Clemson Graduate School Catalog, 1959-1960

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CLEMSON COLLEGE

RECORD

ANNOUNCEMENTS OF
THE GRADUATE SCHOOL
FOR
1959-60

Published quarterly by Clemson College, Clemson, South Carolina. Entered as second-class matter April 25, 1905, at the Post Office at Clemson, South Carolina, under the Act of July 16, 1894, now superseded by the Act of August 24, 1912.
CHECK LIST ON GRADUATE SCHOOL PROCEDURES

The final responsibility for following Graduate School procedures rests with the graduate students. Special problems should be referred to the Graduate School Office, Room 17, Tillman Hall.

After admission the graduate student should be especially careful to follow this check list:

1. Submit Plan for Graduate Study (G. S. Form 2) not later than thirty days from initial registration. (See page 20.)

2. If necessary, submit request for changes in Plan for Graduate Study. (See page 20.)

3. Select in consultation with the appropriate Department Head a major adviser and/or an advisory committee. (See page 23.)

4. Satisfy any prescribed foreign language examination and other qualifying examinations prerequisite to admission to candidacy. (See page 22.)

5. Apply for candidacy to degree (G. S. Form 4) after completing at least half the prescribed residence and course work and after passing any prescribed qualifying examinations. (See page 20.)

6. Place formal order for diploma with the Registrar and pay diploma fee within 4 weeks following opening of final semester prior to graduation. (See page 22.)

7. Submit completed thesis to advisory committee chairman and arrange for final examination by the advisory committee. (See page 23.)

8. Pay binding fee to the Bursar and submit abstracts and approved copies of thesis to the Dean of the Graduate School. (See page 21.)
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COLLEGE CALENDAR

SESSION 1959-60

1959

Matriculation, new students ________________ September 10
Registration, new students __________________ September 14
Matriculation and Registration, current students...September 14, 15
Classes begin ______________________________ September 16
Late Registration fee applies ________________ September 21
Last day for Matriculation ________________ September 22
Foreign Language Examination ________________ October 10
State Fair Holidays ________________________ October 22-24
Thanksgiving Holidays ______________________ November 26-28
Christmas Holidays begin at 12 noon __________ December 19

1960

Classes resumed ____________________________ January 4
Theses due in Graduate Office ________________ January 23
End of first semester _________________________ January 30
Matriculation, new students ________________ February 1
Registration, new students __________________ February 3
Matriculation and Registration, current students February 4
Classes begin ______________________________ February 5
Late Registration fee applies __________________ February 8
Last day for Matriculation __________________ February 11
Foreign Language Examination ________________ April 9
Easter Holidays ______________________________ April 15-18
Theses due in Graduate Office ________________ May 28
Commencement ______________________________ June 5
PERSONNEL

OFFICERS OF ADMINISTRATION

Robert Cook Edwards, B.S., LL.D. --------------------------- President
Francis Marion Kinard, A.M., Litt.D. ---------------- Dean of the College
Walter Thompson Cox, B.S. ------------------ Dean of Student Affairs
Melford A. Wilson, B.S. --------------------------- Comptroller
Frank Johnstone Jervey, B.S., D.Sc. ______ Vice-President for Development
Milton Dyer Farrar, Ph.D. ------------------ Dean, School of Agriculture
Jess Willard Jones, Ph.D. ___________ Director, Agricultural Teaching
Harlan Ewart McClure, M.Arch. ___________ Dean, School of Architecture
Howard Louis Hunter, Ph.D. ___________ Dean, School of Arts and Sciences
James Hagood Sams, Jr., Ph.D. ___________ Dean, School of Engineering
Gaston Gage, M.Ed. ___________ Dean, School of Textiles
Jack Kenny Williams, Ph.D. ___________ Dean, Graduate School
John Wallace Gordon Gourlay, A.M.L.S. ___________ Director of the Library
Kenneth Notley Vickery, B.S. ___________ Registrar

THE GRADUATE COUNCIL

1959-1960

Jack Kenny Williams, Ph.D., Professor of History and Dean of the Graduate School. Chairman ex officio.
Floyd Irving Brownley, Jr., Ph.D., Professor of Chemistry and Head, Department of Chemistry and Geology.
Willie Cecil Godley, Ph.D., Professor of Animal Husbandry.
Charles Edward Littlejohn, Ph.D., Professor of Chemical Engineering and Head, Department of Chemical and Metallurgical Engineering.
Charles Albert Reed, Ph.D., Professor of Physics.
John Kenneth Reed, Ph.D., Professor of Entomology and Zoology.
Howard Louis Hunter, Ph.D., Professor of Chemistry and Dean, School of Arts and Sciences. Ex officio.
James Hagood Sams, Jr., Dean, School of Engineering. Ex officio.
Gaston Gage, M.Ed., Professor of Carding and Spinning and Dean, School of Textiles. Ex officio.
Jess Willard Jones, Ph.D., Professor of Agronomy and Director of Agricultural Teaching. Ex officio.
GENERAL INFORMATION

INTRODUCTION

Clemson is the land-grant college of South Carolina, a state institution, and one of the A. and M. colleges which emphasizes study in agriculture and mechanical industries. Clemson is fully accredited by the Southern Association of Colleges and Secondary Schools. The twenty-nine curriculums under the Schools of Agriculture, Architecture, Arts and Sciences, Engineering, and Textiles form a background of training for the hundreds of occupations which Clemson graduates enter.

The government of the College is vested in a Board of Trustees. In accord with the Thomas G. Clemson will, the Board includes six members elected by the Legislature and a self-perpetuating group of seven life members. The function of the Board is legislative. The Board determines the general policy of the College and directs the expenditure of its funds.

The President of the College is the chief executive and administrative officer.

THE GRADUATE SCHOOL

The Graduate School exists to formulate policies and standards, and to unify administrative procedures concerning all graduate work at Clemson. The Dean of The Graduate School serves as chairman of the Graduate Council, a policy making body appointed from the general faculties of the College.

The aims of graduate programs at Clemson are to provide comprehensive training in special fields, to offer instruction in the methods of independent investigation, and to foster the spirit of research scholarship. Graduate study is much more than a continuation of undergraduate work. Its true spirit is one of inquiry and the desire to add to human knowledge. Graduate study should therefore be contemplated only by students who have already demonstrated in their undergraduate programs unusual intellectual attainments and the power of independent thought and investigation.
**EXPENSES**

**Full-Time Students.** The 1959-1960 charges for regular full-time students for tuition, fees and living expenses, including board room and laundry, are shown below:

<table>
<thead>
<tr>
<th></th>
<th>South Carolina Student</th>
<th>Non-Resident Student</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First Semester</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First Payment:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tuition and Fees (Semester)</td>
<td>$137.80</td>
<td>$237.80</td>
</tr>
<tr>
<td>Living Expenses (½ Semester)</td>
<td>145.30</td>
<td>145.30</td>
</tr>
<tr>
<td><strong>Total Entrance Payment</strong></td>
<td>$283.10</td>
<td>$383.10</td>
</tr>
<tr>
<td>Second Payment:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Living Expenses (due Nov. 10)</td>
<td>145.30</td>
<td>145.30</td>
</tr>
<tr>
<td><strong>Total First Semester</strong></td>
<td>$428.40</td>
<td>$528.40</td>
</tr>
</tbody>
</table>

| **Second Semester**  |                        |                      |
| First Payment:       |                        |                      |
| Tuition and Fees (Semester) | $137.80       | $237.80             |
| Living Expenses (½ Semester) | 145.30          | 145.30              |
| **Total Entrance Payment** | $283.10        | $383.10             |
| Second Payment:      |                        |                      |
| Living Expenses (due April 1) | 145.30         | 145.30              |
| **Total Second Semester** | $428.40         | $528.40             |
| **Total for Year**   | $856.80             | $1,056.80           |

The fees included in these charges are matriculation, laboratory, class maintenance, medical, and student activity. The thesis binding fee, the diploma fee, and the fee for cap and gown rental are not included.
Part-Time Students. The 1959-60 tuition costs to part-time graduate students vary according to the amount of work scheduled as follows:

<table>
<thead>
<tr>
<th>Fraction of Time</th>
<th>S. C. Student</th>
<th>Out-of-State</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4-time student (1-5 credits)</td>
<td>$28.70</td>
<td>$53.70</td>
</tr>
<tr>
<td>1/2-time student (6-8 credits)</td>
<td>55.90</td>
<td>105.90</td>
</tr>
<tr>
<td>3/4-time student (9-11 credits)</td>
<td>83.10</td>
<td>158.10</td>
</tr>
</tbody>
</table>

These charges include matriculation, laboratory, and class maintenance fees.

Graduate assistants and part-time students taking six or more credits are given the opportunity of receiving medical treatment on a semester basis by payment of a hospital fee of $10. Students who elect not to pay the hospital fee are responsible for arranging their own medical care.

Graduate assistants and part-time students taking six or more credits are given the opportunity of participating in student activity programs by paying an annual activity fee of $35 which is payable at the rate of $17.50 per semester. This includes admission to home athletic contests and college concerts. Students electing this option in September shall be required to pay the activity fee of $17.50 at the beginning of the second semester. No change in this option will be permitted during the school year.

A graduate assistant or part-time student not enrolled in the first semester will be given the opportunity of paying the $17.50 activity fee for the second semester at the time of matriculation for that semester.

The College reserves the right to adjust charges to current costs.

FINANCIAL AID FOR GRADUATE STUDY

RESEARCH AND TEACHING ASSISTANTSHIPS are available to outstanding graduate students. Teaching assistantships are normally awarded for the academic year while research assistantships may be granted for periods of twelve months. Both are renewable. Stipends range from $1,200 to $2,400 and tuition is waived. Application forms for assistantships are obtainable from the Dean of the Graduate School or from department heads. Recipients of assistantships are selected by the respective academic departments.
GRADUATE FELLOWSHIPS and GRANTS-IN-AID are also available. Among them are the following:

**The Alexander P. and Lydia Anderson Fellowship** in biological science, including Bacteriology and Entomology.

**Celanese Fellowship.** A $1,500 award plus tuition, fees and research materials, to a student in Textile Chemistry.

**Dow Corning Fellowship.** A $1,500 award plus tuition, fees and research supplies, to a student in Textile Chemistry.

**Edward Orton, Jr., Fellowship.** A $1,350 award plus supplies, to a student in Ceramic Engineering.

**Foundation for Cotton Research and Education.** A limited number of $2,500 awards, made to students in Agricultural Engineering, with concentration in Ginning Engineering. The recipients are selected by the Foundation (Box 9905, Memphis 12, Tenn.) with approval of the College.

**Godfrey L. Cabot Fellowship.** A $1,500 award ($2,400 if married), to a student in Ceramic Engineering.

**Lead Industries Association Fellowship.** A $2,400 award to a student in Ceramic Engineering.

**National Science Foundation Fellowships.** The Graduate School is participating in the National Science Foundation Cooperative fellowship program and also in the Foundation’s Summer fellowship program for graduate teaching assistants. Inquiry about these fellowships should be made early in the academic year and should be directed to the Dean of the Graduate School.

**Scientific Soil Products Fellowships.** Awards ranging from $200 to $1,200 are available to students in Agronomy.

**Wade Stackhouse Loan Fund.** Income from a fund donated by Dr. Wade Stackhouse in memory of his father is used to assist graduate students in the Biological Sciences.

**Warwick Chemical Foundation Fellowships.** Income from a fund, donated in memory of Manfred Caranci, available annually for awards to students in Chemistry.

**Zonolite Fellowship.** A $1,500 award to a student in Ceramic Engineering.
GRANTS-IN-AID to graduate students are sponsored by the Mead Corporation, the Poinsett Lumber and Manufacturing Company, and the Laurence S. Barringer Foundation.

All fellowship awards are made by the heads of departments concerned. Information about grants-in-aid is obtainable from the Dean of the Graduate School.

EDUCATIONAL BENEFITS FOR VETERANS

Eligible veterans of the armed services may qualify for financial aid in graduate study. Forms for filing applications for assistance are provided by the Veteran's Administration.

LIBRARY

The Library Building houses the main Library, the Agricultural Reference Department and the Browsing Room. In addition, several departments of the College maintain departmental libraries in their own buildings.

The main Library collection consists of some 173,308 bound volumes of books, periodicals and government publications. Added to these are thousands of unbound federal and state documents, agricultural and engineering experiment station and extension publications, and more than 12,000 pamphlets and clippings relating to Clemson College and South Carolina.

The Library is essentially a consolidation of special libraries: agriculture and the biological sciences, science and technology, and carefully selected smaller collections in the social sciences and humanities. The Library currently receives 1,938 periodical titles and more than 353 other continuations. Of these, about 314 are foreign publications. The Library receives forty newspapers.

LIVING CONDITIONS

Dormitories. Residence hall accommodations are rented on a semester basis and rent on all dormitories is $86 per semester. Before assignment to a room can be made, an advance payment of $43 for one-half of a semester's rent must be made.
Students who have made an advance payment and later decide not to enroll or to live in the dormitory may obtain a refund of the advance payment provided notification of intent and request for refund is received in the dormitory office prior to September 1 for the fall semester and prior to February 1 for the spring semester. When such notification and request is not received, no refund of the advance payment will be made. When an enrolled student is assigned and occupies a room at the beginning of a semester, he is obligated for the half-semester's rent and no refund will be made.

If a student's arrival on the campus is to be delayed, he should notify the dormitory manager in order that his room assignment will not be cancelled. Failure to file such notice within the first five days of the semester shall give the College the right to cancel the room assignment.

Each student room is equipped with single-width beds, built-in clothes lockers, study table and two chairs. Bed linen, bed cover, pillows, towels and laundry bags must be furnished by the students. Students are responsible for the cleanliness of their rooms.

There are six men's dormitories, one housing approximately 2,000 students and the others 100 each. The room fees are the same for all dormitories. Students are housed two per room with dormitory and room assignment made insofar as possible in accordance with each student's preference.

Radios and record players may be played so long as they do not disturb other dormitory residents. They must be played softly and may not be placed in or near a window or door while in operation.

No student shall have nor operate a television set in a dormitory room.

The College will not be liable for articles lost or stolen in the dormitories.

At the present time dormitory facilities are not available for women students, and they must find housing facilities in the town of Clemson and surrounding areas.

**Dining Hall.** Cost per semester $180.

The new modern equipped and spacious Dining Hall will serve
approximately 3,500 students per meal. The rate includes three meals per day served family style. The Dining Hall is under the direct supervision of a manager, who has as assistants a dietitian and other staff members.

Students who live outside the dormitories may take all meals in the Dining Hall if they pay for such meals on the semester basis.

