Clemson College

Record

Announcements of
The Graduate School

For
1961-62

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COLLEGE CALENDAR

SESSION 1961-1962

Matriculation, new students ------------------------- September 8
Registration, new students ------------------------- September 12
Matriculation and Registration, current
    students ----------------------------------------- September 12, 13
Late Registration Fee applies ---------------------- September 14
Classes begin ------------------------------------- September 14
Last day for Matriculation ------------------------ September 20
Last day to add a subject -------------------------- September 27
Last day to drop a subject without record of drop --- October 11
Last day to order diploma for mid-year graduation --- October 14
Mid-semester reports due -------------------------- November 6
Clemson-Carolina football game—classes suspended ------------------------- November 11
Thanksgiving Holidays ----------------------------- November 23-25
Christmas Holidays begin at 1 p.m. ---------------- December 16
Classes resumed ---------------------------------- January 3
Examinations begin ------------------------------- January 18
Faculty meeting to consider candidates
    for graduation ---------------------------------- January 26
Mid-year graduation ------------------------------- January 27
Matriculation, new students ----------------------- January 29
Registration, new students ------------------------ January 31
Matriculation and Registration, current students -- Jan. 31, Feb. 1
Late Registration Fee applies ---------------------- February 2
Classes begin ------------------------------------- February 2
Last day for matriculation ------------------------- February 8
Last day to add a subject -------------------------- February 15
Last day to drop a subject without record of drop --- March 1
Last day to order diploma for June graduation ----- March 1
Mid-semester reports due -------------------------- March 27
Easter Holidays begin at 1 p.m. --------------------- April 19
Classes resumed ---------------------------------- April 25
Honors and Awards Day—Classes suspended at noon --- May 2
Examinations begin -------------------------------- May 23
Faculty meeting to consider candidates for graduation ----- June 1
Commencement ------------------------------------ June 2
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CLEMSON COLLEGE BOARD OF TRUSTEES

Life Members

R. M. Cooper, President of the Board  Wisacky
Edgar A. Brown  Barnwell
James F. Byrnes  Columbia
Charles E. Daniel  Greenville
Winchester Smith  Williston
Robert R. Coker  Hartsville
James C. Self  Greenwood

Term Expires 1962

W. A. Barnette  Greenwood
A. M. Quattlebaum  Florence
L. D. Holmes  Johnston

Term Expires 1964

Robert L. Stoddard  Spartanburg
Paul Quattlebaum, Jr.  Charleston
W. Gordon McCabe, Jr.  Greenville

G. E. Metz, Secretary  Clemson
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Jack Kenny Williams, Ph.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
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Jess Willard Jones, Ph.D. --------------- Director, Agricultural Teaching
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Walter Lee Lowry, Jr., M.C.E. ___________ Dean, School of Engineering
Gaston Gage, M.Ed. ___________________ Dean, School of Textiles
Hugh Holleman Macaulay, Ph.D. ___________ Dean of the Graduate School
John Wallace Gordon Gourlay, A.M.L.S. ___________ Director of the Library
Kenneth Notley Vickery, B.S. ___________________ Registrar

THE GRADUATE COUNCIL

1961-1962

Hugh Holleman Macaulay, Ph.D., Professor of Economics and Dean of the Graduate School. Chairman ex officio.
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Floyd Irving Brownley, Jr., Ph.D., Professor of Chemistry and Head, Department of Chemistry and Geology.
Lowery Heywood Davis, Ph.D., Professor of Agricultural Education and Head, Department of Agricultural Education.
John Edward Miller, Ph.D., Professor of Physics.
Linvil Gene Rich, Ph.D., Professor of Civil Engineering and Head, Department of Civil Engineering.
Taze Leonard Senn, Ph.D., Professor of Horticulture and Head, Department of Horticulture.
James Marvin Stepp, Ph.D., Professor of Agricultural Economics.
Hugh H. Wilson, Ph.D., Associate Professor of Ceramic Engineering.
Howard Louis Hunter, Ph.D., Professor of Chemistry and Dean, School of Arts and Sciences. Ex officio.
Walter Lee Lowry, Jr., M.C.E., Professor of Civil Engineering and 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.
Harlan Ewart McClure, M.Arch., Professor of Architecture and Dean, School of Architecture. 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 thirty-three graduate 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 and including the academic deans as ex officio members.

