pressure Group.
Phyllis Roberts Bryant, A.B.; Social Studies.
Klara Berta Calitri, A.B.; Foreign Languages.
Mary Luella Charles, A.B.; Romance Languages.
Donald Alston Clarke, B.S.; Pharmacology, Physiology. Thesis: Fixation of Digitalis Glycosides - Application of the Cross-Perfusion Technic.
Edith Helen Cosens, B.A., B. Pedagogy. Home Economics.
Leslie Wallace Dunbar; Political Theory, Constitutional Law. Thesis: The Poor in English Thought of the Seventeenth Century.

Portia Billings Foster, B.S.; Home Economics.
Winifred Adelia Hill, A.B.; Mathematical Analysis, Geometry. Thesis: A Comparison of Two Graphical Methods for Solving First Order Differential Equations In Two Variables.

Ilse Lore Hochhauser, A.B.; Inorganic Chemistry, Physical Chemistry. Thesis: A Study of the Photochemical Reaction of Chlorine and Oxalic Acid: A Comparison with the Chemically Induced Reaction.

Bernard Lazarus, A.B.; International Law and Relations, Education.
Lien Fung Li, B.A.; American Literature, 19th C. English Literature. Thesis: Chinese Folklore of the Lower Yangtze Region.

Burling Hunt Lowrey, B.Ed.; English. Thesis: A Study of the Short Stories of Sherwood Anderson.

Edward Moldover, A.B.; Constitutional Law, Political Theory. Thesis: The Poll Tax as a Limitation on Suffrage in the United States.
Isabelle Caroline Ramel, A.B.; Speech and Drama.

Charles Sloca, B.S. in Ed.; Speech and Phonetics, American Literature. Thesis: Maxwell Anderson: A Study of Growth.
Richard Barney Small, A.B.; French Literature, Spanish Literature of the Golden Age. Thesis: A Study of Honoré de Balzac's La Peau de Chagrin.
Geraldine Hallam Spare, A.B.; English Literature to 1700, Old and Middle English. Thesis: Edward Lord Herbert of Cherbury; A Consideration of His Life, Verse, and Philosophy, with a Note on His Prose Style.

Peter Swan Stutz, A.B.; English.
Norma Wegner, A.B.; Social Psychology, Psychobiology. Thesis: A Personality Study of Rural and Urban College Women.

## MASTERS OF SCIENCE

## CONFERRED OCTOBER 21, 1945

Jose Gil Chaverri, Ingeniero Agronomo; Technical Agriculture. Thesis: Nitrogen and Organic Matter in Their Relation to Soil Fertility of Tropical Soils.
Ellen Townley Cook, A.B.; Animal Physiology, Histology and Embryology. Thesis: Experimental Pancreatic Diabetes in the Calf.
Barbara Gilbert Cross, B.A.; Biological Sciences.
Margaret A. Delaney, A.B.; Home Economics. Thesis: A Study of the Ascorbic Acid Metabolism of Three Subjects on a Synthetic Diet.
Dsai Chwen Dju, B.S.; Animal Nutrition, Foods. Thesis: The Rate of Absorption of Calcium From the Gastrointestinal Tract of the Rat and Its Relation to Phosphorus.

Maurice Fried, B.S.; Soils, Analytical Chemistry. Thesis: The Effect of Lime and Gypsum on Plant Growth and Composition.
Erika Eva Gaertner, B.S.A.; Economic Botany, Plant Taxonomy. Thesis: Some Studies in the Biology of Cuscuta gronovii.
Arland Tillotson Hotchkiss, B.S. in Ed.; Biological Sciences.
Ione Huntington, B.S.; Bacteriology, Animal Nutrition. Thesis: The Relation Between Hydrogen Ion Concentration and Antisepsis.

Alice Lucile Ketchum, B.S.; Home Economics.
Robert Lambert, B.S.; Insect Taxonomy, Economic Entomology. Thesis: The Male Genitalia of the North American Species of Archips Hübner (Lepidoptera, Tortricidae).

Clearhos Logothetis, B.S.; Economic Entomology, Field Crop Production. Thesis: Effectiveness of Certain Soil Poisons and Soil Fumigants for Control of the European Chafer Amphimallon majalis (Razoumowski).

Miguel A. Lugo-Lopez, B.S. in Agr.; Technical Agriculture. Thesis: A Study of the Agriculture of Puerto Rico With Special Emphasis on Soil Erosion.

Margaret Zita Powers, B.S. in H.E.; Education.
Margaret Olive Steinmetz, B.S.; Home Economics.
Gustave Bernhardt Timmel, B.A.; Biological Sciences.

Chu Po Ting, B.S.; Plant Breeding, Cytology. Thesis: Studies of Inheritance in Oats.

Gerald Chi-Loh Wen, B.S.; Marketing, Business Management. Thesis: An Economic Study of the Production and Marketing of Hogs and Hog Bristles in Yungchang, Szechwan, China.

LeRoy Brough Yeatts, Jr., B.S. in Chem.; Analytical Chemistry, Inorganic Chemistry. Thesis: A Magnetic Study of the Type of Bonding Existing in Some Iron Complexes.

CONFERRED FEBRUARY 22, 1946
Joseph Elzear Mathieu Roland Bedard, B.S.A.; Floriculture and Ornamental Horticulture, Plant Pathology. Thesis: A Landscape Planning and Improvement Program for the Province of Quebec.