Commuting students may eat the mid-day meal in the Dining Hall on a five-day week plan (Monday through Friday) by paying for the meal on the semester basis. The cost is $55 per semester.

Dining Hall services will not be provided during the Christmas Holidays.

Refund of paid unused services is made on a pro rata basis, holidays excepted, provided the unused portion during the period (one-half semester) is more than two weeks.

**Laundry.** Cost per semester $24.60.

The new laundry building is equipped with the latest machinery to accommodate the students and departments of the College.

Students paying laundry fees are permitted one bundle of laundry per week, with the number of articles allowed per bundle limited to the usual requirement of the majority of students. The laundry fee amounts to approximately $1.36 per week.

The College will not be liable for lost or damaged laundry unless reported within two days after the date upon which the laundry was due to be delivered, and then not more than the actual depreciated value of such articles as have been lost or damaged.

Laundry services will not be provided during the Christmas Holidays.

Refund of paid unused services is made on a pro rata basis, holidays excepted, provided the unused portion during the period (one-half semester) is more than two weeks.

**Married Student Housing.** Rentals: $24, $31, $34 and $42 per month.

There are three housing projects operated by the College for married students.
The East Campus Apartments consist of 100 two-bedroom apartments located in 50 buildings constructed of brick veneer on concrete block. These apartments are equipped with electric stove, refrigerator, gas fired circulating heater and hot water heater. The rental is $42 per month.

The Littlejohn Apartments consist of 50 two-bedroom units contained in 11 brick veneer on concrete block buildings. The monthly rental is $31 for an interior unit and $34 per month for an end apartment. Oil burning circulating and hot water heaters are installed in these apartments. The rental includes cold water.

The Prefabs consist of 247 two-bedroom houses and are equipped with oil burning circulating and hot water heaters. The monthly rental rate is $24 and includes cold water. Students assigned these units should be prepared to repaint the interior at their expense.

Applications for married student housing should be made to the College Housing Office which maintains waiting lists and assigns units on the basis of date of application.

**STUDENT HEALTH SERVICE**

The Director of Student Health is in charge of the student health services at Clemson College. The medical fee paid by students is intended to cover all ordinary cases of sickness and their treatment. It is not intended to cover fees of doctors or specialists called into consultation, or the costs of operations, special nurses, ambulance service, and medical or surgical attentions performed away from the College. The right of the Director of Student Health Service, with the approval of the President of the College, to incur any of these extra services in behalf of any student under his care is hereby expressly reserved. Clemson College does not assume any responsibility for accidents that happen away from the College.

**PLACEMENT SERVICE**

An office of student placement is maintained in the Student Center. This office endeavors to assist all qualified students and former students in selecting suitable vocations, in arranging part-time work, and in obtaining career employment.
Every graduate student and every prospective graduate student is expected to make himself thoroughly familiar with the regulations of the Graduate School and the requirements for degrees. Failure to follow the regulations and requirements almost inevitably results in complications for which the Graduate School cannot assume responsibility.

In addition to the general regulations of the Graduate School, the candidate for an advanced degree will comply with the specific requirements of the department in which he is pursuing his advanced studies.

A student who wishes to deviate from the normal graduate school regulations and procedures may present his problem in a letter addressed to the Graduate Council signed by himself and his departmental adviser. The Graduate Council will consider the petition at the first meeting following its receipt in proper form. Action taken on a petition will not be considered a precedent for any future action.

The College and its various schools and departments reserve the right to change the rules regulating the admission to, instruction in and graduation from the College or its various schools, and any other regulations affecting the student body. Such regulations become effective whenever the proper authorities may determine and apply not only to prospective students but also to those who may at such time be matriculated in the College. The College also reserves the right to withdraw courses, to change instructors or to change fees at any time.

GRADUATE DEGREES AND CURRICULUMS

Courses and Degrees. Courses are offered leading to the degree of Master of Science in the following fields: Agricultural Economics, Agricultural Education, Agricultural Engineering, Agronomy, Animal Husbandry, Bacteriology, Ceramic Engineering, Chemistry, Civil Engineering, Dairy, Electrical Engineering, Engi-
neering Mechanics, Entomology, Horticulture, Industrial Educa-
tion, Mathematics, Mechanical Engineering, Nuclear Science, Phy-
sics, Plant Pathology, Textile Chemistry, and Zoology.

The degree of Master of Agricultural Education is offered by the Department of Agricultural Education. The degree of Master of Education is offered in the areas of science teaching, English and History.

The degree of Master of Architecture is offered by the School of Architecture.

The degree of Doctor of Philosophy is offered in Agricultural Economics, Chemistry, Plant Pathology, and Entomology.

A list of courses which may be acceptable for graduate credit is found elsewhere in this Bulletin.

**Multiplication of Higher Degrees.** The duplication of higher degrees is discouraged on the same basis as the duplication of the Bachelor's degree. Thus a student holding a Master's degree may not as a rule become a candidate for another Master's degree of the same designation, regardless of the field of study; nor may the holder of an M.A. degree in a given field, received at another institution, become a candidate for the M.S. degree in the same field at Clemson.

**Graduate Degrees and Teachers' Certificates.** Prospective students should understand that the material in this Bulletin applies only to requirements for graduate degrees and has no direct relation to certificates for public school teachers. The Graduate School gives no assurance that a program for a graduate degree and a program for a certificate will coincide. Students interested in certificates should confer with the Director of Teacher Certification at the outset of their work.

**ADMISSION**

Before admission to the Graduate School a degree-seeking student must have the Bachelor's degree from an institution with a scholastic rating satisfactory to the College, must have made a sat-
isfactory score on the Graduate Record Aptitude Tests,* and must have the approval of the Head of the Department in which he plans to do his major work. Students not seeking advanced degrees may take the College Entrance Examination in place of the Graduate Record Aptitude Test.

Admission is restricted to include only those students whose academic records clearly indicate that they are prepared to profit from graduate study. In general, an applicant should have an average undergraduate grade of B or better in his major field and C or better in his remaining course work. A satisfactory grade on the admissions test does not mean automatic admission. Graduate students are admitted as follows: (a) the Registrar recommends admission on the basis of test scores; (b) the department head recommends admission on the basis of a general review of the student's record; (c) the recommendations receive final action in the Graduate School Office.

Applicants accepted for graduate study may be admitted as graduate students in full standing or as provisional graduate students. Only graduate students in full standing may become candidates for advanced degrees.

Students classified as provisional are those who do not plan to obtain a graduate degree from Clemson College; or who have either general or specific deficiencies which require remedial work prior to admission to a degree program.

A provisionally admitted student may apply at any time to the Dean of the Graduate School for reclassification to full standing. An application for such reclassification should indicate that the student has successfully completed any required prerequisites, has maintained at least a "B" average for all courses taken as a graduate student, and desires a graduate degree from Clemson.

Appropriate graduate courses completed by a provisional student may be counted toward a degree program when the student has been reclassified.

*No entrance examination will be required of Clemson honor graduates (G.P.R. of 3.0 or better).
Students desiring to enroll in the Graduate School must make application on Graduate School Form 1. This form may be obtained from the Dean of the Graduate School. The application, accompanied by transcripts of previous college work and by such written recommendations as are necessary in support of the application, is returned to the Graduate School Office. The Registrar will not permit enrollment in courses of the 500 series until the student has been officially admitted to the Graduate School.*

Credentials submitted for admission become the property of the College and are not returned.

An applicant for admission to the Graduate School must register for courses within twelve months after his application has been accepted; otherwise the application will be considered invalid.

**Graduate Record Examinations.** As indicated under "Admission to the Graduate School," applicants for admission to a degree program are required to submit their scores on the Aptitude Test of the Graduate Record Examinations.

This test is prepared and scored by the Educational Testing Service, 20 Nassau Street, Princeton, New Jersey. The Graduate Record Examinations are administered at many centers throughout the United States and several foreign countries four times each year, usually in January, April, July, and November. The test is given at Clemson on November 21, 1959, January 16, 1960, and April 23, 1960.

Students desiring to take the test should request of the Educational Testing Service a booklet of information concerning the Aptitude Test of the Graduate Record Examinations and an application blank. The completed application form, together with the

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*Seniors who are within one semester of graduation and who have grade-point ratios of 3.0 or above may be permitted to register for courses of the 500 series provided their total load is not more than 15 hours, and provided such 500 courses are in addition to the requirements for the undergraduate degree. These courses will not be recorded as graduate credit, but if these students are subsequently admitted to the Graduate School at this institution they may request that these courses be included as a part of their graduate program.
examination fee, should reach the Educational Testing Service a month in advance of the actual test date.

On his application for the Aptitude Test, the prospective student should indicate that his test scores are to be sent to the Dean of the Graduate School, Clemson College, Clemson, South Carolina.

The Aptitude Test of the Graduate Record Examinations is an objective-type examination involving vocabulary, reading comprehension, and logical and mathematical reasoning. It yields two scores: Verbal Factor and Quantitative Factor. No special preparation in advance is necessary for it.

**Academic Standards.** Graduate students are graded on the same A-B-C-D-F scale as undergraduates. Nonetheless a graduate student is expected to do superior work.

Courses primarily for graduate credit are those of the 500 series. Graduate credit may be received for a grade of C on 500 series courses; however, the grade on a credit hour basis for all 500 series courses must average B or better before the student can become eligible for an advanced degree. To receive graduate credit for a course in the 300 or 400 series, a student must attain a grade of B or better. No student shall receive both graduate and undergraduate credit for the same course.

A grade lower than the specified minimum can be raised to count toward an advanced degree only by repetition of the course.

A graduate student must understand that he can be dropped from the Graduate School roll at any time for failure to maintain an adequate academic status.

**Eligibility of College Employees to Pursue Graduate Study.** With the approval of his Dean or Director, a qualified employee of Clemson College may pursue graduate work for credit. However, no member of the faculty or staff who has a rank higher than Instructor or its equivalent may be considered as a candidate for an advanced degree at this institution.

**Maximum Credit Load.** The maximum load for students who are devoting all of their time to graduate work is fifteen credit hours
per semester, or one credit hour per week during the Summer School. Persons who are employed by the College on a full-time basis may not carry more than six semester credits per semester. The maximum graduate load for students devoting part-time to staff duties or research work will be determined by their total work load. The work load is the number of credit hours taken or taught multiplied by three plus the actual number of hours per week spent in performing other staff duties or research work. For students devoting part-time to graduate study, the total work load per week for the first semester of graduate enrollment must not exceed 48 hours. After the first semester, a part-time student whose work is superior may, with the approval of the head of his major department and the Dean of the Graduate School, schedule a work load in excess of 48 hours but not in excess of 60 hours.

In the event of scheduling difficulties, a part-time student may, with the approval of the persons named above, exceed the limits specified by not more than three work load hours for any one semester, provided the average work load for the academic year does not exceed these limits.

**Auditing by Graduate Students.** A graduate student regularly enrolled for a minimum of six semester hours may audit without charge (special course fees excepted) one additional course, provided approval is obtained from the professor offering the course and the head of the department and dean of the school in which the course is offered. Forms for requesting such approval are available at the Registrar's Office.

Audited courses do not carry credit and the fact that a course has been audited is not noted on the graduate student's official record. Audited courses do not count against allowable credit-hour loads.

Graduate auditors are not required to stand tests or examinations. However, the professor, at his own discretion, may demand or deny the auditor's participation in class to whatever extent he deems desirable.

A graduate student may not by audit satisfy a stated prerequisite for a graduate course unless such is agreed to by the head of the department requiring the prerequisite. Additionally, a graduate
student may not establish credit through examination in any course for which he was previously registered as an auditor.

Acceptance of Transfer Credit. The credit requirements for advanced degrees must be satisfied through registrations at Clemson College, except that on the recommendation of the student’s major adviser and the approval of the Dean of the Graduate School, a student may earn in some accredited institution other than Clemson 6 credits in campus courses toward one of the Masters’ degrees and as many as 48 credits toward a Doctors’ degree.

No credit will be granted toward either the Masters’ or Doctors’ degrees for work completed in extension courses or in the off-campus center of another institution. Transfer credit will not be accepted for courses in which a grade lower than B, or its equivalent, has been received.

Transcripts certifying to graduate courses completed at another institution must be received in the Graduate School Office prior to the date of filing application for the degree. The degree will not be conferred at the close of the term during which the student has been registered elsewhere.

Filing of Preliminary Study Plan. Graduate students, within one month after registering for graduate credit, should file with the Dean of the Graduate School a preliminary study plan. The form for this plan (G. S. Form 2) may be obtained from the student’s department head or from the Graduate School Office. Changes in the student’s preliminary plan of study may be requested at any time. Proposals for change should originate in consultation between the student and his major adviser, be approved in writing by the heads of the student’s major and minor departments, and forwarded in quadruplicate to the Dean of the Graduate School.

Admission to Candidacy for a Graduate Degree. Admission to the Graduate School does not qualify a student as a candidate for an advanced degree. Such candidacy depends on the acceptance by the Dean of the Graduate School of a written request for admission to candidacy. This request (G.S. Form 4) should be filed by the student once he has completed at least one-half his prescribed gradu-
ate residence and course work, (research courses excepted), and has successfully undertaken whatever preliminary or qualifying examinations are required. This request for admission to candidacy must list each of the major and minor subjects to be offered for the degree and must contain the title of the proposed thesis or research report. The request should bear the signed approval of the heads of the major and minor departments concerned. A student must be admitted to candidacy for a Master's degree at least one semester, and for a Doctor of Philosophy degree at least two semesters, before the date on which the degree is expected.

The Thesis and Thesis Abstract. Each candidate for an advanced degree (except those of Master of Agricultural Education, Master of Science in Mathematics, and Master of Education) is required to prepare a thesis under the direction of a major adviser. Six hours of credit are allowed for the research leading to the required Master of Science thesis. Nine hours of credit are allowed for the Master of Architecture thesis.

Three typewritten copies of the thesis (the original copy and the first and second carbons) must be presented to the chairman of the student's advisory committee in sufficient time for the chairman to arrange for a final examination to be held at least two weeks prior to the date on which the degree is expected. A doctoral thesis must be completed and accepted by the student's advisory committee at least two weeks prior to the final examination. The three copies of the thesis must be submitted to the Dean of the Graduate School at least one week prior to the date on which the degree is conferred. A binding fee of $9.00 must be paid to the Bursar and the Bursar's receipt submitted to the Graduate School Office at the time the thesis is submitted. If the student desires, he may have an additional copy of his thesis bound for himself at a cost of $3.00. The responsibility for placing the thesis in proper final form rests with the student and the chairman of his advisory committee. A statement of special procedures for writing a thesis at Clemson College may be obtained from the Graduate School Office.