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 1961-1962 charges for regular full-time students 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 (Semester)</td>
<td>$75.00</td>
<td>$175.00</td>
</tr>
<tr>
<td>Matriculation Fee (non-refundable)</td>
<td>5.00</td>
<td>5.00</td>
</tr>
<tr>
<td>Maintenance and Activities Fee (Semester)</td>
<td>85.00</td>
<td>85.00</td>
</tr>
<tr>
<td>Medical Fee (Semester)</td>
<td>13.00</td>
<td>13.00</td>
</tr>
<tr>
<td>Room and Board (½ Semester)</td>
<td>133.00</td>
<td>133.00</td>
</tr>
<tr>
<td><strong>Total Entrance Payment</strong></td>
<td><strong>$311.00</strong></td>
<td><strong>$411.00</strong></td>
</tr>
<tr>
<td>Second Payment:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Room and Board (due Nov. 10.)</td>
<td>133.00</td>
<td>133.00</td>
</tr>
<tr>
<td><strong>Total First Semester</strong></td>
<td><strong>$444.00</strong></td>
<td><strong>$544.00</strong></td>
</tr>
</tbody>
</table>

**Second Semester**
Charges for the second semester are the same as the first semester. The payment for room and board for the last half of the second semester is due April 1.

The thesis binding fee, the diploma fee, and the fee for cap and gown rental are not included in the above charges.

**Part-Time Students.** Graduate students taking less than 12 semester credit hours will be charged each semester according to the following schedule:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Matriculation Fee (non-refundable)</td>
<td>$5.00</td>
</tr>
<tr>
<td>Tuition (per semester hour)</td>
<td>6.00</td>
</tr>
<tr>
<td>Maintenance and Activities Fee (per semester hour)</td>
<td>6.00</td>
</tr>
</tbody>
</table>
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 $13. Students who elect not to pay the hospital fee are responsible for arranging their own medical care.

Graduate assistants and part-time students may be admitted to home athletic games and College concerts upon payment of the faculty rate.

Graduate Assistants and Staff. Graduate assistants and staff members will be charged $4 per semester hour. Staff members may enroll in not more than six credits (or not more than seven credits if only one or two courses are taken).

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 $1,700 to $3,200 and tuition is reduced. 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:

Alumni Fellowships ranging from $200 to $1,200, are awarded in all fields of study. These fellowships are made possible through gifts to the Alumni Loyalty Fund.

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

American Potash Institute Fellowship. A $2,500 award plus research materials to a student in Agronomy.

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.

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

E. C. McArthur Memorial Fellowship. A $2,500 award plus tuition and research materials given by the South Carolina Association of Soil Conservation District Supervisors to a student in Agricultural 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 Clemson graduates who are accepted for graduate study.

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 and the Clemson Alumni through the Alumni Loyalty Fund.

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.
OTHERS FUNDS: Limited assistance may also be available from the Clemson Foundation and Clemson Student Loan Funds. Contact the Student Aid Office for further information.

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 Veterans' Administration.

LIBRARY

The Main Library is essentially a consolidation of special libraries, agricultural and biological sciences, science and technology, and carefully selected smaller collections in the social sciences and the humanities. The collection consists of more than 195,000 bound volumes of books, periodicals, and government publications. Added to these are thousands of unbound federal and state documents, agricultural and engineering experiment station publications, and extension publications which are classified and available for use. In addition to the Main Library there are departmental libraries.

Forty newspapers and about 3,000 serial titles—periodicals, reports, bulletins and the like—are received regularly. Five hundred and sixty-five of these are foreign publications. Microfilm and microcard readers are provided for consulting material that is in microtext.

Library service is maintained for 87 hours a week in the Main Library. With the exception of adjustments in the schedule during holiday periods, the library hours are as follows:

- Monday through Friday: 8 A.M. to 10 P.M.
- Saturday: 8 A.M. to 5 P.M.
- Sunday: 2 P.M. to 10 P.M.

Special study desks are available for graduate students doing thesis research. These desks are assigned by the Dean of the Graduate School.
LIVING CONDITIONS

Dormitories. Cost per semester $86.

Life in the student dormitories is under the direction of dormitory supervisors who are responsible to the Dean of Student Affairs through a resident dormitory manager. 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 must be made.

Students who are enrolled in the spring semester are given priority on room assignments for the fall semester provided a room request is filed and the payment of $43 made prior to July 1. Assignment after this date will be made on a first come, first served basis.

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 August 15 for the fall semester and prior to February 1 for the spring semester. 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.

Bed linen, bed covers, pillows, towels, and laundry bags must be furnished by the students. No student shall have or operate a television set in a dormitory room. The College is not liable for articles lost or stolen in the dormitories.

There are eight men's dormitories, one housing approximately 2,200 students and the others 100-150 each. Students are housed two per room with dormitory and room assignment made insofar as possible in accordance with each student's preference.