Vivian Mayme Frederick, B.S.; Biological Sciences.
Sturla Fridriksson, A.B.; Plant Breeding, Field Crop Production. Thesis: A Study of Self-Fertility in Brome Grass (Bomus inermis).

Guy John Goble, B.S.; Insect Toxicology, Apiculture. Thesis: The Mode of Toxic Action of Dinitro Compounds on the Honeybee (Apis mellifica Linn).

Julia Estelle Haines, B.Sc. in Hs. Ec.; Nutrition, Rural Sociology. Thesis: The Ascorbic Acid Metabolism of Normal Adults on an Intake Approximating the League of Nations Standard.
Miriam Margaret Jameson, A.B.; Home Economics.
Ana Victoria Jimenez, B.S. in Ed.; Home Economics.
Norman Oley Levardsen, B.S.; Zoology, Nature Study. Thesis: A Review of Alaska Fur Seal History and Sealing Methods.

Lien Chun Li, B.S.; Technical Agriculture.
Song-Sheng Liou, B.S.; Prices and Statistics, Marketing. Thesis: An Economic Study of American Cotton Prices.

Glen Pehr Lofgreen, B.S. in Agr.; Animal Nutrition, Animal Physiology. Thesis: Studies on the Value of Methionine in Supplementing Urea in the Rations of Ruminants.

Helen Rice, B.S.; Home Economics.
Emma Dorothea Vieweg, B.S. in H.E.; Home Economics.

CONFERRED JUNE 21, 1946
Glyn Bemister Adsit, B.A.; Social Studies.
Ruth Helen Ahnert, B.S.; Institution Management, Economics of the Household. Thesis: A Study of Industrial Food Service Practices With Particular Reference to the Handling, Cooking, and Service of Vegetables.
Ross Harold Arnett, Jr., B.S.; Medical Entomology, Economic Botany. Thesis: The Mosquitoes of Panama.
Morton Prince Brigham, B.S.; Biological Sciences.
Ervin Trowbridge Bullard, B.S.; Plant Breeding, Vegetable Crops. Thesis: Breeding for Halo Blight Resistance in Beans.

Kwei-Hai Chang, B.S. M.S.; Agricultural Economics.
Rose Patricia Collins, B.S. in Home Ec.; Nutrition, Foods. Thesis: Thiamine Retention in Baking Powder Biscuits as Affected By Benching, Diameter, and Baking Interval Including a Review of Literature on Enriched Flour and its Nutritional Significance.

Harold Fletcher Currier, B.S.; Vertebrate Zoology, Nature Study.
Roy Eugene Emerson, B.S.; Farm Equipment, Agricultural Engineering. Thesis: The Demonstration Method of Teaching Farm Mechanics.

Marjorie Whyte Farnsworth, A.B.; Medical Entomology, Invertebrate Zoology. Thesis: The Morphology and Musculature of the Larval Head of Anopheles Quadrimaculatus Say.

Edith Virginia Folger, B.S.; Biological Sciences. Thesis: The Birds of Nantucket.

Arthur Hugh Glogau, B.S.; Biological Sciences.
Marion Goldberg, A.B.; Bacteriology.
Miriam Henry Heiss (Sister), B.S. in H.E.; Home Economics.
*Doris Mae Hudson Justice, B.S. in H.E.; Nutrition, Foods.
Ruth Kett, A.B.; Bacteriology, Biochemistry.
Lawrence John Martello, B.A.; Marketing, Land Economics and Farm Finance.
Ching Peny Meng, B.S.; Agricultural Economics.
Marion Lois Middleton, B.A.; Education.
James Heberling Moore, A.B., B.D.; Social Studies.
Jane Nicolet, A.B.; Biochemistry, Physiology. Thesis: Monodeuteriocholine In Transmethylation Studies.

Sarah Elizabeth Payne, B.S.; Education.
William McCaddin Pritchett, B.A., M.A.; Agricultural Economics.
Charles Glenwood Rickard, D.V.M.; Diseases of Large Animals, Veterinary Obstetrics. Thesis: The Opsonocytophagic Test in Bovine Brucellosis.

John Stoddard Robas, B.S.; Limnology and Fisheries, Forestry. Thesis: A Method for Determining the Effect of Stream-Improved Devices upon the Composition of Stream Bottom Materials.
*Edith Windets Illick, B.S.; Home Economics.
Martha Holt Roberts, B.S.; Bacteriology, Biochemistry. Thesis: The Relation Between Enzyme Activity and Viability In Disinfection.
Rudolf Mathias Schuster, B.S.; Economic Entomology and Insect Morphology, Botany, Invertebrate Zoology. Thesis: The Insects Associated With Stored Grains and Cereals in New York State, With Especial Reference to the Coleoptera and Their Larvae.

Germaine Dora Seelye, B.S.; Vegetable Crops, Plant Breeding. Thesis: Effects of Spacing on Blossoming, Maturity, and Yield of the Lima Bean.

Frederick Harold Shaffer, B.S.; Ornamental Horticulture, Botany. Thesis: A Course of Landscape Gardening in Secondary Schools.