The student will prepare an abstract of his thesis which must be submitted in triplicate with the thesis to the Dean of the Graduate School. Ordinarily this abstract should not exceed five hundred
words in length. It should be written and edited in such a way that it will be suitable for publication.

Restriction on Use of Theses and Dissertations. Unpublished theses and dissertations submitted to the Graduate School in partial fulfillment of the requirements for graduate degrees and deposited in the College Library are, as a rule, open to the public for reference purposes. However, extended quotations or summaries may be published only with the permission of the author and the Dean of the Graduate School.

Language Examinations. Certain advanced degrees require that the student demonstrate a reading knowledge of one or more foreign languages. Language examinations are given by the Language Department each semester at a stated time as announced by the Dean of the Graduate School.

The language examinations are taken from sources supplied to the Language Department by the student's major department. Examinations are confined to reading knowledge with dictionary and normally are "time limit" in character.

Application for a Diploma. A formal application for a diploma must be placed by the student with the Registrar within 4 weeks following the opening of the final semester or Summer Session prior to the date on which the degree is to be conferred. At this time the diploma fee of $3.00 (or $6.50 if a diploma case is desired) must be paid. Arrangements should be made at this time for cap and gown rental. The student, unless specifically excused by the College President, must attend commencement exercises in order to obtain his degree.

ADDITIONAL REQUIREMENTS FOR MASTER OF SCIENCE DEGREE

To receive the Master of Science degree a student must spend the equivalent of at least one academic year in graduate residence at the College.* No graduate credit will be allowed for any course

*An academic year in graduate residence is defined as a minimum of two regular semesters (or summer equivalent) of enrollment, and the successful completion of a minimum of eighteen hours of course work, exclusive of research.
completed in less than six weeks. Normally no credit toward a graduate degree may be obtained by correspondence or extension study. All course work which is to be credited toward a Master of Science degree must have been completed not more than six calendar years prior to the date on which the degree is to be awarded; except that when approved by the student's department head and the Dean of the Graduate School, as many as six semester hours of course work completed outside the six-year limit of time may be validated by written re-examination. Such examination will be under the direction of the department regularly offering the course or courses for which the student seeks validation. Course work completed outside the six-year limit of time at an institution other than Clemson College may not be transferred to Clemson for graduate credit.

The Student's Advisory Committee. As soon as the student's preliminary plan of study is filed and his objectives crystallized he will, with the approval of the head of his major department, select a major adviser. The major adviser in consultation with the student will recommend to the Dean of the Graduate School for approval and formal appointment at least two associate advisers, one of whom shall represent the student's minor field of study. These associate advisers, with the major adviser as chairman, will constitute the student's advisory committee which will supervise his graduate program, administer his final comprehensive examination, and initiate the recommendation for the awarding of his degree.

Course Work Required. In addition to such supplementary or supporting courses as may be required, the work will consist of a minimum of thirty semester hours, including six semester hours of research which will provide the basis for the required thesis. Of the remaining twenty-four semester hours, at least twelve hours must come from courses numbered 500 or above. A minimum of twelve hours must be in the student's major field and a minimum of six hours in one minor.

Final Examination. Each candidate for a Master's degree, after the completion of the required thesis and at least two weeks before the degree is to be awarded must pass such examination as may be
required by the student's advisory committee. The examination, which may be oral or written, will ascertain the general knowledge of the candidate with particular reference to the major and minor subjects and the thesis or research report. Included with those members of the faculty and staff invited to attend the examination will be the Dean of the Graduate School and members of the Graduate Council. Immediately after the examination the examining committee will notify the Dean of the Graduate School of its findings. This notification will be made on Graduate School Form 7.

ADDITIONAL REQUIREMENTS FOR MASTER OF SCIENCE DEGREE IN NUCLEAR SCIENCE

To receive the Master of Science degree in Nuclear Science the student must complete on campus at least twenty-four semester hours of acceptable course work (exclusive of thesis courses) in Chemistry, Mathematics, and Physics. At least twelve of the twenty-four hours shall be in courses of the 500 series. Eighteen of the required hours will be the following:

Chemistry 491 Introduction to Radiochemistry .......... 3 cr.
Chemistry 542 Radiochemistry --------------------- 3 cr.
Mathematics 453 and 454 Advanced Calculus -------------- 6 cr.
Physics 452 Atomic and Nuclear Physics ----------- 3 cr.
Physics 543 Reactor Theory I --------------------- 3 cr.

If any of the above courses have already been satisfactorily completed by the student as an undergraduate, other courses in the same field of study shall be substituted as approved by the student's advisory committee.

Thesis research for the degree may be carried out on-campus or at a specified off-campus Atomic Energy Commission installation.

Prior to admission to candidacy for the degree, the student must pass a reading knowledge test in the German language.
ADDITIONAL REQUIREMENTS FOR THE MASTER OF AGRICULTURAL EDUCATION DEGREE

Course Work Required. In addition to such supplementary or supporting courses as may be required, the work for the Master of Agricultural Education degree will consist of a minimum of thirty-three semester hours, at least eighteen of which will be earned in courses numbered above 500. The course requirements will be distributed as follows:

1. Twelve hours in Education, as a major
2. Twelve hours in technical agriculture. Six of these hours must be in the same field and will be considered as a minor.
3. Three hours in a discipline outside the field of the major.
4. Three hours in agricultural research techniques and three in experimental statistics.

With the exception of the thesis and foreign language proficiency, all other regular requirements of the Graduate School for the Master of Science degree will be met.

ADDITIONAL REQUIREMENTS FOR MASTER OF EDUCATION DEGREE

The Master of Education degree is offered only to experienced high school or junior college teachers in the subject areas of English, History and Government, and the natural sciences. Thesis and foreign language requirements are waived.

Course Work Required. In addition to such supplementary or supporting courses as may be required, course work for the Master of Education degree will consist of a minimum of thirty semester hours, distributed as follows:

1. A maximum of twelve hours in Education, as a major.
2. A minimum of eighteen hours in English, History and Government, or the "T" series science courses, depending on the subject area selected.

All other regular requirements of the Graduate School for the Master of Science will be met. As a rule, the candidate’s final examination will be written.
ADDITIONAL REQUIREMENTS FOR DOCTOR OF PHILOSOPHY DEGREE

Work leading to the Doctor of Philosophy degree is planned in such a way as to give the student a comprehensive knowledge of his fields of specialization and a mastery of the methods of research. The degree is not awarded solely on the basis of course work completed, residence or other routine requirements. The final basis for granting the degree will be the student's grasp of the subject matter of a broad field of study, his competency to plan and conduct research, and his ability to express himself adequately and professionally in oral and written language.

Advisory Committee. Not later than the time of his initial registration in a doctoral program the student shall designate in writing to the Dean of the Graduate School his selection of a major field and two minor fields of study. The student and the heads of these departments in consultation will recommend to the Graduate Dean for approval and formal appointment an advisory committee composed of at least five professors. One member of the committee will be designated as chairman and will direct the student's dissertation. The advisory committee will aid the student in planning his course work; arrange for his preliminary and final comprehensive examinations; and initiate the recommendation for the awarding of his degree.

Residence Requirements. To receive the Doctor of Philosophy degree the student must spend the equivalent of at least three academic years in full residence as a graduate student. At least one academic year (ordinarily the second) must be in continuous resident study at this institution. The definition of an academic year in residence is found elsewhere in this Bulletin.

Time Limit. All work for a Doctor of Philosophy degree must be completed within a period of seven years. If the student begins his doctoral program after receiving the Master's degree, all work above the Master's level must be completed within a six-year period.

Language Requirement. A reading knowledge of both French and German is required of all candidates for the doctorate; except
that other languages may be substituted in cases where it is demonstrated that they will be of more value in the particular specialty of the student. Such substitutions must be approved by the student's department head and by the Dean of the Graduate School. All language requirements must have been satisfied prior to the student's preliminary or qualifying examination and prior to his admission to candidacy for the degree.

**Qualifying Examinations Before Admission to Candidacy.** The student must undertake such preliminary or qualifying examinations as may be prescribed before he applies for admission to candidacy for his degree. These examinations may be written, oral, or a combination of both. The function of the examinations is to obtain objective evidence of an adequate intellectual mastery of the student's areas of major and minor specialization.

The student's performance on these examinations will determine whether the heads of his major and minor departments shall recommend acceptance of his application for admission to candidacy. Immediately after the examination the examining committee will notify the Dean of the Graduate School of its findings.

Should the student fail to pass his preliminary examinations he may be given the opportunity to undergo the examinations a second time. A second failure shall result in the student's being declared ineligible for the Doctor of Philosophy degree at Clemson College.

**Final Doctoral Oral Examination.** The candidate for the Doctor of Philosophy degree must pass a final oral examination at least two weeks prior to the time of the convocation at which he plans to obtain the degree. The examination will be conducted by the student's advisory committee, and all faculty members will be invited to participate. The Graduate School Office will be notified of the time and place of the examination at least ten days prior to the time scheduled.

This final examination demands a broad and penetrating interpretation by the student of his research project and conclusions. It may include examination of the student in his major and minor fields of specialization.
The courses listed below will carry graduate credit when properly approved by graduate advisers. Courses of the 500 series are specially designed for graduate student enrollment. Courses of the 300 and 400 series will enroll undergraduate and graduate students; however, the graduate students will normally be expected to complete such additional assignments as instructors may require.

Enrollment in any course must be approved by the department offering it.

Complete descriptions of the 300 and 400 series courses listed in this Bulletin may be found in the general College catalog, obtainable from the Registrar.

AGRICULTURAL ECONOMICS
G. H. Aull, Chairman

Courses are offered leading to the degrees of Master of Science and Doctor of Philosophy.

Ag Ec 352—PUBLIC FINANCE—3 cr. (3 and 0)
Ag Ec 357—CONSERVATION OF NATURAL RESOURCES—3 cr. (3 and 0)
Ag Ec 401—STATISTICS—3 cr. (2 and 3)
Ag Ec 451—AGRICULTURAL COOPERATION—2 cr. (2 and 0)
Ag Ec 452—AGRICULTURAL POLICY—3 cr. (3 and 0)
Ag Ec 456—PRICES—3 cr. (3 and 0)
Ag Ec 460—AGRICULTURAL FINANCE—2 cr. (2 and 0)
Ag Ec 462—APPLIED STATISTICS—3 cr. (2 and 3)
Ag Ec 501—ADVANCED FARM MANAGEMENT—3 cr. (2 and 3)
  Study and appraisal of methods of assembling and analyzing information concerning the business of farming. Prerequisites: Ag Ec 302 and Ag Ec 401.
Ag Ec 503—LAND ECONOMICS—3 cr. (3 and 0)
  A study of the characteristics of land and its utilization in relation to population and public policies.
Ag Ec 505—ECONOMIC THEORY—3 cr. (3 and 0)
A study of the use of theory in the analysis of economic problems and an appraisal of recent developments in capitalistic economic theory.

Ag Ec 506—ECONOMIC DEVELOPMENT IN AGRICULTURAL AREAS—3 cr. (3 and 0)
A critical examination of the theory of economic growth and development with emphasis on both its macro- and its microeconomic aspects.

Ag Ec 507—AGRICULTURAL MARKETING PROBLEMS—3 cr. (3 and 0)
A study of special problems involved in research and marketing Southern fruits, vegetables, livestock and livestock products. Students will undertake individual assignments in the field of their interest. Prerequisite: Ag Ec 309 or permission of instructor.

Ag Ec 510—RESEARCH PROBLEMS IN FARM MANAGEMENT—3 cr. (3 and 0)
Review of economic problems in operating and managing a farm; examination of related published materials and critical evaluation of methodology used; selection of specific management problems and preparation of outlines of applicable research procedures for their solution. (Open to Ph.D. candidates only).

Ag Ec 511—RESEARCH PROBLEMS IN FARM MANAGEMENT—3 cr. (3 and 0)
(Continuation and extension of Ag Ec 510).

Ag Ec 512—EXPERIMENTAL DESIGNS—3 cr. (3 and 0)
An examination of the ways to plan and conduct comparative experiments so they will provide, efficiently, specific answers to scientific questions under investigation. Prerequisite: Ag Ec 401 or permission of instructor.

Ag Ec 514—CONTEMPORARY ECONOMIC PROBLEMS—3 cr. (3 and 0)
A critical review of the nature of contemporary economic problems, the background out of which they developed, the remedies which have been applied, and possible alternatives. (Special emphasis will be given to problems relating to agriculture and rural life.)

Ag Ec 516—RESEARCH PROBLEMS IN MARKETING—3 cr. (3 and 0)
Review of literature in field of marketing; critical examination of methodology and findings; and preparation of outlines, plan of work and procedures for specific marketing studies. (Open only to Ph.D. candidates).

Ag Ec 517—RESEARCH PROBLEMS IN MARKETING—3 cr. (3 and 0)
(Continuation and extension of Ag Ec 516)

Ag Ec 591—THESIS RESEARCH—3 cr.
Ag Ec 592—THESIS RESEARCH—3 cr.
AGRICULTURAL EDUCATION
L. H. Davis, Chairman

Courses are offered leading to the degrees of Master of Science and Master of Agricultural Education.

A student desiring to pursue graduate work with a major in the field of Agricultural Education is expected to have as prerequisite sufficient work in this field to qualify him for a Class III teacher's certificate under the rules of the State Board of Education.

Ag Ed 401—METHODS IN AGRICULTURAL EDUCATION—3 cr. (2 and 3)
Ag Ed 463—ADVANCED CONSERVATION EDUCATION—3 cr. (3 and 0)
Ag Ed 501—RECENT DEVELOPMENTS IN THE TECHNOLOGY OF AGRICULTURE—3 cr. (2 and 3)
   A thorough analysis and appraisal of the experimental findings and successful farming practices developed during World War II and in the post-war period in the various fields of agriculture. Emphasis will be on crops and mechanization.
Ag Ed 502—RECENT DEVELOPMENTS IN THE TECHNOLOGY OF AGRICULTURE—3 cr. (2 and 3)
   A continuation of Ag Ed 501 with emphasis on developments in animal sciences and agricultural economics.
Ag Ed 504—SPECIAL PROBLEMS IN TEACHING VOCATIONAL AGRICULTURE—3 cr. (2 and 3)
   A course devoted to the analysis, exploration and development of plans for the solution of some of the current problems encountered by teachers of Vocational Agriculture.
Ag Ed 515—ADVANCED METHODS OF TEACHING FARM MECHANICS—3 cr. (2 and 3)
   Organization of teaching units, methods of determining the content of the course, securing and equipping the shop, teaching farm mechanics and other shop problems involved in teaching farm people are considered in this course.
Ag Ed 520—TEACHING YOUNG FARMERS—3 cr. (3 and 0)
   The purpose of this course is to provide training for young farmers establishing themselves in the business of farming. Emphasis will be placed upon organization, cooperation and private enterprise. Buying and selling of various types of markets will be covered. The uses of governmental facilities for handling goods, credit, communications, and power will be studied. Conservation as a community and individual enterprise will be discussed.
Ag Ed 525—SUPERVISION OF STUDENT TEACHING—3 cr. (3 and 0)

Major emphasis is placed upon the following: (1) developing a point of view or philosophy of teacher education; (2) analyzing the present teacher training program in South Carolina, to discover problem situations that may be used as a basis for teacher education programs; (3) determining the relative emphasis for each teacher to place upon the solution of the problems in the teacher-education program; (4) projecting plans for an apprentice training program; and (5) supervising apprentice training in the state.