At the present time dormitory facilities are not available for women students. They may find housing facilities in the town of Clemson and surrounding areas.
Dining Hall. Cost per semester $180.

The new College Dining Hall offers a counter-service cafeteria-type meal to students. Six large counters provide timely service of quality foods.

Students who live in the dormitories will be required to pay the Dining Hall fee. 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 5-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—Dry Cleaning.

A new building with modern equipment is conveniently located on the campus. Reasonable prices are charged for individual items on a cash and carry basis.

Married Student Housing. Rentals $27, $33, $36, 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 venetian blinds, electric stove, electric refrigerator, gas fired circulating heat, 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 $33 for an interior unit and $36 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 $27 and includes cold water.
Graduate assistants and graduate fellows are given priority over undergraduate students in assignments to married student housing. To qualify for this priority their applications must be received at the Housing Office before May 10 for first semester housing; before November 10 for second semester housing; or before March 10 for summer session housing.

Requests for applications and for further information regarding married student housing should be made to the College Housing Office.

**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.

The Student Government of Clemson College, with full approval of the administration, offers a plan of accident and sickness insurance to full-time students.

Each year, prior to the beginning of the fall semester, complete information on this insurance plan will be sent to students.

**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.
GRADUATE SCHOOL INFORMATION

CHECK LIST ON GRADUATE SCHOOL PROCEDURES

In obtaining admission to the Graduate School, the following procedure is followed:

1. Letter of inquiry from prospective student to Graduate School or to Department Head.
2. Information and forms mailed to student by Graduate School.
3. Application forms, transcript, and Graduate Record Aptitude test scores received in the Graduate School Office. If graduate study will begin before the next Graduate Record testing date, the student may be admitted provisionally, pending receipt of a satisfactory score on this test.
4. Application information sent to Department Head for study.
5. Department Head and Dean of Graduate School act on student’s application and Dean notifies student.

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

1. Select in consultation with the appropriate Department Head a major adviser and/or an advisory committee. (See page 24.)
2. Submit Plan for Graduate Study (G. S. Form 2) (See page 21.)
3. If necessary, submit request for changes in Plan for Graduate Study. (See page 21.)
4. Satisfy any prescribed foreign language examination and other qualifying examinations prerequisite to admission to candidacy. (See page 23.)
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 22.)
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 23.)
7. Submit completed thesis to advisory committee chairman and arrange for final examination by the advisory committee. (See page 22.)
CLEMSON COLLEGE

8. Pay binding fee to the Bursar and submit abstracts and approved copies of thesis to the Dean of the Graduate School. (See page 23.)

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

REGULATIONS AND PROCEDURES

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.

Except as they apply to undergraduate students only, graduate students are subject to the usual procedures and regulations of the College and to such Graduate School rules and procedures as are outlined on the following pages.
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, Chemical Engineering, Chemistry, Civil Engineering, Dairy, Electrical Engineering, Entomology, Horticulture, Mathematics, Mechanical Engineering, Nuclear Engineering, Physics, Plant Pathology, Poultry, Textile Chemistry, Water Resources Engineering, 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 teaching, and in Industrial Education.

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

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

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 head of the Department of Secondary Education 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 satisfactory 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.

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 department head recommends admission on the basis of a general review of the student’s record; (b) 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; or who have not taken the Graduate Record tests.

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). The Graduate Record aptitude tests may with approval be taken after enrollment in classes.
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 work of fragmentary character taken over a long period of years, or work completed many years before the student becomes a degree candidate will not be accepted as satisfying the requirements of residence. Students who find it necessary to interrupt their program of study for a period longer than a summer vacation should, before departure, leave with the Graduate Office a statement of the reason for interruption, mailing address, and expected date of return.

**Visiting Scholars.** Visiting professors from other institutions, post-doctorate fellows, and other visiting scholars who have attained doctoral status or the equivalent may attend classes as visitors without payment of fees. This privilege will be granted upon approval of the head of the department in which the work will be done and approval of the Dean of the Graduate School. Registration is to be made without payment of fees, and no credit is given for courses attended. Persons in this category who wish to use credit toward a degree at Clemson or elsewhere must register as regular graduate students and pay the appropriate fee.

**Graduate Record Examinations.** As indicated under “Admission to the Graduate School,” applicants for admission to a degree pro-

*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.
gram 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 five times each year, usually in January, March, April, July, and November. The test is given at Clemson November 18, 1961, April 28, 1962, and July 7, 1962.

Students desiring to take the test should request from the Graduate School a booklet of information concerning the Aptitude Test of the Graduate Record Examinations and an application blank. The completed application form, together with the examination fee, should reach the Educational Testing Service about a month in advance of the actual test date.