Priscilla Shaw, B.S.; Foods and Nutrition, Biochemistry. Thesis: The Ascorbic Acid, Thiamine, Riboflavin and Carotene Content of Fresh, Stored, and Frozen Spinach both before and After Cooking.
Gloria Silbiger, B.A.; Physical Chemistry, Physics. Thesis: An Electron Diffraction Investigation of the Structures of Beryllium Borohydrede and Decaborane, A Discussion of the Present Status of the Structures of Boron Hydrides.
Katherine Elna Stanford, B.S.; Nutrition, Family Life. Thesis: A Comparative Study of Food Likes and Dislikes of Two Groups of Nursery School Children.

Dorothy Margaret Stewart, B.S. in Ed.; Home Economics.
Juniata Emma Strom, B.S. in H.E.; Nutrition, Biochemistry. Thesis: Evidence of Citric Acid Synthesis in Human Subjects.

Margery Canedy Swisher, B.S. in H.E.; Home Economics.
Eugene Lester Ten Brink, A.B., B.D.; Education.
Naomi Rosenhaus Yager, B.S.; Animal Nutrition, Animal Physiology. Thesis: Some Studies on Vitamin C Methods with a Consideration of Their Application to the Study of the Total Ascorbic Content of Some Cooked Vegetables.

## MASTERS OF SCIENCE IN AGRICULTURE

## CONFERRED OCTOBER 21, 1945

Vernon Oliver Ferrer, D.I.C.T.A.; Land Economics and Farm Finance, Marketing. Thesis: Some Economic Aspects of Peasant Farming in Tobago, British West Indies, and the Possible Function of Medium-Term Credit in the Rehabilitation of Low-Income Farming Areas in Trinidad and Tobago.
Martin Hernandez-Ramirez, Jr., B.S.; Farm Management, Land Economics and Farm Finance. Thesis: Cost of Producing Sea Island Cotton in Southwestern Puerto Rico, 1941 and 1943.
Sellers Jerial Parker, B.S.; Vegetable Crops, Rural Education. Thesis: The Effect of Temperature on the Type of Growth of Certain Vegetable Crop Plants.
John Richard Ross, B.S.; Technical Agriculture.
Tsuneo Tanabe, B.S.; Animal Husbandry, Animal Nutrition. Thesis: The Influence of Age on Breeding Efficiency of Dairy Cattle in Artificial Insemination.

CONFERRED FEBRUARY 22, 1946
James David Burke, B.S.; Animal Husbandry, Animal Breeding. Thesis: Effect of Hay Making Methods on Hay Quality.
Ernest Hastings Casseres, B.S. in Agr.; Vegetable Crops, Plant Breeding. Thesis: Effect of Date of Sowing, Spacing and Foliage Trimming of Plants in Flats on Yield of Tomatoes.

George Dewey Mulloy, B.S.; Farm Management, Marketing. Thesis: The Relation of Education to Size of Business and Income.

Robert Selig Robison, B.S.; Soils, Plant Physiology. Thesis: The Antagonistic Action of the By-Products of Several Soil Micro-organisms on the Legume Bacteria and Their Effect on the Nodulation of Leguminous Crops.

Marco Antonio Baeza, B.S.; Vegetable Crops, Plant Breeding. Thesis: Effects of Spraying Potato Plants with Growth Substances on Yield, Quality, and Subsequent Behavior in Storage.

Ronald Bower Brook, B. Eng., B.Th., M.Th.; Technical Agriculture.
Adriano Cabal-Concha, Ingeniero Agronomo; Economic Entomology, Medical Entomology. Thesis: The Biology and Control of the Coffee Bean Weevil Araecerus fasciculatus De Geer, Fam (Anthribiidae), in Barranquilla, Colombia, South America.
Francis John DiVesta, B.S. in Ed.; Agricultural Education, General Biology. Thesis: The Use of Interpretive Science in Vocational Agriculture.

Elizabeth Carol Koudal, B.S.; Vegetable Crops, Plant Breeding. Thesis: Some Effects of Environment on Self-Incompatability in Cabbage, Brassica Oleracea Var. Capitata.

Jerome Kaleruo Pasto, B.S.; Agricultural Economics.
Copeland Kendrick Robinson, D.I.C.T.A.; Agricultural Economics.
Nicolas Theodore Theodorou; Education. Thesis: Vocational Rural Extension Education Organization and Administration for Greece.

Clifford Hoag Towle, B.S., B.D.; Technical Agriculture.
Oswaldo E. de Urrutia, B.S. in Agr.; Marketing, Land Economics and Farm Finance. Thesis: Marketing Livestock and Livestock Products in Puerto Rico.

## MASTER OF FINE ARTS

CONFERRED JUNE 21, 1946
Eugenia Lillian Petty, B.F.A.; Painting, History of Painting. Thesis: A Group of Paintings and Drawings.

## MASTER OF REGIONAL PLANNING

CONFERRED FEBRUARY 22, 1946
Thomas Jefferson Baird, B. Arch.; Regional Planning, Landscape Design. Thesis: A Master Plan for City of Cortland, New York.

## MASTERS OF SCIENCE IN ENGINEERING

## CONFERRED OCTOBER 21, 1945

Norman Robert Bell, B.S. in E.E.; Electric Power Application, Machine Design. Thesis. A Study of the Effect of Ballast Design upon the Operation of Fluorescent Lamps.

Michael Chih-Chi Chow, B.S. in E.E.; Machine Design, Industrial Engineering.