Ag Ed 591—INTRODUCTION TO RESEARCH IN EDUCATION—3 cr.
Ag Ed 592—RESEARCH IN AGRICULTURAL EDUCATION—3 cr.

AGRICULTURAL ENGINEERING

A. W. Snell, Chairman

Courses are offered leading to the Master of Science degree.

Ag En 352—FARM POWER—3 cr. (2 and 3)
Ag En 360—FARM AND HOME UTILITIES—3 cr. (2 and 3)
Ag En 401—SOIL AND WATER CONSERVATION ENGINEERING—3 cr. (2 and 3)
Ag En 402—DRAINAGE AND IRRIGATION—3 cr. (2 and 3)
Ag En 451—FARM STRUCTURES—3 cr. (2 and 3)
Ag En 452—ADVANCED FARM STRUCTURES—3 cr. (2 and 3)
Ag En 481—FUNDAMENTALS OF GINNING ENGINEERING—3 cr. (2 and 3)
Ag En 501—SPECIAL PROBLEMS IN AGRICULTURAL ENGINEERING—3 cr. (3 and 0)

Each student will select a subject pertaining to his particular interest or major field of study in Agricultural Engineering. Library and/or laboratory research will be conducted and a technical report will be written. The subject may be selected from one of the following: (a) Power and Machinery, (b) Soil and Water, (c) Farm Structures, or (d) Rural Electrification.

Ag En 504—ENGINEERING APPLICATIONS TO AGRICULTURAL PROCESSING—3 cr. (2 and 3)

A course dealing with the unit operation involved in the processing of agricultural products. The application of engineering principles and instrumentation to size reduction, cleaning and grading, mixing, materials handling, work simplifications, dehydrating and drying, refrigeration, storage, and related subjects.
Ag En 511—AGRICULTURAL POWER AND MACHINERY—3 cr. (3 and 0)
A critical analysis is made of present problems and trends in the design and application of machines and machine systems for agriculture. Advanced methods of analysis and design, research methods, techniques, and instrumentation are covered along with other topics of current importance. **Prerequisite:** Ag En 406 or equivalent.

Ag En 522—ADVANCED DRAINAGE & IRRIGATION ENGINEERING—3 cr. (3 and 0)
A study of theory and principles of drainage, irrigation and water storage. Principal topics include theory and application of flow of water through soil in unsaturated and saturated states, flow nets and seepage forces, and the fundamentals of engineering design with respect to ground water problems and soil moisture relationships. **Prerequisites:** Ag En 401, 402 or by special permission.

Ag En 582—ADVANCED GINNING ENGINEERING—3 cr. (3 and 0)
Design, development, analysis and synthesis of gin machinery to meet the functional requirements necessary for processing and handling cotton in modern gin establishments. Special emphasis is placed on the problems created by the introduction of mechanical harvesters. Special problems are assigned to give the student an opportunity for independent thinking. **Prerequisite:** Ag En 406 or equivalent.

Ag En 591—RESEARCH—3 cr.
Ag En 592—RESEARCH—3 cr.

AGRONOMY

G. H. Collings, Chairman

Courses are offered leading to the Master of Science degree.

Agron 301—FERTILIZERS AND MANURES—3 cr. (3 and 0)
Agron 302—GENETICS—3 cr. (2 and 3)
Agron 306—FORAGE AND PASTURE CROPS—3 cr. (3 and 0)
Agron 308—PHYSICAL AND CHEMICAL EDAPHOLOGY—3 cr. (3 and 0)
Agron 403—SOIL CLASSIFICATION—2 cr. (1 and 3)
Agron 405—PLANT BREEDING—3 cr. (2 and 3)
Agron 409—COTTON AND TOBACCO—3 cr. (3 and 0)
Agron 452—SOIL FERTILITY AND MANAGEMENT—2 cr. (2 and 0)
Agron 455—SEMINAR—1 cr. (1 and 0)
Agron 456—SEMINAR—1 cr. (1 and 0)
Agron 501—ADVANCED NUTRITION OF CROPS—3 cr. (3 and 0)
A course dealing with the relationship existing between the physical and chemical properties of the various nutrient elements and their absorption and utilization by plants.

Agron 502—ADVANCED PEDOLOGY AND SOIL CLASSIFICATION—3 cr. (3 and 0)
A course dealing largely with the factors of soil formation and soil classification. A study is made of such factors of soil formation as parent material, topography, climate, and organisms. Particular attention is given to the classification of Southeastern soils.

Agron 503—ADVANCED CROP PRODUCTION—3 cr. (3 and 0)
A course dealing with specific problems commonly encountered in the production of crops in the Southeast. Major attention is given to the production of cotton, bright tobacco, corn and oats.

Agron 504—ADVANCED PLANT BREEDING AND GENETICS—3 cr. (3 and 0)
A course designed to acquaint the student with the best methods now employed in the production and development of superior strains of plants. Visits will be made to neighboring plant breeding establishments and their methods will be observed.

Agron 505—ADVANCED SOIL FERTILITY—3 cr. (3 and 0)
A course dealing with soil conditions affecting plant growth, soil and plant relationships from the standpoint of normal growth under field conditions, and the essential principles in improving and maintaining soil fertility.

Agron 506—SPECIAL PROBLEMS—2 cr. (2 and 0)
Original investigation of special problems in Agronomy which are not related to a thesis but designed to provide experience and training in research.

Agron 507—SOIL PHYSICS—3 cr. (2 and 3)
A study of fundamental principles of soil physics, methods of physical analysis of soils, and applications of soil physics in Agriculture.

Agron 591—RESEARCH—3 cr.
Agron 592—RESEARCH—3 cr.

ANIMAL HUSBANDRY
R. F. Wheeler, Chairman

Courses are offered leading to the Master of Science degree.

AH 310—PORK PRODUCTION—3 cr. (3 and 0)
AH 314—PORK PRODUCTION LABORATORY—1 cr. (0 and 3)
AH 353—MEATS—1 cr. (1 and 0)
AH 355—MEATS LABORATORY—2 cr. (0 and 6)
AH 401—BEEF PRODUCTION—3 cr. (3 and 0)
AH 403—BEEF PRODUCTION LABORATORY—1 cr. (0 and 3)
AH 452—ANIMAL BREEDING—3 cr. (2 and 3)
AH 502—TOPICAL PROBLEMS—1-3 cr. (1-3 and 0)
A critical study of Animal Husbandry experiments and the interpretation of their results.
AH 503—MEAT TECHNOLOGY—3 cr. (3 and 0)
Biochemistry, histology and microbiology of fresh, frozen, cured, smoked and processed meats and by-products. Processing methods and techniques. Prerequisites: AH 353 and 355.
AH 504—METHODS IN ANIMAL BREEDING—3 cr. (3 and 0)
A study of factors governing gene and zygotic frequency; systems of mating; heritabilities; genetic consequences of selection; and criteria for evaluating improvement in beef cattle, swine, and sheep.
AH 505—NUTRITION OF MEAT ANIMALS—3 cr. (3 and 0)
A course dealing with the metabolism of carbohydrates, lipids, proteins, inorganic elements, and vitamins in the nutrition of beef cattle, swine, and sheep; the nutrient requirements of meat animals with special emphasis on the properties and functions of nutrients.
AH 591—RESEARCH—3 cr.
AH 592—RESEARCH—3 cr.

ARCHITECTURE
H. E. McClure, Chairman

Courses are offered leading to the Master of Architecture degree.

Arch 511—HISTORY SEMINAR I—3 cr.
Seminar discussion and creative writing concerning questions of function, structure and beauty in historic and contemporary architecture.

Arch 512—HISTORY SEMINAR II—3 cr.
Continuation of Arch 511, culminated in a terminal paper.

Arch 515—STRUCTURAL SEMINAR I—3 cr.
An advanced comparative analytical study of contemporary structural systems and the materials utilized therein. Discussion and laboratory work.
Arch 516—STRUCTURAL SEMINAR II—3 cr.
Continuation of Arch 515. A terminal report with adjunct studies will be required.

Arch 551—PLANNING & HOUSING SEMINAR I—3 cr.
Discussion of problems of urban design and housing. Special research topics will be assigned.

Arch 552—PLANNING & HOUSING SEMINAR II—3 cr.
Continuation of Arch 551, with the requirement of a final term paper or planning study.

Arch 561—GRADUATE ARCHITECTURAL DESIGN—9 cr.
Project work in advanced areas of architectural design arranged to develop the creative capacities of mature graduate students.

Arch 592—GRADUATE THESIS—9 cr.
A thesis of the student's own choosing provides the terminal vehicle for comprehensive research in architectural, structural or planning design. A complete oral, written and visual presentation of the solution is required.

BACTERIOLOGY
W. M. Epps, Chairman

Courses are offered leading to the Master of Science degree.

Bact 301—GENERAL BACTERIOLOGY—4 cr. (3 and 3)

Bact 310—ADVANCED BACTERIOLOGY—4 cr. (2 and 6)

Bact 402—DAIRY BACTERIOLOGY—3 cr. (2 and 3)

Bact 406—SANITARY BACTERIOLOGY—4 cr. (3 and 3)

Bact 410—SOIL MICROBIOLOGY—3 cr. (2 and 3)

Bact 501—BACTERIAL TAXONOMY—3 cr. (2 and 3)
This course covers the history of determinative bacteriology, and the basic morphological, cultural, and physiological differences used in distinguishing between the various taxonomic groups of bacteria. Opportunity will be given in the laboratory to isolate and identify bacteria from natural sources. Prerequisites: Bact 301, 310, and organic chemistry.

Bact 502—ADVANCED BACTERIOLOGICAL TECHNIC—4 cr. (2 and 6)
A course including methods of preparing special equipment for use in the bacteriological laboratory, sterilization by filtration, isolation of viruses, immunological procedures, and the experimental infaction of animals. This course is designed to give students interested in research in the field of bacteriological experience in more advanced methods of investigation. Prerequisites: Bact 301, 310, and organic chemistry.
Bact 503—SPECIAL PROBLEMS IN BACTERIOLOGY—2 cr.
Original research on special problems in bacteriology not related to the thesis.

Bact 505—PHYSIOLOGY OF BACTERIA—3 cr. (2 and 3)
A study of bacterial cytology, enzymes, growth curves, respiration, aerobiosis, anaerobiosis, nutrition of bacteria and degradation of proteins, carbohydrates, and fats. **Prerequisites:** Bact 301 and 310.

Bact 591—RESEARCH—3 cr.
Bact 592—RESEARCH—3 cr.

**BOTANY**

W. M. Epps, Chairman

The Master of Science degree is offered in Botany and Plant Pathology. The Doctor of Philosophy degree is offered in Plant Pathology.

Bot 351—PLANT MORPHOLOGY—4 cr. (2 and 6)
Bot 352—PLANT PHYSIOLOGY—4 cr. (3 and 3)
Bot 355—HISTOLOGY—2 cr. (0 and 6)
Bot 356—TAXONOMY—3 cr. (1 and 6)
Bot 401—PLANT PATHOLOGY—3 cr. (2 and 3)
Bot 451—MORPHOLOGY OF THE FUNGI—3 cr. (2 and 3)
Bot 501—ADVANCED PHYSIOLOGY—4 cr. (2 and 6)
A theoretical and practical study of methods used in investigation of physiological processes and the factors influencing those processes. Topics include sand and solution culture methods, measurement and control of soil water content, atmospheric humidity and radiant energy, and determinations of osmotic quantities, hydrogen ion concentration, and metabolic processes. **Prerequisites:** Bot 352; Chem 101, 102; Phys 201, 202, 203, 204.

Bot 502—ADVANCED MYCOLOGY—3 cr. (2 and 3)
A course designed chiefly for students majoring in plant pathology and closely allied fields. A detailed study is made of specific groups of fungi, especially those of economic importance of this region. Emphasis is placed on field collection identification, morphology, and cytology through lectures and student reports and laboratory work. **Prerequisites:** Bot 356, 451.

Bot 503—ADVANCED PLANT PATHOLOGY—4 cr. (3 and 3)
Essentially an introduction to research on plant diseases with review and recording of literature; preparation of media; isolation of single-cells of organisms in pure culture; a class study of infection and epidemiology of one fungus, one bacterial, and one virus disease; and an individual “prob-
lem' with preparation of a manuscript according to standards of a scientific journal. **Prerequisite:** Bot 401.

**Bot 504—PHYSIOLOGY OF PARASITISM IN PLANTS—3 cr. (3 and 0)**

This course is designed to acquaint the student with the interaction of host and parasite as affected by environmental conditions and nutrition of the host. Emphasis will be given to the factors that influence infection and the development of the parasite within the host. **Prerequisites:** Bot 351, 352, and 401.

**Bot 505—SPECIAL PROBLEM IN PLANT PATHOLOGY—*^**

Original investigation of special problems in plant pathology which are not related to a thesis but designed to provide experience and training in research. **Prerequisite:** Permission of instructor.

**Bot 506—CONTROL OF PLANT DISEASES—2 or 4 cr. (2 and 0 or 2 and 6)**

A theoretical and practical coverage of all aspects of plant disease control. Laboratory facilities are available for qualified students to conduct specialized investigations in plant disease control. **Prerequisites:** Bot 401, Organic Chemistry.

**Bot 591—RESEARCH—3 cr.**

**Bot 592—RESEARCH—3 cr.**

*^Hours of credit to be arranged with instructor. Credit will be given under Bot 505 for special problems performed in connection with other graduate courses.