On his application for the Aptitude Test, the prospective student should indicated 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 Master's degrees and as many as 48 credits toward a Doctor's degree.

No credit will be granted toward either the Master's or Doctor's 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. Each graduate student, when so advised by his major professor, shall 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 quintuplicate 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 graduate 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 Physics, Mathematics, or Water Resources Engineering, 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

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*Multilithed copies are as a rule acceptable. Graduate School approval should be obtained in advance.*
School at least one week prior to the date on which the degree is conferred. A binding fee of $9 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. 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 four copies of an abstract of his thesis which must be submitted 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.

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 $3.25 (or $6.75 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 Dean of the Graduate School, 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 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

*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 courses.
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 ENGINEERING

To receive the Master of Science degree in Nuclear Engineering 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. The required courses will be:

- Chemistry 491 Introduction to Radiochemistry 3 cr.
- Mathematics 403-404 Statistics and Fourier Series 6 cr. and 508
- Nuclear Engineering 501 and 502 Reactor Engineering 6 cr.
- Physics 451, 452 Modern and Nuclear Physics 7 cr. and 453

If any of the above courses have 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.

**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 IN SECONDARY EDUCATION**

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. At least six and not more than twelve hours in Education.
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. The candidate's final examination may be oral and/or written.

**ADDITIONAL REQUIREMENTS FOR MASTER OF EDUCATION DEGREE FOR INDUSTRIAL EDUCATION TEACHERS**

This degree is offered only to experienced teachers of Industrial Education. 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 this degree will consist of a minimum of thirty-three semester hours, distributed as follows:

1. Twelve hours in Industrial Education.
2. A minimum of nine hours in Education.
3. A minimum of six hours in a related field.

All other regular requirements of the Graduate School for the Master of Science will be met.

**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.** Shortly after 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 heads of these departments in consultation with the student will recommend to the Graduate Dean for approval and formal appointment an advisory committee composed of at least five professors. One member of the commit-
tee 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 on page 24 of 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.

**COURSES OF STUDY**

A graduate student is defined as one who has been admitted to advanced study beyond the Bachelor’s degree.

The branch of learning to which a graduate student devotes the greater part of his time and effort is termed his “major.” Any subject of advanced nature selected with reference to its bearing upon the major or to the broadening of the student's training is known as the “minor.” Other subjects taken by a graduate student to meet technical requirements or for any other reason are termed supporting subjects. The credits earned for supporting courses do not count toward the attainment of an advanced degree.

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 or permission of the instructor.
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 504—WATER RESOURCE POLICIES—3 cr. (3 and 0)
A study of economic and legal aspects of the control, use, development, and management of water resources.
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.

*May be used for graduate credit under special conditions only.
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 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 the 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.
(See also courses listed under Economics.)

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 465—PROGRAM PLANNING IN AGRICULTURAL EDUCATION—3 cr. (3 and 0)

Ag Ed 501—RECENT DEVELOPMENTS IN THE TECHNOLOGY OF AGRICULTURE—3 cr. (2 and 3)
An analysis and appraisal of the experimental findings and successful farming practices 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 the animal sciences.

Ag Ed 504—SPECIAL PROBLEMS—3 cr. (2 and 3)
Planning, conducting and reporting a special problem in agricultural education appropriate to the need of the student.

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)
Principles and practices appropriate to the solution of problems in developing and conducting instructional programs for young farmers.

Ag Ed 525—SUPERVISION OF STUDENT TEACHING—3 cr. (3 and 0)
Major emphasis is placed upon the following: (1) developing a philosophy of teacher education; (2) analyzing the present teacher training program in South Carolina, to discover problem situations to 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. Prerequisite: Experience in agricultural education and permission of the instructor.

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

AGRICULTURAL ENGINEERING
T. V. Wilson, Chairman

Courses are offered leading to the Master of Science degree.

*AgE 352—FARM POWER—3 cr. (2 and 3)
*AgE 360—FARM AND HOME UTILITIES—3 cr. (2 and 3)

*May be used for graduate credit under special conditions only.
AgE 401—SOIL AND WATER CONSERVATION ENGINEERING—3 cr. (2 and 3)
AgE 402—DRAINAGE AND IRRIGATION—3 cr. (2 and 3)
AgE 406—ADVANCED AGRICULTURAL MACHINERY—3 cr. (2 and 3)
AgE 433—AGRICULTURAL PROCESS ENGINEERING—3 cr. (2 and 3)
AgE 452—FARM STRUCTURES DESIGN—3 cr. (2 and 3)
AgE 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.