Thesis: Study of the Factors and the Principles to be Applied in the Design and Use of Ball and Roller Bearings.
Pei Tung Hsu, B.S.; Structural Engineering, Mathematics. Thesis: A Comparative Study of an Unsymmetrical Double Span Rigid Frame Bridge.

Shih-Tsung Sang, B.M.E.; Industrial Engineering, Administrative Engineering. Thesis: A Design of a Tin Can Manufacturing Plant.

Biau Yang, B.S. in C.E.; Highway Engineering, Structural Engineering. Thesis: A Terminal Building Design in the Airport at Kunming, China.

## CONFERRED FEBRUARY 22, 1946

Li Chow, B.S.; Highway Engineering, Structural Engineering. Thesis: Present Knowledge of the Design of Rigid Pavements.
Chung-Yuan Li, B.S. in C.E.; Sanitary Engineering, Architectural Construction. Thesis: Design and Study of the Water Supply System of the City of Ithaca, New York.

James Che Ming Liu, B.S. in Eng.; Machine Design, Mechanics. Thesis: Fluid Coupling.

## CONFERRED JUNE 21, 1946

William James Corcoran, S.B.; Chemical Engineering, Organic Chemistry. Thesis: Title Withheld for Military Reasons.

David Adrian Dickson, A.B.; Chemical Engineering, Organic Chemistry. Thesis: Title Withheld for Military Reasons.

Ernest William Dobie, Jr., B.S.; Chemical Engineering, Physical Chemistry. Thesis: Title Withheld for Military Reasons.

Oscar Frank Dreyer, B.S.; Chemical Engineering, Physical Chemistry. Thesis: Title Withheld for Military Reasons.

Su-Yu Miao, B.S. in E.E.; Electrical Design, Electronics. Thesis: A Study of Transformer Design.

Joseph Morgan Parsons, B.S.; Chemical Engineering, Physical Chemistry. Thesis: Title Withheld for Military Reasons.

Ming-lung Pei, B.S. in C.E.; Structural Engineering, Railroad Engineering. Thesis: Hipped Plate Structures and Force Distribution Method.

Morton Alva Prager, B.S.; Chemical Engineering, Organic Chemistry. Thesis: The Stabilization of Smokeless Powder.

Walter Lawrence Prehn, B.Sc. in Ch.E.; Chemical Engineering, Organic Chemistry. Thesis: The Commercial Production of Nitration Grade Toluene from Petroleum.

John Adolph Quense, B.S. in Chem., Ph.D.; Chemical Engineering, Physics. Thesis: Title Withheld for Military Reasons.

Wilson Bee Robertson, B.S.; Chemical Engineering, Physical Chemistry. Thesis: Factors Governing the Nitration of Cellulose.

Ward Hanson Sachs, Jr., B.S. in Chem. Eng., M.S.; Chemical Engineering, Physical Chemistry. Thesis: Conversion Efficiency in the Production of Sulfuric Acid by the Contact Process.

Edward Chester Staehling, B.Ch.E.; Chemical Engineering, Physical Chemistry. Thesis: Fuels for Jet Propulsion.

Robert Jenkins Williams, B.Ch.E.; Chemical Engineering, Physical Chemistry. Thesis: Hydrogen Production.

Thomas James Wishlinski, B.S.; Chemical Engineering, Organic Chemistry. Thesis: Guanidine and Its Nitrogen Derivatives.

Leonard William Zahnstecher, B.Ch.E.; Chemical Engineering, Physical Chemistry. Thesis: Plant Design Applied to Continuous Dehydration with Diethylene Glycol.

## MASTERS OF CIVIL ENGINEERING

CONFERRED OCTOBER 21, 1945
Luis Paredes-Manrique, B.S. in C.E.; Structural Engineering, Sanitary Engineering. Thesis: Determination of the Moments in a Rectangular Frame Under Concentrated Loads.

CONFERRED FEBRUARY 22, 1946
Alexander Torleiv Andreassen, B.C.E., Structural Engineering, Hydraulic Engineering. Thesis: Comparison Study of the Characteristics of Strain Gauges Used for Static Tests.
David Kuang-Tse Ho, B.S.; Structural Engineering, Regional and City Planning. Thesis: Architectural and Engineering Design of a Modern Commercial Hotel.

## CONFERRED JUNE 21, 1946

Darwin Chang, B.S.; Highway Engineering, Management Engineering. Thesis: A Review of Road Stabilization for Highways and Airports.
Warner Lansing, B.C.E.; Mechanics, Hydraulics. Thesis: Dimensional Analysis and Its Application to Models of Structures Dynamically Loaded by Fluid Forces.
Milton Rafael Martinez-Delgado, B.S. in C.E.; Structural Engineering, Hydraulic Engineering. Thesis: The Plastic Theory Applied to Rectangular Reinforced Concrete Columns.

## MASTERS OF ELECTRICAL ENGINEERING

## CONFERRED OCTOBER 21, 1945

Raj Pratap Misra, B.S. in E.E.; Materials of Engineering, Physics. Thesis: Measurement of Potential Distribution on Post-Type Insulators.

## CONFERRED JUNE 21, 1946

Samuel Abner Ward, B.E.E.; Electronics, Physics. Thesis: The Effect of Electrode Spacings Upon the Electrical Characteristics of High-Vacuum Parallel-Plane Triodes.

## MASTERS OF MECHANICAL ENGINEERING

CONFERRED OCTOBER 21, 1945
Samuel Keller Wolcott, Jr., M.E.; Fluid Mechanics, Experimental Engineering. Thesis: Design of a Centrifugal Pump.