**CERAMIC ENGINEERING**

**G. C. Robinson, Chairman**

**Courses are offered leading to the degree of Master of Science.**

**Cr Ar 301—POTTERY GLAZES—3 cr. (3 and 0)**

**Cr Ar 401—ADVANCED POTTERY—3 cr. (2 and 3)**

**Cr En 301—THE DRYING AND FIRING OF CERAMIC PRODUCTS—4 cr. (3 and 3)**

**Cr En 305—THERMO-CHEMICAL CER.—5 cr. (3 and 6)**

**Cr En 402—CERAMIC BODIES—3 cr. (3 and 0)**

**Cr En 403—GLASSES—3 cr. (3 and 0)**

**Cr En 404—ENAMELS—3 cr. (3 and 0)**

**Cr En 410—GLASS MANUFACTURE—3 cr. (3 and 0)**

**Cr En 412—RAW MATERIAL PREPARATION—3 cr. (3 and 0)**
Cr En 416—CEMENT, LIME AND PLASTER—3 cr. (3 and 0)
Cr En 418—PROCESS CONTROL—3 cr. (3 and 0)
Cr En 419—PHYSICAL CERAMICS—3 cr. (3 and 0)
Cr En 420—PHYSICAL CERAMICS—3 cr. (3 and 0)
Cr En 501—ADVANCED ANALYTICAL PROCEDURES AND EQUIPMENT—3 cr. (2 and 3)
  The use and application of the X-ray, spectograph, and electron microscope in ceramics.
Cr En 502—SILICATE CRYSTALLOGRAPHY—3 cr. (3 and 0)
  The basic laws of chemical crystallography and their application to the structure of silicate minerals.
Cr En 503—CERAMIC PRODUCTION CONTROL—3 cr. (3 and 0)
  The techniques and procedures for providing the required quantity and quality of materials at the required time and place in ceramic industries. Motion study, job analysis, job and wage evaluation in these industries.
Cr En 504—CERAMIC QUALITY CONTROL—3 cr. (3 and 0)
  Organization and procedure for quality control in ceramic industries. Practices and techniques used for systematic control of ceramic products and materials.
Cr En 505—ADVANCED DRYING—3 cr. (2 and 3)
  Drying fundamentals, drying problems, and dryer design.
Cr En 506—ADVANCED FIRING—3 cr. (2 and 3)
  Fuels, combustion, heat transfer, firing problems, and firing equipment.
Cr En 507—SPECIALIZED CERAMICS—3 cr. (3 and 0)
  An advanced study of one of the divisions of ceramics. The student may select either structural products, refractories, whitewares, abrasives, enamels, glass, elements, or raw materials processing.
Cr En 591—RESEARCH—3 cr.
Cr En 592—RESEARCH—3 cr.

CHEMICAL ENGINEERING

C. E. Littlejohn, Chairman

The department does not award advanced degrees. Courses are offered to provide a minor for students majoring in engineering or physical science fields.

ChE 301—PRINCIPLES OF CHEMICAL ENGINEERING—3 cr. (3 and 0)
ChE 302—PRINCIPLES OF CHEMICAL ENGINEERING—3 cr. (3 and 0)
CHEMISTRY

F. I. Brownley, Chairman

Courses are offered leading to the Master of Science and Doctor of Philosophy Degrees.

In addition to the general requirements of the Graduate School, students who register for graduate work in Chemistry must satisfy the following departmental requirements:

For the Master of Science Degree. Each entering graduate student will be given placement examinations in the four fields of chemistry—analytical, inorganic, organic and physical. These examinations are given during the week preceding the first semester of residence, and allow the department to arrange a program of study for the student so that any deficiency in undergraduate training may be rectified.

A reading knowledge of German is required. This requirement should be met as early in the student's program as is possible, and in no case later than the semester preceding the one in which the degree is to be awarded.

For the Doctor of Philosophy Degree. Placement examinations, as described above, are required.

The qualifying examinations for admission to candidacy shall consist of comprehensive written examinations in each of the four fields of chemistry.
*Chem 310—AGRICULTURAL BIOCHEMISTRY—4 cr. (3 and 3)

*Chem 323—ELEMENTARY ORGANIC CHEMISTRY—4 cr. (3 and 3)

*Chem 324—ELEMENTARY ORGANIC CHEMISTRY—4 cr. (3 and 3)

*Chem 331—PHYSICAL CHEMISTRY—5 cr. (3 and 6)

*Chem 332—PHYSICAL CHEMISTRY—5 cr. (3 and 6)

*Chem 335—PHYSICAL CHEMISTRY—3 cr. (3 and 0)

*Chem 336—PHYSICAL CHEMISTRY—2 cr. (2 and 0)

*Chem 337—PHYSICAL CHEMISTRY—4 cr. (3 and 3)

*Chem 338—PHYSICAL CHEMISTRY—4 cr. (3 and 3)

*Chem 402—INORGANIC CHEMISTRY—3 cr. (3 and 0)

Chem 411—INSTRUMENTAL ANALYSIS—4 cr. (2 and 6)

Chem 421—QUALITATIVE ORGANIC ANALYSIS—4 cr. (2 and 6)

Chem 423—GENERAL BIOCHEMISTRY—3 cr. (2 and 6)

Chem 454—INORGANIC SYNTHESIS—2 cr. (0 and 6)

Chem 472—ORGANIC SYNTHESIS—4 cr. (2 and 6)

Chem 491—INTRODUCTION TO RADIOCHEMISTRY—3 cr. (2 and 3)

Chem 503—INORGANIC CHEMISTRY—3 cr. (3 and 0)

A comprehensive review of the field of inorganic chemistry.

Chem 505—ADVANCED INORGANIC CHEMISTRY—3 cr. (3 and 0)

A study of atomic crystal and molecular structure and its relationship to inorganic chemistry. **Prerequisites:** Chem 402 or 503.

Chem 511—ADVANCED ANALYTICAL CHEMISTRY—3 cr. (3 and 0)

This course includes error analysis, the elementary statistical theory involved in procedures, and design of experiments and certain industrial control methods. Selected methods for the determination of a few elements not covered in the elementary courses are discussed as well as the less commonly used physio-chemical methods. **Prerequisites:** Chem 331 and 332 or 530 and 531.

Chem 512—CHEMICAL SPECTROSCOPIC METHODS—3 cr. (2 and 3)

This course is designed to give the student an understanding of the principles of spectroscopic procedures. Both absorption and emission techniques will be considered. Emphasis will be placed on ultraviolet and infrared as well as visible spectra.

* Courses which may be used for a minor in chemistry by students majoring in other fields.
Chem 521—ADVANCED ORGANIC CHEMISTRY I—3 cr. (3 and 0)
The object of this course is to give a general survey of organic chemis-
try with special attention given to the general types of organic reactions
and to important processes. The lectures are supplemented by assigned
problems and reports on current organic literature which are discussed
during a weekly conference. **Prerequisite:** Chem 520.

Chem 522—ADVANCED ORGANIC CHEMISTRY II—3 cr. (3 and 0)
A continuation of Chem 521. **Prerequisite:** Chem 521.

Chem 523—ORGANIC REACTION MECHANISMS—3 cr. (3 and 0)
The mechanisms of organic chemical reactions, both aliphatic and aro-
matic.

Chem 524—FUNDAMENTAL PRINCIPLES OF POLYMER CHEMISTRY—
3 cr. (3 and 0)
The organic chemistry of natural and synthetic macromolecules.

Chem 530—PHYSICAL CHEMISTRY—3 cr. (3 and 0)
A comprehensive review of the field of physical chemistry. The student
will also be required to take laboratory work if he has not been suffi-
ciently well grounded previously in this phase of the subject. **Prerequisites:**
Courses in qualitative analyses, organic chemistry, and a working knowl-
edge of integral calculus.

Chem 531—PHYSICAL CHEMISTRY—3 cr. (3 and 0)
A continuation of Chem 530.

Chem 532—ADVANCED PHYSICAL CHEMISTRY—3 cr. (3 and 0)
An advanced course covering special phases of physical chemistry such
as recent advances in the theory of solutions, chemical kinetics, catalysis
and phase equilibrium. **Prerequisites:** Chem 530 and 531.

Chem 541—ATOMIC AND MOLECULAR STRUCTURE—3 cr. (3 and 0)
The purpose of this course is to strengthen the student's understanding
of atomic structure and to extend his knowledge of the structure of mole-
cules. Major emphasis will be given to studying the relationship of struc-
ture to physical and chemical properties with examples drawn from both
the organic and inorganic fields.

Chem 551-552—SEMINAR—0, 1, 2 cr.
(May be taken more than one semester.)

Chem 591—RESEARCH—3 cr.

Chem 592—RESEARCH—3 cr.

Chem 621—HETEROCYCLIC COMPOUNDS—3 cr. (3 and 0)
The organic chemistry of heterocyclic compounds.

Chem 622—STEREOCHEMISTRY—3 cr. (3 and 0)
A study of all phases of stereochemistry as applied to organic compounds.
Chem 623—CHEMISTRY OF NATURAL PRODUCTS—3 cr. (3 and 0)
The chemistry of the isolation, proof of structure and synthesis of naturally occurring organic compounds.

Chem 632—COLLOID CHEMISTRY—3 cr. (3 and 0)
The principles of the physical chemistry of colloidal systems.

Chem 650—MICROANALYTICAL TECHNIQUES—3 cr. (1 and 6)
A course designed to perfect the laboratory technique of the advanced graduate student. Procedures followed are those used to analyze organic compounds for elemental composition.

Chem 691—DOCTORAL RESEARCH AND DISSERTATION—Credit to be arranged.
(May be taken more than one semester.)

CIVIL ENGINEERING
W. L. Lowry, Jr., Chairman

Courses are offered leading to the Master of Science degree.

CE 305—ROUTE SURVEYING—3 cr. (2 and 3)
CE 307—ROADS AND PAVEMENTS—3 cr. (2 and 3)
CE 309—TRUSSES—1 cr. (0 and 3)
CE 310—STRUCTURES—3 cr. (2 and 3)
CE 317—MATERIALS AND METHODS OF CONSTRUCTION—2 cr. (2 and 0)
CE 401—STRUCTURAL DESIGN—3 cr. (2 and 3)
CE 402—STRUCTURAL ANALYSIS—2 cr. (2 and 0)
CE 409—REINFORCED CONCRETE STRUCTURES—3 cr. (2 and 3)
CE 410—MUNICIPAL AND SANITARY ENGINEERING—3 cr. (2 and 3)
CE 412—REINFORCED CONCRETE DESIGN—2 cr. (1 and 3)
CE 414—SOIL MECHANICS—3 cr. (2 and 3)
CE 452—ADVANCED STRUCTURAL ANALYSIS—2 cr. (2 and 0)
CE 501—ADVANCED STRUCTURAL ENGINEERING—3 cr. (2 and 3)
Analysis of statistically indeterminate structures including secondary stresses and rigid frames.
CE 502—ADVANCED STRUCTURAL ENGINEERING—3 cr. (2 and 3)
A continuation of CE 501.
CE 503—MODEL ANALYSIS—3 cr. (2 and 3)
Methods of determining moments and stresses from a study of models; principals of similitude; use of the Beggs deformator.

CE 510—HIGHWAY SAFETY AND TRAFFIC CONTROL—3 cr. or 2 cr. (3 and 0) or (2 and 0)
Study of highway safety principles affecting the design of city streets and rural highways, devices for controlling highway traffic and related subjects, and design of traffic signal systems. Prerequisite: CE 307.

CE 511—HIGHWAY DESIGN—3 cr. (2 and 3)
Studies of economics of highway grades, location, alignment with road surfaces and factors that control highway planning. Prerequisite: CE 307.

CE 519—HIGHWAY RESEARCH—2 to 4 cr.
Independent investigation of some problems in highway engineering.

CE 520—CONCRETE MIXES AND MATERIALS—3 cr. (2 and 3)
Properties and factors controlling properties of concrete: investigation and selection of materials; mixes and design of mixes; inspection, field laboratory facilities and reports; concrete manufacture; handling, placing and curing; special types; sonic method of testing. Prerequisite: CE 409.

CE 531—SOIL ENGINEERING—3 cr. (2 and 3)
Shearing resistance consolidation, settlement, displacement and compaction, pile supporting strength, application of principles to earthwork, foundations and highway problems. Prerequisite: CE 414.

CE 591—RESEARCH—3 cr.
CE 592—RESEARCH—3 cr.

DAIRY

B. E. Goodale, Chairman

Courses are offered leading to the Master of Science degree.

Dairy 307—MARKET MILK—3 cr. (2 and 3)
Dairy 351—ADVERTISING AND MERCHANDISING—3 cr. (3 and 0)
Dairy 358—ARTIFICIAL INSEMINATION OF FARM ANIMALS—3 cr. (2 and 3)
Dairy 403—ANIMAL NUTRITION—3 cr. (3 and 0)
Dairy 404—DAIRY PLANT MANAGEMENT—3 cr. (2 and 3)
Dairy 405—DAIRY MANUFACTURES—4 cr. (3 and 3)
Dairy 407—CHEESE AND BUTTER MANUFACTURE—3 cr. (2 and 3)
Dairy 452—DAIRY CATTLE FEEDING AND MANAGEMENT—3 cr. (2 and 3)

Dairy 453—REPRODUCTION OF FARM ANIMALS—3 cr. (3 and 0)

Dairy 501—TOPICAL PROBLEMS—1 to 3 cr.
Topics of interest to the graduate students. The course is designed to give experience with problems in dairying not covered by thesis research. Credit varies with the problems selected.

Dairy 502—GENETICS OF DAIRY CATTLE IMPROVEMENT—3 cr. (3 and 0)
A study of the inheritance in dairy cattle, with emphasis on milk and butterfat production, methods used in proving sires and dams and in analyzing herds as aids to selection.

Dairy 504—ENDOCRINOLOGY—3 cr. (3 and 0)
This course includes a study of the anatomy and physiology of the glands of internal secretion. The chemistry of the hormones is considered. Emphasis is placed on the relationship of the endocrine glands to growth, reproduction, and lactation.

Dairy 505—NEWER KNOWLEDGE OF ANIMAL NUTRITION—3 cr. (3 and 0)
The application of the latest information on digestion, metabolism, and the nutritional requirements of animals.

Dairy 506—PHYSIOLOGY OF REPRODUCTION—3 cr. (3 and 0)
The influence of the endocrine glands on reproduction with special reference to domestic farm animals.

Dairy 507—FERMENTED DAIRY PRODUCTS—3 cr. (2 and 3)
The biological and chemical changes involved in the processing and aging of cheese, yoghurt and other fermented dairy products.

Dairy 508—INDUSTRIAL DAIRY SCIENCE—3 cr. (3 and 0)
Provides advanced technological training in dairy plant processing and manufacturing.

Dairy 591—RESEARCH—3 cr.

Dairy 592—RESEARCH—3 cr.

DRAWING AND DESIGN

C. M. McHugh, Acting Chairman

The department does not award advanced degrees. Courses are offered to provide a minor for students majoring in related fields.