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

A course dealing with the unit operations 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.

AgE 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:** AgE 406 or equivalent.

AgE 522—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:** AgE 401, 402 or by special permission.

AgE 582—GINNING ENGINEERING—3 cr. (2 and 3)

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. **Prerequisite:** AgE 406 or equivalent.

AgE 591—RESEARCH—3 cr.
AgE 592—RESEARCH—3 cr.
AGRONOMY

U. S. Jones, Chairman

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

*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. (1 and 6)

Agron 401—CROP AND SEED LABORATORY—1 cr. (0 and 3)
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—NUTRITION OF CROPS—3 cr. (3 and 0)
    Deals with the relationship existing between the physical and chemical properties of the various nutrient elements and their absorption and utilization by plants.
Agron 502—PEDOLOGY AND SOIL CLASSIFICATION—3 cr. (3 and 0)
    Deals 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—CROP PRODUCTION—3 cr. (3 and 0)
    An advanced analysis of the factors affecting the growth and reproduction of crops. Special emphasis is given to important field crops.
Agron 504—PLANT BREEDING AND GENETICS—3 cr. (3 and 0)
    Concepts and principles of plant breeding and genetics as applied to the development and maintenance of improved crop varieties. Theoretical considerations of the various breeding methods are emphasized.
Agron 505—SOIL FERTILITY—3 cr. (3 and 0)
    A study of the essential nutrients in the soil-plant system with emphasis on mechanisms of retention and transport; supplies and availability; re-

*Courses which may be used by students majoring in other fields.
actions and interactions; deficiency diagnosis and remedies. Concepts and techniques for evaluating soil fertility problems will be studied.

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 508—SOIL CHEMISTRY—3 cr. (2 and 3)
Principles and theories concerning the structure and chemical properties of soil colloids, ionic exchange and membrane phenomena, chemical equilibria, soil acidity, oxidation-reduction relations, soil chemistry of plant nutrients.

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 401—BEEF PRODUCTION—3 cr. (3 and 0)
AH 403—BEEF PRODUCTION LABORATORY—1 cr. (0 and 3)
AH 408—PORK PRODUCTION—3 cr. (3 and 0)
AH 410—PORK PRODUCTION LABORATORY—1 cr. (0 and 3)
AH 452—ANIMAL BREEDING—3 cr. (3 and 0)
AH 502—TOPICAL PROBLEMS—1-3 cr. (1-3 and 0)
A critical study of Animal Husbandry experiments and 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)
Gene and zygotic frequency; systems of mating; heritabilities; genetic consequences of selection; and criteria for evaluating improvement in beef cattle, swine, and sheep. Prerequisite: AH 452

AH 505—NUTRITION OF MEAT ANIMALS—3 cr. (3 and 0)
Deals 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. **Prerequisite:** Dairy 403

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. (3 and 0)
- Seminar discussion and creative writing concerning questions of function, structure and beauty in historic and contemporary architecture.

Arch 512—HISTORY SEMINAR II—3 cr. (3 and 0)
- Continuation of Arch 511.

Arch 515—STRUCTURAL SEMINAR I—3 cr. (2 and 3)
- An advanced comparative analytical study of contemporary structural systems and the materials utilized therein. Discussion and laboratory work.

Arch 516—STRUCTURAL SEMINAR—3 cr. (2 and 3)
- Continuation of Arch 515. A terminal report with adjunct studies will be required.

Arch 551—PLANNING & HOUSING SEMINAR I—3 cr. (2 and 3)
- Discussion of problems of urban design and housing. Special research topics will be assigned.

Arch 552—PLANNING & HOUSING SEMINAR II—3 cr. (2 and 3)
- Continuation of Arch 551, with the requirement of a final term paper or planning study.

Arch 561—GRADUATE ARCHITECTURAL DESIGN—9 cr. (3 and 18)
- Project work oriented to the individual student in advanced areas of architectural design and arranged to develop the creative capacities of mature graduate students.

Arch 592—GRADUATE THESIS—9 cr. (3 and 18)
- 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 normally required, although in special cases, the presentation may take one form.

**BACTERIOLOGY**

W. M. Epps, Chairman

Courses are offered leading to the Master of Science degree.

*Bact 312—FOOD MICROBIOLOGY—3 cr. (2 and 3)

*May be used for graduate credit under special conditions only.
Bact 401—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)
The history of determinative bacteriology and the basic morphological, cultural, and physiological differences used in distinguishing between the various taxonomic groups of bacteria. Opportunity is given in the laboratory to isolate and identify bacteria from natural sources. **Prerequisites:** Bact 301, 401, and organic chemistry.