CONFERRED FEBRUARY 22, 1946
Thomas Brodhead Tracy, M.E.; Heat-Power Engineering, Experimental Mechanical Engineering. Thesis: The Thermo-Syphon Refrigerator.

CONFERRED JUNE 21, 1946
Charles Raymond Otto, M.E.; Experimental Mechanical Eng'g, Engineering Materials. Thesis: Laboratory Equipment to Demonstrate the Problems and Performance of Automatic Controllers.

Ivar Stakgold, B.M.E.; Mechanics of Engineering, Mathematics. Thesis: The Buckling of Sandwich-Type Panels.

## MASTERS OF LAW

CONFERRED OCTOBER 21, 1945
Francis James Kope, L.L.B.; Jurisprudence, Private Law.

CONFERRED FEBRUARY 22, 1946
Lewis Harry Kirshner, L.L.B.; Private Law, Public Law.

CONFERRED JUNE 21, 1946
Stephen Patsy Vinciguerra, A.B., L.L.B.; International Law and Relations, Public Law, Private Law.

MASTER OF EDUCATION
CONFERRED JUNE 21, 1946
Henry Leland McDougal, B.S.; Education.

## MASTERS OF SCIENGE IN EDUCATION

CONFERRED OCTOBER 21, 1945
Alta Thompson Backus, B.S.(Ed). Thesis: Redirection of the British Secondary Education.

Vivian Millicent Collier, B.S.
Edward Craig Donnan, B.S.

Gordon Elihu Gifford, E.E.
George Howard Goold, B.S.
Arthur William Neff, B.S. in Ed.
Irene Van Deventer Skinner, B.S.
Ada Ruth Stovall, B.S.

CONFERRED FEBRUARY 22, 1946
Albert Eugene Palm, B.S. Thesis: A Critical Study of the Greene Centralization.
CONFERRED JUNE 22, 1946
Lester Hoag Benson, B.S.; Education.
Clark Clements Carnal, B.S. in Ed.; Education.
John Richard Cook, B.S.; Education.
William Lee Gragg, B.S., Education.
Madison Monroe Hess, B.S.; Education.
William Rudolph Kunsela, B.S.; Education.
Everett Courter Lattimer, B.S.; Education.
Frankye Daniels Ledbetter, B.S.; Education.
Harold Niles Slone, B.S.; Education.
Edgar F. Snyder, B.S.; Education.
Helen Mae Sullivan, B.S.; Education.
Harold Templeton Walker, A.B.,'B. Theo.; Education.
Ray Leech Wheeler, B.S.; Education.

## MASTER OF SCIENCE IN INDUSTRIAL AND LABOR RELATIONS

## CONFERRED JUNE 21, 1946

Donald Adler Strauss, A.B.; Collective Bargaining, Labor Legislation. Thesis: The Impartial-Chairman System of Arbitration as Illustrated Principally by the Rochester Men's Clothing Industry.

## DOGTORS OF PHILOSOPHY

CONFERRED OCTOBER 21, 1945
Robert Francis Ball, B.S., M.S.; Animal Pathology, Animal Breeding, Parasitology. Thesis: A Study of Iris-Depigmentation in Single Comb White Leghorns.

George Pershing Baumann, B.S. Ch.E.; Chemical Engineering, Organic Chemistry, Physical Chemistry. Thesis: (Withheld for military purposes)

Kaare Roald Bergethon, A.B., A.M.; German Literature, German Philology, English Literature. Thesis: Some Aspects of G.E. Lessing's Attitude Toward Society. A Study and Interpretation of His Major Dramas.

John Markus Blatt, A.B.; Theoretical Physics, Experimental Physics, Mathematics. Thesis: The Meson Charge Cloud around a Proton.
Lowell William Charkey, B.S., M.S.; Animal Nutrition, Animal Physiology, Organic Chemistry. Thesis: Factor R and its Relation to other Newer Members of the Vitamin B Complex.
Walter Hung-Wo Ching, B.S.; Marketing, Industrial Management, Land Economics and Farm Finance; Thesis: Sugar Marketing in the United States.
Evelyn Linda Cosby, B.S.; Biochemistry, Pathogenic Bacteriology, Economic Botany. Thesis: Some Studies on Lipoxidase and Rhodanese.

Louise Jane Daniel, B.S. in Ed., M.S.; Animal Nutrition, Biochemistry, Organic Chemistry. Thesis: Studies on the Relationship of Lactobacillus casei Factor and Folic Acid.

James Nelson Freeman, B.S., M.S.; Agricultural Education, Supervision, Soils. Thesis: A Program of Education in Agriculture for Negroes of Missouri based Upon an Analysis of Economic Factors and of Social Activities of Negroes in Selected Communities in Southeast Missouri.

Victor Lionel Guzman, Ingeniero Agronomo, M.S. in Agr.; Vegetable Crops, Plant Breeding, Plant Physiology. Thesis: Some Aspects of Plant Tissue Analysis as an Index of Nitrogen Requirements of Certain Vegetable Crop Plants.
Lyle Johnson Hayden, B.S., M.S.; Agricultural Education, Agricultural Engineering, Educational Administration. Thesis: Characteristics of College Curriculums for the Education of Teachers of Vocational Agriculture, Based on Students' Transcripts.