DD 302—ADVANCED GRAPHICS—2 cr. (1 and 3)
DD 401—FUNDAMENTALS OF MACHINE DESIGN—3 cr. (3 and 0)

DD 402—THE DESIGN OF MACHINE ELEMENTS—3 cr. (2 and 3)

DD 464—LUBRICATION—2 cr. (2 and 0)

DD 501—DESIGN PROBLEMS IN VIBRATIONS AND DYNAMICS—3 cr. (3 and 0)

The application of vibration theory and dynamics to the design of machinery, critical speeds and inertia disturbances, equivalent systems, non-linear systems, isolators, damping devices and vibration instruments. Prerequisite: Math 455 or approval of instructor.

DD 502—PLASTICITY—3 cr. (2 and 3)

A study of the behavior of metal machine elements in the plastic region. Development of current theories of failure and application of these to problems involving tension, compression, torsion, bending, and various combinations. Prerequisite: Math 306.

DD 503—PHOTOELASTICITY—3 cr. (2 and 3)

Development of fundamental relations, study of the polariscope, stress distribution, and short unsolved problems.

ECONOMICS

C. L. Epting, Chairman

Advanced degrees are not awarded in Economics. Courses are offered in support of graduate programs in Agricultural Economics and to provide a minor for students majoring in other areas. To be eligible to obtain graduate credit in Economics, the student must have completed at least twelve semester hours of undergraduate work in the discipline.

Econ 403—DEVELOPMENT OF ECONOMIC THOUGHT—3 cr. (3 and 0)

Econ 406—BUSINESS FLUCTUATIONS—3 cr. (3 and 0)

Econ 412—INTERNATIONAL TRADE—3 cr. (3 and 0)

Hist 502—SEMINAR IN UNITED STATES ECONOMIC HISTORY—3 cr. (3 and 0)

IM 402—PRODUCTION PLANNING AND CONTROL—3 cr. (3 and 0)

IM 404—MANAGERIAL ECONOMICS—3 cr. (3 and 0)

EDUCATION

J. L. Brock, Education Adviser
C. B. Green, English Adviser
C. L. Epting, History and Government Adviser
J. H. Hobson, Science Teaching Adviser
Courses are offered leading to the Master of Education degree with subject specialties in English, History and Government, or Science Teaching.

Ed 494—SCHOOL AND COMMUNITY RELATIONSHIPS—3 cr. (3 and 0)
Ed 497—AUDIO VISUAL AIDS IN EDUCATION—3 cr. (3 and 0)
Ed 503—ADVANCED METHODS IN TEACHING—3 cr. (3 and 0)
   The principles and practices involved in promoting effective learning are developed in this course which is planned primarily to assist experienced teachers.
Ed 505—OCCUPATIONAL GUIDANCE AND PLACEMENT—3 cr. (3 and 0)
   The organization and administration of a guidance program for public schools. An analysis is made of procedures and techniques used in guidance. Data are collected on placement activities and follow-up work. (This is the basic course in guidance which is required in South Carolina for certification as a counselor in a high school.)
Ed 506—HISTORY AND PHILOSOPHY OF EDUCATION—3 cr. (3 and 0)
   The development of education, with emphasis being placed upon development in the United States. Education policies and practices and newer philosophy of American education are given detailed attention.
Ed 508—EDUCATIONAL TESTS AND MEASUREMENTS—3 cr. (3 and 0)
   A study of improved methods and techniques which are used in the measurement of intelligence, special aptitudes, and achievement. A survey is made of standardized tests, the sources from which they may be secured and the purposes which they may serve in classification and/or instruction of students. Emphasis is given to the construction of informal tests of achievement, and to the administration and interpretation of standardized tests. (This is one of the five courses which are required in South Carolina for certification as a counselor in a high school.)
Ed 509—ANALYSIS OF THE INDIVIDUAL—3 cr. (3 and 0)
   Emphasis is placed on the study and use of techniques of discovering the characteristics of individuals. Training experiences are provided in securing, recording, and interpreting significant data as they relate to counseling. (This is one of the five courses which are required in South Carolina for certification as a counselor in a high school.) Prerequisite: Eighteen semester credits in undergraduate and/or graduate professional education, or two years of experience in teaching.
Ed 510—TECHNIQUES OF COUNSELING—3 cr. (3 and 0)
   This course is designed to assist graduate students in developing competencies which are needed when dealing with the problems of individuals in counseling situations. Emphasis is placed upon these major objectives in interviewing: (a) securing information, (b) furnishing information, and (c) helping counselors to interpret information in making acceptable decisions. (This is one of the five courses which are required in South Carolina
for certification as a counselor in a high school.) **Prerequisites:** Completion of six credits from Ed 505, 508, 509 or 513.

Ed 511—PUBLIC SCHOOL ADMINISTRATION (Finance)—3 cr. (3 and 0)
A study of sound principles and suitable procedures relating to school administration and finance.

Ed 513—EDUCATIONAL AND OCCUPATIONAL INFORMATION—3 cr. (3 and 0)
An examination and evaluation is made of techniques for collecting, filing, interpreting, and using occupational information in counseling. Practice in the use of these techniques is emphasized. Community surveys and follow-up studies are considered as means of securing pertinent information. (This is one of the five courses which are required in South Carolina for certification as a counselor in a high school.)

Ed 521—ADULT EDUCATION DEVELOPMENT AND ADMINISTRATION—3 cr. (3 and 0)
An analysis of the adult education movement and its influence on trade and industrial workers; the applicability of education practices to industrial training problems; and major fields of training in industry.

Ed 530—TECHNIQUES OF SUPERVISION—THE PUBLIC SCHOOLS—3 cr. (3 and 0)
This course is designed for teachers, supervisors, and administrators who are interested in improving, coordinating, and evaluating instruction. Modern trends of supervisory practices will be emphasized.

Ed 531—PUBLIC SCHOOL EVALUATION—3 cr. (3 and 0)
To determine the effectiveness of a school program, its work should be measured by recognized educational criteria. The regional accrediting agencies have developed gauges and devices which are worthwhile instruments when used by competent educators. Total personal growth, subject matter progress, and physical facilities should be evaluated in terms of desirable standards. Development of total long-term plans should be carefully evaluated against community needs. The objectives of this course include those mentioned above and problems presented by members of the class.

The following courses are applicable only to the Master of Education degree in Science teaching.

Biol 450T—BIOLOGY FOR HIGH SCHOOL TEACHERS—3 cr. (3 and 0)
Chem 450T—REVIEW OF GENERAL CHEMISTRY—3 cr. (3 and 0)
Chem 550T—A REVIEW OF GENERAL CHEMISTRY II—3 cr. (2 and 3)
The lecture portion of this course deals with recent advances in the field of chemistry. Special selected topics will be considered with some emphasis being placed on those of current interest. The laboratory time will be devoted to the study of effective methods of presenting laboratory material.
Geol 500T—EARTH SCIENCE I—3 cr. (2 and 3)
A study of the earth, its origin and subsequent development. The evolution of continents and ocean basins and the developments of life on earth in all its forms; theories of the internal constitution of the earth and the materials and structures of the crust, as determined from geologic principles. Laboratory exercises and field trips are designed to familiarize the student with earth materials, fossils and physical concepts.

Geol 550T—EARTH SCIENCE II—3 cr. (2 and 3)
A course devoted to mineralogy, petrology and economic geology. The main objectives are: (1) to recognize a number of common minerals; (2) to practice procedures for the identification of unknown materials; (3) to study the occurrence of mineral deposits and their economic aspects, as well as some details of the genesis, classification, and field identification of rocks.

Math 450T—MATHEMATICS IN THE ELEMENTARY SCHOOL—3 cr. (3 and 0)

Math 551T—FUNDAMENTAL CONCEPTS IN MATHEMATICS I—3 cr. (3 and 0)
A development of basic concepts in mathematics, designed to provide a suitable mathematical background for teachers of secondary school mathematics. The material is presented by first considering a few of its historical connections, then descriptive material about it, followed by numerous illustrations of how it enters into the work of the world and development of methods of solutions. The course starts with the simplest concept and ends with trigonometry.

Math 552T—FUNDAMENTAL CONCEPTS IN MATHEMATICS II—3 cr. (3 and 0)
A continuation of Math 551T. Topics include material from the following: trigonometry, logarithms, series, mathematics of finance, probability, analytic geometry, statistics and calculus.

Math 560T—TEACHING SECONDARY MATHEMATICS—3 cr. (3 and 0)
A study of the problems in classroom instruction as related to arithmetic in the secondary school, algebra, geometry, trigonometry, and calculus. Also considered are the place and function of mathematics in secondary education.

Phys 460T—MODERN PHYSICS FOR HIGH SCHOOL TEACHERS—3 cr. (3 and 0)
An elementary treatment of mechanics, heat and sound from a mature viewpoint. Material will be chosen to show the growth of ideas and the development of the general laws. Applications to atomic Physics as well as to large scale problems will be studied.
Phys 502T—PHYSICS FOR HIGH SCHOOL TEACHERS II—3 cr. (3 and 0)
A continuation of Physics 501T covering electricity and magnetism, optics, and an introduction to atomic and nuclear physics.

Courses applicable to the Master of Education degree in English and History-Government are found under the headings "English" or "History."

The following courses are offered during the Summer Sessions as a service to elementary school teachers. As a rule the courses are not applicable to a graduate degree at Clemson:

Ed 460—CURRICULUM DEVELOPMENT IN THE ELEMENTARY SCHOOL—3 cr. (3 and 0)

Ed 518—ORGANIZATION AND ADMINISTRATION OF ELEMENTARY SCHOOL—3 cr. (3 and 0)

This course is an approach to the organization of the elementary school in terms of improved situations for students, teachers, and administrators. It deals with problems of curriculum design and implementation in terms of needs of modern society and the resultant implication for curriculum development. The course includes comprehensive discussion of the duties and responsibilities of the elementary principal in improving educational opportunities.

ELECTRICAL ENGINEERING

J. N. Thurston, Chairman

Courses are offered leading to the Master of Science degree.

EE 312—ELECTRICAL MACHINERY I—3 cr. (3 and 0)
EE 313—ELECTRIC AND MAGNETIC FIELDS—2 cr. (2 and 0)
EE 314—ELECTRICAL MACHINERY I LABORATORY—1 cr. (0 and 3)
EE 315—ALTERNATING-CURRENT CIRCUITS—4 cr. (3 and 3)
EE 316—ALTERNATING-CURRENT CIRCUITS—3 cr. (3 and 0)
EE 317—MEASUREMENTS LABORATORY—1 cr. (0 and 3)
EE 320—ELECTRONICS I—3 cr. (3 and 0)
EE 321—PRINCIPLES OF ILLUMINATION—3 cr. (3 and 0)
EE 322—ELECTRONICS I LABORATORY—1 cr. (0 and 3)
EE 402—ENGINEERING ANALYSIS—1 cr. (0 and 3)
EE 407—ELECTRONICS II—3 cr. (3 and 0)
EE 409—ELECTRONICS II LABORATORY—1 cr. (0 and 3)
EE 410—TRANSIENTS AND SERVOMECHANISMS—3 cr. (3 and 0)
EE 415—ADVANCED CIRCUITS—3 cr. (3 and 0)
EE 417—ELECTRICAL MACHINERY II—3 cr. (3 and 0)
EE 419—ELECTRICAL MACHINERY II LABORATORY—1 cr. (0 and 3)
EE 420—POWER SYSTEM ANALYSIS—3 cr. (3 and 0)
EE 431—RADIO COMMUNICATION—3 cr. (3 and 0)
EE 433—RADIO COMMUNICATION LABORATORY—1 cr. (0 and 3)
EE 434—INDUSTRIAL ELECTRONICS—2 cr. (2 and 0)
EE 436—RADIATION AND WAVE PROPAGATION—3 cr. (3 and 0)
EE 438—INDUSTRIAL ELECTRONICS LABORATORY—1 cr. (0 and 3)

EE 501—TRANSIENTS IN LINEAR SYSTEMS—3 cr. (3 and 0)
A study of linear electrical and mechanical systems using the Laplace transformation to determine transient as well as steady-state response.

EE 510—CLOSED-LOOP CONTROL SYSTEMS—3 cr. (3 and 0)
The application of Laplace transform methods as well as transfer-function analysis to the study of regulators, servomechanisms, and other automatic control systems.

EE 511—ELECTRIC POWER STATIONS—3 cr. (3 and 0)
A comprehensive study of station lay-out, generating equipment, exciters, transformers, meters, switching and protective devices. Economical arrangement and operation are emphasized.

EE 513—POWER SYSTEM STABILITY—3 cr. (3 and 0)
Problems related to the interconnection of power systems. Division of load, maximum feasible lengths of interconnecting lines, synchronization and related topics.

EE 521—RADIATION AND WAVE PROPAGATION—3 cr. (3 and 0)
An advanced study of electric fields, vector analysis, Maxwell’s equations and their use in the study of wave guides, radiation and wave propagation.

EE 525—TRANSISTOR THEORY AND APPLICATIONS—3 cr. (3 and 0)
Basic theory of conduction processes in semiconductors, equivalent circuits of transistors, and applications of these devices in amplifiers, switching circuits, etc. Prerequisite: Permission of instructor.

EE 530—PULSE TECHNIQUES—4 cr. (3 and 3)
Analysis of basic circuits applicable to pulse-modulation communication systems, computers, high-speed time measurements, and cathode-ray instrumentation. Principles involved in electronic instruments for nuclear
measurements, nuclear reactor control, and other applications involving pulsed electrical energy.

EE 591—RESEARCH—3 cr.
EE 592—RESEARCH—3 cr.

ENGINEERING MECHANICS
R. W. Moorman, Chairman

Courses are offered leading to the Master of Science degree.

Mech 401—FLUID MECHANICS—3 cr. (3 and 0)
Mech 403—FLUID MECHANICS LABORATORY—1 cr. (0 and 3)
Mech 450—MECHANICAL VIBRATIONS—3 cr. (3 and 0)
Mech 460—HYDROLOGY—2 or 3 cr. (2 or 3 and 0)
Mech 462—WATER POWER ENGINEERING—2 or 3 cr. (2 or 3 and 0)
Mech 464—FLOW IN OPEN CHANNELS—2 or 3 cr. (2 or 3 and 0)
Mech 470—EXPERIMENTAL STRESS ANALYSIS—3 cr. (2 and 3)
Mech 501—EXPERIMENTAL STRESS ANALYSIS-ADV.—3 cr. (2 and 3)

Experimental analysis of stress fields and determination of maximum principal stresses in deformable bodies. Emphasis is on the theoretical consideration in the reduction of data as well as the obtaining of data. Methods studied include photoelasticity, electrical resistance strain gages, brittle lacquer, and birefringent coatings. Also required is the conduct of an individual investigation and the preparation of a report of findings. **Prerequisite:** Mech 304 and permission of instructor. Student may not receive credit for this course and Mech 470.