Bact 502—BACTERIOLOGICAL TECHNIC—4 cr. (2 and 6)
Methods of preparing special equipment for use in the bacteriological laboratory, sterilization by filtration, isolation of viruses, immunological procedures, and the experimental infection of animals. Designed to give students experience in more advanced methods of investigation. **Prerequisites:** Bact 301, 401, 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, aero-, anaerobiosis, nutrition of bacteria and degradation of proteins, carbohydrates, and fats. **Prerequisites:** Bact 301, 401.

Bact 510—SOIL MICROBIOLOGY—3 cr. (2 and 3)
Characterization and ecology of soil microorganisms. Interrelations of soil microbial populations; associative and antagonistic effects. Effect of soil microorganisms on plant growth. Relations of plant rhizospheres to nutritional groups of microorganisms. **Prerequisite:** Bact 410.

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

**BOTANY**

W. M. Epps, Chairman

The Master of Science and the Doctor of Philosophy degrees are offered in Plant Pathology.

*Bot 352—PLANT PHYSIOLOGY—4 cr. (3 and 3)
*Bot 356—TAXONOMY—3 cr. (1 and 6)

*May be used for graduate credit under special conditions only.
Bot 401—PLANT PATHOLOGY—3 cr. (2 and 3)
Bot 404—CYTOLOGY—4 cr. (3 and 3)
Bot 451—MORPHOLOGY OF THE FUNGI—3 cr. (2 and 3)
Bot 455—PLANT MORPHOLOGY—4 cr. (2 and 6)
Bot 501—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 deter-
   minations of osmotic quantities, hydrogen ion concentration, and metabolic
   processes. Prerequisites: Bot 352; Chem 101, 102; Phys 201, 202, 203, 204.
Bot 502—MYCOLOGY—3 cr. (2 and 3)
   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, stu-
   dent reports, and laboratory work. Prerequisites: Bot 356, 451.
Bot 503 PLANT PATHOLOGY—4 cr. (3 and 3)
   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 "problem" 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 352,
   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 cr. (2 and 0)
   A theoretical and practical coverage of all aspects of plant disease control.
   Laboratory facilities are available for qualified students to conduct spe-

**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.
Clemson College specialized investigations in plant disease control. **Prerequisites:** Bot 401, Organic Chemistry.

Bot 591—RESEARCH—3 cr.
Bot 592—RESEARCH—3 cr.

**CERAMIC ENGINEERING**

**G. C. Robinson, Chairman**

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

CrE 402—SOLID STATE CERAMICS—3 cr. (3 and 0)
CrE 403—GLASSES—3 cr. (3 and 0)
CrE 404—ENAMELS—3 cr. (3 and 0)
CrE 410—GLASS MANUFACTURE—3 cr. (3 and 0)
CrE 412—RAW MATERIAL PREPARATION—3 cr. (3 and 0)
CrE 416—CEMENT, LIME AND PLASTER—3 cr. (3 and 0)
CrE 418—PROCESS CONTROL—3 cr. (3 and 0)
CrE 419—PHYSICAL CERAMICS—3 cr. (3 and 0)
CrE 420—PHYSICAL CERAMICS—3 cr. (3 and 0)
CrE 501—ANALYTICAL PROCEDURES AND EQUIPMENT—3 cr.
   (2 and 3)
   The use and application of the X-ray, spectograph, and electron microscope in ceramics.
CrE 502—SILICATE CRYSTALLOGRAPHY—3 cr. (3 and 0)
   The basic laws of chemical crystallography and their application to the structure of silicate minerals.
CrE 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.
CrE 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.
CrE 505—DRYING—3 cr. (2 and 3)
   Drying fundamentals, drying problems, and dryer design.
CrE 506—FIRING—3 cr. (2 and 3)
   Fuels, combustion, heat transfer, firing problems, and firing equipment.
CR 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 591—RESEARCH—3 cr.
CR 592—RESEARCH—3 cr.

CHEMICAL ENGINEERING  
C. E. Littlejohn, Chairman

Courses are offered leading to the Master of Science degree.