Irma Highbaugh, A.B., A.M.; Family Life, Social Psychology, Rural Education. Thesis: A Family Centered Program in Rural Reconstruction in West China With Special Emphasis on the Preschool Child.

Robert Leslie Hull, B.Mus., M.Mus.; Musical Composition, Musicology, Aesthetics. Thesis: I. Quintet for Strings. II. Kyrie. III. Prelude and Fugue for Orchestra.

Louis Carl Knorr, A.B., M.S.; Plant Pathology, Plant Physiology, Bacteriology. Thesis: Research on the Bacterial Ring Rot of Potatoes.

Julio Oscar Morales, B.S. in Agr., M.S. in Agr.; Farm Management, Marketing, Money, Banking and International Finance. Thesis: A Study of the Adjustments Made by 39 Cost Account Farmers to Changing Prices and Technological Conditions.
Calvin Clyde Murray, B.S. in Agr. Ed., M.S. in Agr.; Plant Breeding, Soils, Field Crops. Thesis: Inheritance of Length of Fiber in American Upland Cotton.

Helen Florence North, A.B., A.M.; Latin Language and Literature, Greek Language and Literature, Ancient History. Thesis: The Concept of Sophrosyne in Greek Literature from Homer to Aristotle.

Richard Hsueh-Jui Pian, B.S.C.E., M.S. in Eng.; Structural Engineering, Hydraulic Engineering, Regional and City Planning. Thesis: Strength of Structural Members Subject to Elastic Instability.

Bayard Elmer Quinn, B.S. in M.E., M.S. in Eng.; Machine Design, Mechanics, Secondary Education. Thesis: Worm Gear Design.
Josephine Gertrude Rickard, A.B., A.M.; The Victorian Period, The English Renaissance, American Literature. Thesis: The Reputation of Matthew Arnold as a Poet 1849-1869.

Crystal Leone Rork, A.B., A.M.; Cytology, Genetics, Plant Taxonomy. Thesis: A Cytotaxonomic Investigation of the Genus Gentiana and Related Genera.

Milton Leonard Scott, A.B.; Animal Nutrition, Animal Physiology, Organic Chemistry. Thesis: Studies of Organic Factors Required for Prevention of Anemia in the Chicken.

Frederick Harry Stutz, A.B., A.M.; Social Studies Education, Modern European History, American History. Thesis: An Evaluation of the Contributions of Textbook Illustrations to Understanding in World History.

Georges Elias Tabet, B.A., B.S. in Chem. Eng., M.Sc.; Organic Chemistry, Physical Chemistry, Inorganic Chemistry. Thesis: (Withheld for military reasons).

John Franklin Whitney, B.S.; Physical Chemistry, Inorganic Chemistry, Physics. Thesis: The Crystal Structure of Sodium Octofluotantalate.

Antoinette Miele Wilkinson, B.A.; Plant Morphology, Economic Botany, Paleobotany. Thesis: The Floral Anatomy and Morphology of Some Species of Cornus and of the Caprifoliaceae.

## CONFERRED FEBRUARY 22, 1946

Howard William Boehmer, B.S. in Eng.; Experimental Physics, Theoretical Physics, Mathematics. Thesis: (Title Withheld for military reasons.)
Vivian Murray Chambers, B.S., A.M.; Economic Entomology, Vertebrate Zoology, Medical Entomology. Thesis: The Effects of Type of Spray, Concentration, Surface, and Temperature on the Residual Action of DDT Against the Housefly, Musca domestica L.

Jeffrey Earl Dawson, B.S.A.; Soils, Plant Physiology, Physical Chemistry. Thesis: Boron as a Factor in the Production of Alfalfa in New York State.

Aubrey Alfred Foster, B.S.; Plant Pathology, Plant Physiology, Biochemistry. Thesis: Stimulation and Retardation of Germination of Some Vegetable Seeds Resulting From Treatment with Protective Fungicides.

Stephanie Marie Jakimowitz, A.B., A.M.; Latin Language and Literature, Greek Literature, Ancient History. Thesis: The Concept of Andreia in Greek Literature from Homer Through Aristotle.

Herman Alexander Lang, S.B., S.M.; Mechanics, Mathematics, Physics. Thesis: Large Deflections of Elastic Plates.

Patricia Ann Mooney, B.A., M.A.; Spanish Literature, Education, Private Law. Thesis: Serious Content in the Alvarez Quintero Comedies.

Mehmet Ali Oksal, B.S. in M.E., M.M.E.; Machine Design, Mechanical Processing, Industrial Engineering. Thesis: The Introduction of Variable Viscosity in the Analysis of Full Journal Bearings.

Arthur Oliner, B.A.; Experimental Physics, Theoretical Physics, Mathematics. Thesis: (Title withheld for military reasons).

Norman Emory Parnell, A.B., M.S.; Physical Chemistry, Organic Chemistry, Physics. Thesis: A Freezing Point Study of Aqueous Alanine Solutions.

William Edward Reed, B.S., M.S.; Soils, Plant Physiology, Field Crop Production. Thesis: The Effect of Plants on the Physical Properties of a Dunkirk Silty Clay Loam and the Effect of Soil Aeration on Plant Growth and Composition.

Ali Resat Saribas, B.M.E., M.M.E.; Industrial Engineering, Administrative Engineering, Machine Design. Thesis: A Study of the Most Efficient Means of Increasing Production 25 Per Cent in a Given Plant.