Mech 502—ADVANCED MECHANICS OF MATERIALS—3 cr. (3 and 0)

Covers the general state of stress and strain, theories of failure, shear center, unsymmetrical bending, curved flexural members, and other selected topics such as torsion of non-circular sections, stress concentrations, thick wall cylinders, contact stresses, energy methods, flat plates, elastic stability. **Prerequisite:** Mech 304.

Mech 504—DYNAMICS—3 cr. (3 and 0)

A development of more advanced methods of analysis of problems in dynamics with emphasis on practical solutions. Topics are systems with variable mass and variable forces, shaking forces, balancing, vibration, gyroscopes and models. **Prerequisite:** Mech 303.
Mech 506—FLUID MECHANICS—3 cr. (3 and 0)
A comprehensive study of the principles of fluid flow and the application of the principles to practical engineering problems. Among the topics considered are fluid velocity and acceleration, significance of the flow net, pressure distributions, viscosity, surface tension, compressibility, boundary layer and circulation and magnus effect. Prerequisite: Mech 401.

Mech 508—FLOOD CONTROL—3 cr. (3 and 0)
A study of the hydrology of floods and the engineering considerations relating to their control. Topics considered in the scope of control measures are economic justification, types of control structures, and survey of flood control measures on major streams in the U. S. Prerequisite: Mech 460.

Mech 510—ADVANCED HYDROLOGY—2 cr. (2 and 0)
Special work to strengthen the student's background in modern methods. The technical literature is used extensively for the latest developments. Emphasis is laid on evaporation, infiltration and the synthetic hydrograph. Prerequisite: Mech 460.

Mech 512—HYDRAULIC PROJECTS—3 cr. (3 and 0)
This course is devoted to the detailed investigation of engineering problems in hydraulics and related fields. Application of theoretical principles developed in previous courses is emphasized. Subjects include: Spillway and stilling basin; reservoirs; inverted siphons. Prerequisites: Mech 460, 464; must be accompanied or preceded by Mech 506.

Mech 591—RESEARCH—3 cr.
Mech 592—RESEARCH—3 cr.

ENGLISH

H. M. Cox, Chairman

The department does not award advanced degrees. Courses are offered in support of the Master of Education program, and as a minor for students majoring in other areas. Students who expect graduate credit in English should present at least six semester hours of undergraduate credit in English or American Literature above the sophomore level.

Engl 405—SHAKESPEARE—3 cr. (3 and 0)
Engl 406—SHAKESPEARE—3 cr. (3 and 0)
Engl 409—CHAUCER—3 cr. (3 and 0)
Engl 423—A SURVEY OF AMERICAN LITERATURE—3 cr. (3 and 0)
Engl 424—A SURVEY OF AMERICAN LITERATURE—3 cr. (3 and 0)
Engl 425—THE ROMANTICS—3 cr. (3 and 0)
Engl 427—VICTORIAN LITERATURE—3 cr. (3 and 0)
Engl 429—THE ENGLISH NOVEL—3 cr. (3 and 0)
Engl 430—THE ENGLISH NOVEL—3 cr. (3 and 0)
Engl 431—RESTORATION AND EIGHTEENTH CENTURY—3 cr. (3 and 0)
Engl 433—CONTEMPORARY BRITISH LITERATURE—3 cr. (3 and 0)
Engl 434—CONTEMPORARY AMERICAN LITERATURE—3 cr. (3 and 0)
Engl 435—SOUTHERN LITERATURE—3 cr. (3 and 0)
Engl 503—SEMINAR IN AMERICAN LITERATURE I—3 cr. (3 and 0)
Engl 504—SEMINAR IN AMERICAN LITERATURE II—3 cr. (3 and 0)

ENTOMOLOGY
J. H. Cochran, Chairman

Courses are offered leading to the Master of Science and Doctor of Philosophy degrees.

Ent 305—ECONOMIC ENTOMOLOGY—3 cr. (2 and 3)
Ent 306—ECONOMIC ENTOMOLOGY—3 cr. (2 and 3)
Ent 405—INSECT MORPHOLOGY—4 cr. (3 and 3)
Ent 408—GENERAL AND TAXONOMIC ENTOMOLOGY—5 cr. (3 and 6)
Ent 468—INTRODUCTION TO RESEARCH—2 cr. (1 and 3)
Ent 508—TAXONOMY OF IMMATURE INSECTS—3 cr. (1 and 6)
Identification of immature insects with particular emphasis on the Holometabola. Each student will make and submit an identified collection of immature insects.

Ent 556—MEDICAL ENTOMOLOGY—3 cr. (2 and 3)
Disease vectors of animals with emphasis on insects and related Arthropod disease carriers. Prerequisite: Ent 301.

Ent 560—PRINCIPLES OF INSECT CONTROL—3 cr. (3 and 0)
Covers the mechanical, physical, cultural, biological, chemical and legal aspects of insect control.

Ent 561—INSECT TOXICOLOGY—3 cr. (2 and 3)
History, development, application, chemical nature and mode of action of insects. Prerequisites: Chem 220 and Ent 405.

Ent 562—INSECT PHYSIOLOGY—3 cr. (2 and 3)
The physiology of nutrition, digestion, respiration, excretion, nervous and hormonal systems. Prerequisites: Chem 220 and Ent 405.
Ent 563—SPECIAL PROBLEMS IN ENTOMOLOGY—3-6 cr.
Original investigation of special problems in entomology not related to a thesis but designed to provide experience and training in research. Emphasis will be placed on insect toxicology, insect physiology, medical entomology and biological control of insects.

Ent 590—RESEARCH TECHNIQUES IN AGRICULTURE—3 cr. (2 and 3)
This course is designed to give the student a comprehensive understanding of research procedures and techniques in solving problems in the various fields of agriculture. Special attention will be given to the design of experiments, interpretation of results and report writing. The student will be expected to prepare a written report on a selected problem.

Ent 591—RESEARCH—3 cr.
Ent 592—RESEARCH—3 cr.

GEOLOGY
C. Q. Brown, Chairman

Advanced degrees are not awarded in Geology. Courses are offered as a minor for students majoring in other areas.

Geol 306—MINERALOGY—3 cr. (2 and 3)
Geol 307—OPTICAL MINERALOGY—3 cr. (2 and 3)
Geol 309—PETROLOGY—3 cr. (2 and 3)
Geol 311—STRATIGRAPHY AND SEDIMENTATION—3 cr. (3 and 0)
Geol 402—STRUCTURAL GEOLOGY—3 cr. (3 and 0)
Geol 404—ECONOMIC GEOLOGY—2 cr. (2 and 0)

HISTORY AND GOVERNMENT
C. L. Epting, Chairman

The department does not award advanced degrees. Courses are offered in support of the Master of Education Program, and as a minor for students majoring in other fields. To be eligible for graduate credit in History and Government the student should present at least twelve semester hours of undergraduate work in this field.

Gov 401—COMPARATIVE GOVERNMENT—3 cr. (3 and 0)
Hist 401—HISTORY OF SOUTH CAROLINA—3 cr. (3 and 0)
Hist 403—HISTORY OF THE SOUTH TO 1865—3 cr. (3 and 0)
Hist 404—HISTORY OF THE SOUTH SINCE 1865—3 cr. (3 and 0)
Hist 405—THE AMERICAN FRONTIER—3 cr. (3 and 0)
Hist 406—HISTORY OF MANUFACTURING IN THE UNITED STATES—3 cr. (3 and 0)
Hist 407—DIPLOMATIC HISTORY OF THE UNITED STATES—3 cr. (3 and 0)
Hist 408—EUROPE SINCE 1914—3 cr. (3 and 0)
Hist 409—INTRODUCTION TO HISTORICAL RESEARCH—2 cr. (1 and 3)
Hist 501—SEMINAR IN SOUTH CAROLINA HISTORY—3 cr. (3 and 0)
Hist 502—SEMINAR IN THE UNITED STATES ECONOMIC HISTORY—3 cr. (3 and 0)

HORTICULTURE
T. B. Hagler, Chairman

Courses are offered leading to the Master of Science degree.

Hort 302—PRINCIPLES OF VEGETABLE PRODUCTION—3 cr. (2 and 3)
Hort 310—FLORICULTURE—3 cr. (2 and 3)
Hort 352—COMMERCIAL POMOLOGY—3 cr. (2 and 3)
Hort 402—GARDEN DESIGN—3 cr. (2 and 3)
Hort 405—NUT CULTURE AND SPRAYS—3 cr. (2 and 3)
Hort 407—LANDSCAPE DESIGN—3 cr. (2 and 3)
Hort 451—SYSTEMATIC POMOLOGY AND SMALL FRUIT CULTURE—3 cr. (2 and 3)
Hort 456—TRUCK CROPS—3 cr. (2 and 3)
Hort 460—ADVANCED LANDSCAPE DESIGN—5 cr. (3 and 6)
Hort 464—FOOD PRESERVATION—3 cr. (2 and 3)
Hort 468—INTRODUCTION TO RESEARCH—2 cr. (1 and 3)

Prerequisite: Hort 451.

Hort 501—PROBLEMS IN SMALL FRUIT PRODUCTION—3 cr. (3 and 0)
A study of selected problems encountered in the production of blueberries, strawberries, brambles and grapes. Prerequisite: Hort 451.

Hort 502—ADVANCES IN HORTICULTURE—3 cr. (2 and 3)
Technical advances in horticulture. Consideration will also be given to experimental techniques including uses of specialized equipment in horticultural research.
Hort 503—ADVANCED VEGETABLE CROPS—3 cr. (3 and 0)
A systematic study of sources of information and practices with emphasis on the application and handling of vegetable crops. **Prerequisite:** Hort 456.

Hort 505—FOOD TECHNOLOGY—3 cr. (1 and 6)
This course includes quality control methods and equipment such as special titrations, taste panels, refractometers, succulometers, tenderometers, and colorimeters; the role of sugars, salts, and acids and chemical preservatives in foods; quality grade standards, and special problems. **Prerequisites:** Bact 301, Hort 464.

Hort 507—ADVANCED POMOLOGY—3 cr. (3 and 0)
A study of the growth and development of deciduous fruits with emphasis on the peach and apple. **Prerequisite:** Hort 452.

Hort 508—SPECIAL PROBLEMS IN HORTICULTURE—2 cr. (2 and 0)
Special research problems in horticulture not related to a thesis, but designed to provide opportunities for research experience and training.

Hort 591—RESEARCH—3 cr.
Hort 592—RESEARCH—3 cr.

**INDUSTRIAL EDUCATION**

**J. L. Brock, Chairman**

Courses are offered leading to the Master of Science degree.

Ed 591—INTRODUCTION TO RESEARCH IN EDUCATION—3 cr.

Ed 594—RESEARCH—3 cr.

In Ed 421—COORDINATION METHODS IN VOCATIONAL EDUCATION—2 cr. (2 and 0)

In Ed 446—SHOP PLANNING AND LAYOUT—3 cr. (3 and 0)

In Ed 496—PUBLIC AND INDUSTRIAL RELATIONS FOR VOCATIONAL TEACHERS AND SUPERVISORS—3 cr. (3 and 0)

In Ed 516—HISTORY AND PHILOSOPHY OF VOCATIONAL EDUCATION—3 cr. (3 and 0)

A comprehensive course including the development of vocational education to the present time, the influence of European vocational programs on the United States, and the Federal Vocational Acts policies. Current problems and trends are discussed.

In Ed 521—ADULT EDUCATION DEVELOPMENT AND ADMINISTRATION—3 cr. (3 and 0)

A critical analysis of the adult education movement and its influence on trade and industrial workers; the applicability of education practices to industrial training problems; major fields of training in industry; evaluation of union participation in education programs; psychological approaches to problems in worker-management relations.
In Ed 561—ADMINISTRATION AND SUPERVISION OF VOCATIONAL EDUCATION—3 cr. (3 and 0)
The expanding program of vocational education under the George-Barden Act and problems on national, state and local levels are discussed. Major specific problems in unit trade programs, and out-of-school youth, selection and training of teachers, veteran training and others are covered.

In Ed 596—RESEARCH IN INDUSTRIAL EDUCATION—3 cr.

MATHEMATICS

D. C. Sheldon, Chairman

Courses are offered leading to the Master of Science degree. Students may choose a thesis or a non-thesis program. A student choosing the non-thesis option will complete a minimum of thirty semester hours, distributed between mathematics and one minor subject. At least fifteen hours will be in courses of the 500 series. The minor will consist of not less than six or more than twelve hours.

Math 302—THEORY OF EQUATIONS—3 cr. (3 and 0)
Math 304—STATISTICS—3 cr. (3 and 0)
Math 306—ORDINARY DIFFERENTIAL EQUATIONS—3 cr. (3 and 0)
Math 307—ELEMENTARY PARTIAL DIFFERENTIAL EQUATIONS—3 cr. (3 and 0)
Math 309—THEORY OF APPROXIMATIONS—3 cr. (2 and 3)
Math 451—VECTOR ANALYSIS—3 cr. (3 and 0)
Math 453—ADVANCED CALCULUS—3 cr. (3 and 0)
Math 454—ADVANCED CALCULUS—3 cr. (3 and 0)
Math 502—DETERMINANTS AND MATRICES—3 cr. (3 and 0)

Some of the topics included in the course are determinants, polynomials and forms, transformations, system of linear equations.

Math 503—THEORY OF FUNCTIONS OF COMPLEX VARIABLES—3 cr. (3 and 0)

This is a basic course in analysis. The topics include differentiation and integration of analytic functions, power series, residues, contour integration, analytic continuation, and conformal mapping.

Math 504—THEORY OF FUNCTIONS OF COMPLEX VARIABLES—3 cr. (3 and 0)

A continuation of Math 503.

Math 505—NUMERICAL ANALYSIS—3 cr. (3 and 0)

A study of the theory of measurements and errors, properties of the error curve, curve fitting by the method of least squares, use of orthogonal polynomials in curve fitting, methods of the calculus of finite differences.
Math 506—CALCULUS OF FINITE DIFFERENCES—3 cr. (3 and 0)
Difference operators, summation formulas, difference equations, interpolation, orthogonal polynomials. **Prerequisite:** Math 554.

Math 507—INTERMEDIATE DIFFERENTIAL EQUATIONS—3 cr.
(3 and 0)
An introduction to complex variables and series solutions in the neighborhood of regular singular points. Ricatti equations, equations of Fuchsian type and the hypergeometric equations. **Prerequisite:** Math 454.

Math 508—FOURIER SERIES—3 cr. (3 and 0)
Fourier series with applications to the solution of boundary value problems in the partial differential equations of physics and engineering; and introduction to Bessel functions and Legendre polynomials, with applications. **Prerequisite:** Math 454.