ChE 401—PRINCIPLES OF CHEMICAL ENGINEERING—3 cr. (3 and 0)  
ChE 406—INDUSTRIAL CHEMICAL CALCULATIONS—2 cr. (2 and 0)  
ChE 407—UNIT OPERATIONS—2 cr. (0 and 6)  
ChE 409—PLANT DESIGN—2 cr. (0 and 6)  
ChE 415—INTRODUCTION TO NUCLEAR ENGINEERING I—3 cr.  
(3 and 0)  
ChE 416—INTRODUCTION TO NUCLEAR ENGINEERING II— 3 cr.  
(3 and 0)  
ChE 421—DIMENSIONAL ANALYSIS AND THE THEORY OF MODELS—  
2 cr. (2 and 0)  
ChE 423—BIO-OXIDATION PROCESSES—2 cr. (2 and 0)  
ChE 430—CHEMICAL ENGINEERING THERMODYNAMICS—3 cr.  
(3 and 0)  
ChE 451—CHEMICAL ENGINEERING KINETICS—2 cr. (2 and 0)  
ChE 452—MOLECULAR AND TURBULENT TRANSPORT—3 cr. (3 and 0)  
ChE 501—MOMENTUM AND HEAT TRANSFER—3 cr. (3 and 0)  
Development of momentum and heat transfer from a theoretical viewpoint and the simplifications and approximations necessary to obtain solutions for specific cases. Presentation of the elements of boundary layer theory and comparison with other theoretical and semi-theoretical approaches to the problems of fluid mechanics and heat transfer.

ChE 502—MASS TRANSFER—3 cr. (3 and 0)  
An advanced study of Mass Transfer, considering particularly diffusion and the other mechanisms of Mass Transfer. Some application is made to Gas Absorption and Liquid-liquid Extraction.
ChE 504—CHEMICAL ENGINEERING THERMODYNAMICS—3 cr. (3 and 0)
Advanced topics in Chemical Engineering Thermodynamics including equilibria of physical and chemical systems, generalized properties of hydrocarbons and the application of thermodynamic methods in the design of equipment.

ChE 505—CHEMICAL ENGINEERING KINETICS—3 cr. (3 and 0)
An advanced treatment of the kinetics of chemical reactions, particularly in the design and operation of chemical reactors.

ChE 506—CHEMICAL ENGINEERING CALCULATIONS I—3 cr. (3 and 0)
Design and analysis of chemical engineering experiments. The interpretation of data and the limitations involved in obtaining and reproducing results obtained from physical and chemical processes.

ChE 507—CHEMICAL ENGINEERING CALCULATIONS II—3 cr. (3 and 0)
Emphasis is given to the mathematical formulation of chemical engineering problems, particularly in the area of steady and unsteady-state transport phenomena, along with the methods of solution of such problems.

ChE 508—CHEMICAL ENGINEERING DESIGN AND ANALYSIS—3 cr. (1 and 6)
Design and analysis of chemical process equipment through the solution of comprehensive problems involving unit operations, kinetics, thermodynamics, strength of materials, and chemistry.

ChE 509—WASTE TREATMENT—3 cr. (3 and 0)
Basic biochemical principles underlying bio-oxidation and their applications in activated sludge and trickling filter processes: basic theory of oxygen transfer and its application to aeration equipment; and the design of typical industrial waste treatment processes.

ChE 510—BIOCHEMICAL ENGINEERING—3 cr. (3 and 0)
Principles of biochemical reaction systems and their applications in the chemical process industries. Enzyme systems, their sources, essential characteristics, and employment in commercial chemical production (Fermentation). Certain related topics (i.e., biological waste disposal, protein technology, etc.) introduced for illustration.

ChE 511—SEMINAR—0 to 2 cr.
Graduate seminar on selected chemical engineering subjects. May be repeated for credit.

ChE 591—RESEARCH—3 cr.
ChE 592—RESEARCH—3 cr.
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 three fields of chemistry — analytical, 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.

Qualifying examinations are required in each of the four fields of chemistry. In lieu of these examinations, graduate credit in certain courses provides proof of competence in the field. A list of these courses may be obtained from the department.

A comprehensive examination will be given in the major field. This examination will consist of a written examination, followed one week later by an oral examination.

No student may take the comprehensive examination prior to completion of the language requirement.

*Chem 310—AGRICULTURAL BIOCHEMISTRY—4 cr. (3 and 3)
*Chem 323—ELEMENTARY ORGANIC CHEMISTRY—5 cr. (3 and 6)
*Chem 324—ELEMENTARY ORGANIC CHEMISTRY—5 cr. (3 and 6)
*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)

*Courses which may be used by students majoring in other fields.
*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—4 cr. (3 and 3)
Chem 424—GENERAL BIOCHEMISTRY—4 cr. (3 and 3)
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 505—INORGANIC CHEMISTRY—3 cr. (3 and 0)

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

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

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 physico-chemical methods. Prerequisites: Chem 331 and 332 or 520 and 531.

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

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.