## CONFERRED JUNE 21, 1946

Martin McRae Barnes, B.S.; Economic Entomology, Insect Physiology, Insect Toxicology. Thesis: Investigations on the Control of the Codling Moth, Carpocapsa Pomonella (Linn.), by Dusting and Spray-Dusting.

Samuel Wilson Blizzard, Jr., B.A., Th.B., Th.M.; Rural Sociology, Animal Husbandry, Agricultural Economics. Thesis: The Attitudes of Rural and Urban High School Students toward the Values of Rural Living.

James Edward Briggs, B.S., M.S.; Animal Husbandry, Animal Nutrition, Animal Physiology. Thesis: The Optimum Protein Requirements of Growing Fattening Lambs.

Stella Brewer Brookes, A.B., A.M.; American Literature, Dramatic Literature, English Poetry. Thesis: Folklore in the Writing of Joel Chandler Harris.

Wayne Burns, A.B., A.M.; Prose Fiction, Literary Theory and Criticism, The Victorian Period. Thesis: Charles Reade: The Making of a Social Novelist.

William Michael Cashin, B.Sc.; Physical Chemistry, Inorganic Chemistry, Physics. Thesis: An Investigation of the Crystal Structure of Ammonia-Boron Trifluoride.

Ellis Brady Clough, B.S., M.S.; Agricultural Education, Rural Education, Land Economics and Farm Finance. Thesis: Some Personal, Family, and Home Farm Factors Related to the Dissociation of Sons From Parental Farm Families.
Virginia Farrer Cutler, B.S., A.M.; Education, Family Life, Sociology and Anthropology. Thesis: Development of an Educational Instrument to Reveal Personal and Family Values in the Choice of a Home.
Mateo Lian Pao Go, B.C.E., M.S. in C.E.; Structural Engineering, Soil Mechanics, Highway Engineering. Thesis: Air Transportation and Airport Problems.
George Richard Hill, A.B.; Inorganic Chemistry, Physical Chemistry, Plant Physiology. Thesis: A Study of the Reaction of Hydrogen with Boron Bromide and an Aluminum Halide at a Hot Surface of Tantalum or Glass. The Pyrolysis of Aluminum Borohydride.
Ruth Edwinna Hopson, B.A., M.A.; Nature Study, Geology, Vertebrate Zoology. Thesis: The Study of a Valley. The McKenzie River Region of Oregon, with Special Reference to the Educational Significance of Its Natural History.
Francis Chung Siu Hung, B.C. in C.E., M.C.E.; Structural Engineering, Mechanics, Regional and City Planning. Thesis: Stresses in Slender I-Z-Beams.
Kathleen Ardies Johnston, B.A., B.S.; Economics of the Household, Prices and Statistıcs, Nutrition. Thesis: Availability and Price of Fruits and Vegetables in Retail Stores, Ithaca, New York, 1943 and 1944.

Dean Graeme Jones, B.S. in Agr., M.S.; Animal Breeding, Histology and Embryology, Animal Physiology. Thesis: The Relationships Between Development of the Comb, Body Size, and Reproductive Capacity in White Leghorn Males.
Geneva Emerson Kenway, A.B., M.S.; Educational Psychology, Social Psychology, Family Life. Thesis: A Study of the Value Content of Elementary School Readers.
Earle Wayne Klosterman, B.S., M.S. in Agr.; Animal Husbandry, Animal Physiology, Animal Nutrition. Thesis: Protein Requirements and Value of Urea for Fattening Lambs.
Hai-Chang Benjamin Koo, B.S. in C.E., M.S. in Eng.; Structural Engineering, Regional and City Planning, Railroad Engineering. Thesis: Analysis of Columns in Rigid Frames.
Aubrey Arnold Larsen, B.S., M.S.; Organic Chemistry, Physical Chemistry, Inorganic Chemistry. Thesis: Synthesis of Indole Derivatives Related to Gliotoxin.
Robert Lee Livezey, B.S., M.S.; Vertebrate Zoology, Botany, *Geo-Morphology. Thesis: A Synoptic Key to the Salientian Eggs of the United States.
*Meteorology
Joseph Daniel Loconti, A.B., M.S.; Biochemistry, Organic Chemistry, Analytical Chemistry. Thesis: Lipoxidase-Activity-Specificity-Secondary Oxidation of Beta-Carotene.
Mei-Hung Loh, B.S., M.C.E.; Structural Engineering, Mathematics, Regional and City Planning. Thesis: Buckling of Rigid Frames.
Evelyn June Lorenzen, B.S. in H.E.; Foods and Nutrition, Biochemistry, Animal Nutrition. Thesis: Copper and Manganese Storage in the Liver at Various Age Levels (Rat, Rabbit, and Guinea Pig.)
John Richard McCartney, A.B.; Physical Chemistry, Inorganic Chemistry, Physics. Thesis: The Investigation of Polymer Systems by Light Scattering.
John Kenneth McClennan, B.S., M.S.; Organic Chemistry, Inorganic Chemistry, Analytical Chemistry. Thesis: Thermal Stability of Nuclear Substituted N -Nitrosoacylarylamines.