Math 509—OPERATIONAL MATHEMATICS—3 cr. (3 and 0)
A study of the operational properties of the Laplace and other integral transforms. The applications are chiefly to problems in engineering and physics that involve differential equations, with emphasis on boundary value problems in partial differential equations. **Prerequisite:** Math 454.

Math 591—RESEARCH—3 cr.
Math 592—RESEARCH—3 cr.

**MECHANICAL ENGINEERING**

J. C. Cook, Jr., Chairman

Courses are offered leading to the Master of Science degree.

IE 402—METALLURGY—3 cr. (2 and 3)
ME 403—GAS DYNAMICS—3 cr. (3 and 0)
ME 404—AUTOMATIC CONTROL ENGINEERING—3 cr. (3 and 0)
ME 411—GAS POWER—3 cr. (3 and 0)
ME 412—STEAM POWER—3 cr. (3 and 0)
ME 413—MECHANICAL ENGINEERING LABORATORY—1 cr. (0 and 3)
ME 414—MECHANICAL ENGINEERING LABORATORY—1 cr. (0 and 3)
ME 417—ENGINEERING ANALYSIS—1 cr. (0 and 3)
ME 422—PRINCIPLES OF TURBOMACHINERY—3 cr. (3 and 0)
ME 423—INTERNAL COMBUSTION ENGINE ANALYSIS—1 cr. (0 and 3)
ME 429—AIR CONDITIONING—3 cr. (3 and 0)
ME 430—AIR CONDITIONING DESIGN—1 cr. (0 and 3)
ME 433—ELEMENTARY AERODYNAMICS—3 cr. (3 and 0)
ME 434—REFRIGERATION—2 cr. (2 and 0)
ME 501—ADVANCED AIR CONDITIONING—3 cr. (3 and 0)
An analysis of the principles of air conditioning. The following topics are among those covered: enthalphy of air-vapor mixtures; adiabatic mixtures of air with water, steam or ice; fogged air; adiabatic saturation; air in contact with water; fundamental simultaneous and fundamental successive conditioning processes; humid air below 32 degrees F., geometry of the psychrometric chart. A critical analysis of current literature on special topics. **Prerequisite:** ME 429.

ME 510—ADVANCED THERMODYNAMICS—3 cr. (3 and 0)
A critical review of the first and second laws, entropy, and general thermodynamics relations. The relations of entropy to probability and communication theory. Non-steady flow processes. Selected topics. **Prerequisites:** One year of thermodynamics and registration in Math 306.

ME 511—THERMODYNAMICS OF COMPRESSIBLE FLUID FLOW—3 cr. (3 and 0)
An application of thermodynamics to the flow of compressible fluids. **Prerequisite:** ME 403 or equivalent or permission of instructor.

ME 521—ADVANCED INTERNAL COMBUSTION ENGINES—3 cr. (3 and 0)
Internal combustion process analysis, deviation from the ideal processes, detonation, and knock testing, carburetion and fuel injection, combustion chamber and cylinder head design, engine cooling, mechanics of principle moving parts, engine vibration and balance and engine design.

ME 523—ADVANCED INTERNAL COMBUSTION ENGINE LABORATORY—1 cr. (0 and 3)
Analysis of engine instrumentation, air-fuel ratio tests, detonation limited power test, injection and analysis with test apparatus, fuels testing and general test codes.

ME 524—ADVANCED GAS TURBINES—3 cr. (3 and 0)
Gas turbine process analysis, deviation from the ideal process, fuels stratification, efficiencies, pressure ratio, including the development of charts for cycle analysis.

ME 532—ADVANCED HEAT TRANSFER—3 cr. (3 and 0)
A comprehensive and rigorous study of the principles of heat transfer and their application to engineering problems. The course is designed to strengthen and extend the student's knowledge of heat transfer phenomena. **Prerequisites:** ME 304, Math 306.

ME 591—RESEARCH—3 cr.
ME 592—RESEARCH—3 cr.

**PHYSICS**
L. D. Huff, Chairman

Courses are offered leading to the Master of Science degree.
Graduate students majoring in Physics are normally expected to take at least two of the following three courses as a part of their graduate program: Physics 521, 541 and 542. Students majoring in this field are required to demonstrate a reading knowledge of one modern foreign language. It is suggested that these students select a minor in Mathematics, Chemistry or one of the branches of Engineering.

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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>Phys 521</td>
<td>DYNAMICS</td>
<td>3 cr</td>
<td>(3 and 0)</td>
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<tr>
<td></td>
<td>The more advanced phase of dynamics including the equations of Lagrange and Hamilton, generalized coordinates, oscillatory and cyclic motion and Newtonian potential theory.</td>
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<tr>
<td>Phys 522</td>
<td>HYDRODYNAMICS</td>
<td>3 cr</td>
<td>(3 and 0)</td>
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<td>The mathematical theory of the motions of an ideal fluid including effects produced by moving submerged bodies; theory of waves, ripples and vortices; effects of viscosity.</td>
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<tr>
<td>Phys 541</td>
<td>ELECTRODYNAMICS</td>
<td>3 cr</td>
<td>(3 and 0)</td>
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<tr>
<td></td>
<td>The field theory of electromagnetism. Maxwell's equations and their ap-</td>
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plication to the study of electromagnetic wave production and propagation, wave optics and theories of interference and diffraction.

Phys 542—RADIATION THEORY—3 cr. (3 and 0)
  The production and propagation of electromagnetic waves are studied using Maxwell's equations as a starting point. Discussions of wave guides, diffraction phenomenon, and boundary effects are included. An introduction to the theory of electrons and microscopic phenomenon will be given.

Phys 543—REACTOR THEORY I—3 cr. (3 and 0)
  A brief account of nuclear physics: basic instrumentation; interaction of neutrons with matter; chain reactions; neutron diffusion; flux distribution and critical mass; the bare homogeneous reactor; lattice constants; reactor kinetics.

Phys 544—REACTOR THEORY II—3 cr. (3 and 0)
  Homogenous reactors with reflector; power reactors, materials of construction; methods of heat removal; reactor control; radiation hazards; shielding.

Phys 545—SOLID STATE I—3 cr. (3 and 0)
  The study of the physical properties of crystalline solids. The topics treated are crystalline state determination by diffraction methods, theories of specific heat, properties of metallic lattices and alloys, lattice energy and ferroelectrics.

Phys 546—SOLID STATE II—3 cr. (3 and 0)
  A continuation of Physics 545, but includes the electronic properties of solids. The topics treated are band theory of solids, rectifiers and transistors, theories of magnetism and magnetic resonance phenomenon.

Phys 551—INTRODUCTION TO QUANTUM MECHANICS—3 cr. (3 and 0)
  An introductory course formulating the mathematical physical ideas associated with wave mechanics. Solution of simple physical systems including the hydrogen atom are discussed. Prerequisites: Phys 451 and Math 306.

Phys 552—THEORY OF ATOMIC SPECTRA—3 cr. (3 and 0)
  The excitation of spectra, computation of wave lengths from spectral photographs, the computation of energy levels and the correlation with theories of atomic structure.

Phys 553—NUCLEONICS—3 cr. (3 and 0)
  This course is designed to give the basic properties of and the experimental methods employed in the study of particles associated with the nucleus. A survey is made of the theories so far advanced for the interaction of these particles and the theories pertaining to the structure of simple nuclei.

Phys 556—RELATIVITY—3 cr. (3 and 0)
  This course is intended to give a survey of the special and general theory of relativity including tensor calculus, the Lorentz transformation and three experimental tests of the general theory: (1) planetary motion and the ad-
vance of the perihelion of Mercury (2) the bending of light rays in gravitational fields and (3) the gravitational shift of spectral lines.

Phys 575—SEMINAR IN CONTEMPORARY PHYSICS—1 or 2 cr. (1 or 2 and 0)

A joint study by graduate students and interested members of the faculty of some area of physics which is currently being extensively investigated.

Phys 591—RESEARCH—3 cr.

Phys 592—RESEARCH—3 cr.

PLANT PATHOLOGY

W. M. Epps, Chairman

Courses are offered leading to the Doctor of Philosophy degree. See Botany for a listing of courses available.

POULTRY

J. B. Cooper, Chairman

The department does not award advanced degrees. Courses are offered to provide a minor for students majoring in other fields.

PH 352—POULTRY FEEDING AND FLOCK MANAGEMENT—3 cr. (2 and 3)

PH 354—POULTRY BREEDING—3 cr. (2 and 3)

PH 355—POULTRY GRADING AND PROCESSING—3 cr. (2 and 3)

PH 457—INCUBATION AND BROODING—3 cr. (2 and 3)

PH 458—POULTRY DISEASES AND PARASITES—3 cr. (2 and 3)

PH 460—SEMINAR—2 cr. (2 and 0)

SOCIOLOGY

G. H. Aull, Chairman (Rural Sociology)

C. L. Epting, Chairman (General Sociology)

Advanced degrees are not awarded in Sociology. Courses are offered to provide a minor for students majoring in other fields.

RS 454—FARMERS' MOVEMENTS—3 cr. (3 and 0)

RS 459—THE RURAL COMMUNITY—3 cr. (3 and 0)

RS 461—RURAL LEADERSHIP—3 cr. (3 and 0)

RS 501—RURAL SOCIAL SYSTEMS—3 cr. (3 and 0)

A course designed to provide the advanced student with a brief review of the basic working concepts of rural sociology and a knowledge of the basic institutions of rural life and to acquaint the student with the techniques used in applying scientific methods and theory toward understanding the social structure of rural life. Prerequisite: Permission of the instructor.

Soc 403—CRIMINOLOGY—3 cr. (3 and 0)

Soc 404—SOCIAL ANTHROPOLOGY—3 cr. (3 and 0)

Soc 405—INDUSTRIAL SOCIOLOGY—3 cr. (3 and 0)
TEXTILE CHEMISTRY
Joseph Lindsay, Jr., Chairman

Courses are offered leading to the Master of Science degree.

TC 456—CHEMISTRY OF SYNTHETIC FIBERS AND FINISHES—3 cr. (3 and 0)
TC 475—CELLULOSE CHEMISTRY—2 cr. (2 and 0)
TC 511—THE THEORY AND APPLICATION OF SYNTHETIC RESINOUS MATERIALS—3 cr. (2 and 3)
   This course gives the student a comprehensive survey of the history, present utility, and probable future expansion of synthetic resins. Prerequisite: TC 306 or Chem 222.
TC 512—THE THEORY AND APPLICATION OF SYNTHETIC RESINOUS MATERIALS—3 cr. (2 and 3)
   A continuation of TC 511.
TC 521—ADVANCED CELLULOSE CHEMISTRY—3 cr. (3 and 0)
   This course presents the chemistry of cellulose and closely related polysaccharides, through a systematic study of the extensive volume of research which has been completed on these substances. Prerequisite: TC 306 or Chem 324.
TC 531—CHEMISTRY OF COLORING MATTERS—3 cr. (2 and 3)
   The work of this course consists of an advanced study of coloring bodies in their major forms, as dyes, pigments and lakes. Their structure and formulation for use is covered in detail with the chief emphasis being placed on the more complex forms, such as the vat colors and insoluble azo compounds. Prerequisite: TC 452.
TC 591—RESEARCH—3 cr.
TC 592—RESEARCH—3 cr.

TEXTILE MANAGEMENT
Gaston Gage, Chairman

The department does not award advanced degrees. Courses are offered to provide a minor for students majoring in other fields.

TM 403—TEXTILE MANAGEMENT—3 cr. (3 and 0)
TM 460—NATURAL FIBERS—3 cr. (3 and 0)
TM 462—TEXTILE MICROSCOPY—2 cr. (1 and 3)
TM 464—PHYSICAL TEXTILE TESTING—2 cr. (1 and 3)

ZOOLOGY
J. H. Cochran, Chairman

Courses are offered leading to the Master of Science degree.

Zool 301—COMPARATIVE VERTEBRATE ANATOMY—3 cr. (2 and 3)
Zool 302—VERTEBRATE EMBRYOLOGY—3 cr. (2 and 3)
Zool 402—ANIMAL ANATOMY AND PHYSIOLOGY—3 cr. (2 and 3)
Zool 403—PROTOZOOLOGY—3 cr. (2 and 3)
Zool 456—PARASITOLOGY—3 cr. (2 and 3)
Zool 501—ADVANCED ANIMAL HISTOLOGY—3 cr. (2 and 3)
   An advanced study in the microscopic structures of the tissues and
   organs of the animal body and the relation of histology to physiology and
   pathology. Prerequisites: Zool 101, 103, and 402.
Zool 502—HISTOLOGICAL TECHNIQUES—3 cr. (1 and 6)
   The fixing, staining, sectioning, and identification of all tissues, glands
   and organs of animals. Prerequisites: Zool 101, 103.
Zool 503—ANIMAL ECOLOGY—4 cr. (2 and 6)
   A comprehensive study of animals in relation to their natural environ-
   ment. Typical animal habitats are visited to study the animal life and the
   ocean, shore, lakes, streams, swamps, cultivated fields, woodlands, and
   mountains.
Zool 504—ORNITHOLOGY—3 cr. (2 and 3)
   The identification, life history and ecology of birds. Field trips, work
   with bird specimens and correlated reading will give the student a work-
   ing knowledge of at least 100 species of the common birds.
Zool 505—ADVANCED ANIMAL PATHOLOGY—3 cr. (3 and 0)
   Designed to acquaint the student with the cause, prevention, and treat-
   ment of pathogenic diseases.
Zool 511—RECENT ADVANCES IN ZOOLOGY AND ENTOMOLOGY I—
   1 cr. (1 and 0)
   A review of the current literature in the fields of Zoology and Ento-
   mology. Needs and changes in future research in Zoology and Entomology
   will be discussed.
Zool 512—RECENT ADVANCES IN ZOOLOGY AND ENTOMOLOGY II—
   1 cr. (1 and 0)
   A continuation of Zool 511.
Zool 513—EVOLUTION—3 cr. (3 and 0)
   Covers the principles which have governed the evolution of plants and
   animals and also of the relationships of the Phyla and classes which are
   the results of this process.
Zool 552—PRINCIPLES AND METHODS OF SYSTEMATIC ZOOLOGY—
   2 cr. (2 and 0)
   Presents the problems which confront the taxonomist in the zoological
   sciences and the conventional practices which have been developed to
   handle them.
Zool 556—ECONOMIC ZOOLOGY—3 cr. (2 and 3)
   A study of all phyla (exclusive of class insecta) to include those animals
   either beneficial or destructive to man. Prerequisites: Zool 101, 103.
Zool 591—RESEARCH—3 cr.
Zool 592—RESEARCH—3 cr.