Ernest Mercier, B.A., B.S. in Agr., M.S. in Agr.; Animal Breeding, Animal Physiology, Genetics. Thesis: The Effects of Season on Spermatogenic Activity and Reproduction in Cattle.
Clarence Richard Morgan, B.S. in Chem., M.S.; Organic Chemistry, Biochemistry, Inorganic Chemistry. Thesis: Title Withheld for Military Reasons.

Felix Alexander Nylund, B.S., M.S.; Agricultural Education, Rural Secondary Education, Agricultural Economics. Thesis: The Discovery and Analysis of the Occupational Opportunities in Farming and Related Service Occupations for Former Students of Vocational Agriculture. A Study of the Spencer-Van Etten Community, Its Families, Needs, and Resources.
Cullen Bryant Owens, A.B., M.S.; Rhetoric and Public Speaking, Social Psychology, Phonetics and Speech Training. Thesis: A Survey of Social Psychology as Bearing on the Teaching of Public Speaking.

Vernon Sennock Pate, L., A.B.; Insect Toxonomy, Zoology, Insect Ecology. Thesis: A Conspectuș of the Tribe Pemphilidini (Hymenoptera-Sphecidae).

Howard Linklater Patterson, B.S.A.; Farm Management, Economic Theory, Rural Economy. Thesis: An Economic Study of Dairy Farms in the Province of Alberta, Canada, 1939-1943.

Sirvart Poladian, A.B., M.A.; Musicology, American Literature, German Literature. Thesis: Handel As An Opera Composer.

Maurice Prober, B.S., M.S.; Organic Chemistry, Physical Chemistry, Inorganic Chemistry. Thesis: Withheld for Military Reasons.

Emmett Idolia Robertson, B.S. in Agr., M.S. in Ag.; Animal Nutrition, Animal Physiology, Biochemistry. Thesis: The Role of Folic Acid in the Nutrition of the Chick.

Christian Robert Spork, A.B.; Physical Chemistry, Physics, Mathematics. Thesis: The Electrostatic Effect of Substituents on Reaction Rates.

Frank Louis Stark, Jr., B.S. in Agr., M.S.; Plant Pathology, Plant Physiology, Entomology. Thesis: Investigations Relative to the Use of Chloropicrin for Soil Fumigation.

William C. Stokoe, Jr., A.B.; Old and Middle English, Literary Theory and Criticism, Latin Literature. Thesis: The Work of the Redactors of Sir Launfal, Richard Coeur de Lion, and Sir Degare.

Helene Wallace Toolan, S.B.; Pathology; Bacteriology, Biochemistry. Thesis: Resistance to Implanted Lymphosarcoma Cells of Mice Treated with Various Rabbit Antisera.

Ellsworth Haines Wheeler, B.Sc., M.S.; Economic Entomology, Insect Morphology, Botany. Thesis: The Pathogenicity of Bacillus Lentimorbus Dutky and Strains of Bacillus Popilliae Dutky to Larvae of Amphimallon Majalis (Razoumowski), Scarabaeidae.

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[^0]:    ${ }^{1}$ Open only to students who have had a four-year course in Agriculture or the equivalent.
    ${ }^{2}$ Under the special jurisdiction of the Division of Architecture and Fine Arts.
    ${ }^{3}$ Under the special jurisdiction of the Division of Engineering.
    ${ }^{4}$ Under the special jurisdiction of the Division of Law.
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[^2]:    ${ }^{1}$ The candidate should consult the chairman of his Committee to ascertain if additional copies are required by the department.

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[^4]:    ${ }^{1}$ In special cases two members of the Faculty may be chosen to represent either the Major or a Minor Subject. If the candidate chooses two members to represent the Major Subject, he may designate one of them as chairman.

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[^9]:    RESEARCH IN TAXONOMY. Professors Eames and Muenscher and Associate Professor Clausen.

[^10]:    *Except in the case of candidates for the degree M.Aero.E. (see p. 179).

[^11]:    ${ }^{1}$ See pages 8 ff .
    ${ }^{2}$ Although not under the supervision of the Engineering Division, it is to the advantage of candidates for non-professional degrees in Engineering who have registered in the Graduate School to register also in the appropriate branch of the Engineering Division.

[^12]:    *Candidates for the degree M.Aero.E. see p. 179.

[^13]:    *Candidates for the degree M.Aero.E. see p. 179.
    ${ }^{1}$ Members of the Faculty who are qualified to supervise the work of graduate students are Professors, Associate Professors, Assistant Professors, and those Instructors who hold the doctor's degree. For the sake of brevity any such member is herein referred to as "Professor."

[^14]:    4121. Electron Tubes and Circuits. Three hours.
    4122. Electronic Circuit Elements. Four hours.
    4123. Electronics Laboratory. Two hours.
    4124. Direct Current Machinery. Three hours.
    4125. Electrical Machinery Laboratory. Four hours.
    4126. Alternating Current Machinery. Three hours.
    4127. Electrical Machinery Laboratory. Four hours.
[^15]:    3551. STEAM TURBINES. Alternate terms. Two hours a week. Prerequisite, 3535 and 3536. Mr. Clark.

    Classification of turbines and description of leading features of the various types; mechanical and thermal considerations underlying the action of steam in turbines; calculations involved in turbine design; discussion of building, erecting, and testing; adaptability to special conditions of service; economic results of the use of turbines in engineering practice.

[^16]:    *Will be given any term when there is demand, and staff is available.

[^17]:    * Field experience or interneship may be included as part of the research program under the direction of the student's special committee.