Chem 521—ORGANIC CHEMISTRY I—3 cr. (3 and 0)

A general survey of organic chemistry with special attention given to the general types of organic reactions and to important processes. Lectures are supplemented by assigned problems and reports on current organic literature which are discussed during a weekly conference.

Chem 522—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 aromatic.

*Courses which may be used by students majoring in other fields.
Chem 524—FUNDAMENTAL PRINCIPLES OF POLYMER CHEMISTRY—
3 cr. (3 and 0)
The organic chemistry of natural and synthetic macromolecules.

Chem 525—CURRENT TOPICS IN ORGANIC CHEMISTRY—1 cr.
(1 and 0)
A discussion by faculty and students of recent developments in the field of organic chemistry. (May be taken more than one semester)

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 sufficiently well grounded previously in this phase of the subject. Prerequisites: Courses in qualitative analyses, organic chemistry, and a working knowledge of integral calculus.

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

Chem 532—PHYSICAL CHEMISTRY II—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 533—CHEMICAL THERMODYNAMICS—3 cr. (3 and 0)
Primarily a study of classical thermodynamics, with emphasis on theory and significance of energetics, and on systems of variable composition. Prerequisites: Chem 530, or Chem 331 or its equivalent.

Chem 534—CHEMICAL THERMODYNAMICS—3 cr. (3 and 0)
A treatment of statistical thermodynamics. Prerequisites: Chem 530 and Chem 531.

Chem 535—CHEMICAL KINETICS—3 cr. (3 and 0)
A study of rate processes and reaction mechanisms. Topics such as the following are treated: Order of reaction, theory of rate processes, relation of reaction rates to mechanism, homogeneous and heterogeneous catalysis, experimental methods, chain reactions, diffusion, and the effects of solvent, temperature and pressure on reaction rates and mechanisms. Lectures are supplemented by assigned problems, and a paper and oral examination of a topic of special interest to the individual student.

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 molecules. Major emphasis will be given to studying the relationship of structure to physical and chemical properties with examples drawn from both the organic and inorganic fields.

Chem 551-552—SEMINAR—0, 1, or 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. Prerequisite: Chem 622 or permission of the instructor.

Chem 624—CURRENT TRENDS IN ORGANIC CHEMISTRY—1 cr. (1 and 0)
   A study of current trends and developments in organic chemistry.

Chem 625—CHEMISTRY OF NATURAL PRODUCTS—3 cr. (3 and 0)
   A continuation of Chem 623.

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)
   Designed to perfect the laboratory technique of the advanced graduate students. 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

L. G. Rich, Chairman

Courses are offered leading to the Master of Science degree.

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 413—SANITATION CONTROLS—3 cr. (2 and 3)
CE 414—SOIL MECHANICS—3 cr. (2 and 3)
CE 434—CONSTRUCTION COSTS AND ESTIMATES—3 cr. (2 and 3)
CE 452—ADVANCED STRUCTURAL ANALYSIS—2 cr. (2 and 0)

CE 501—STRUCTURAL ENGINEERING I—3 cr. (2 and 3)
Analysis of statistically indeterminate structures including secondary stresses and rigid frames.

CE 502—STRUCTURAL ENGINEERING II—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—2 or 3 cr.
(2 and 0 or 3 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 303—CHEMICAL AND PHYSICAL NATURE OF MILK—3 cr.
(2 and 3)

*Dairy 307—MARKET MILK—3 cr. (2 and 3)

*Courses which may be used by students majoring in other fields.
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 458—ARTIFICIAL INSEMINATION OF FARM ANIMALS—3 cr.
   (2 and 3)
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 ana-
   lyzing herds as aids to selection.
Dairy 503—PHYSIOLOGY OF REPRODUCTION AND MILK SECRETION
   —3 cr. (3 and 0)
   The influence of the endocrine glands on reproduction and on milk
   secretion.
Dairy 504—ENDOCRINOLOGY—3 cr. (3 and 0)
   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 DAIRY NUTRITION—3 cr.
   (3 and 0)
   The application of the latest information on digestion, metabolism, and
   the nutritional requirements of dairy cattle.
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, manu-
   facturing, and management.
Dairy 591—RESEARCH—3 cr.
Dairy 592—RESEARCH—3 cr.
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 404—COMPARATIVE ECONOMIC SYSTEMS—3 cr. (3 and 0)
Econ 406—BUSINESS FLUCTUATIONS—3 cr. (3 and 0)
Econ 407—NATIONAL INCOME AND EMPLOYMENT ANALYSIS—3 cr. (3 and 0)
Econ 412—INTERNATIONAL TRADE—3 cr. (3 and 0)
Econ 416—DEVELOPMENT OF THE MODERN ECONOMY—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)
Econ 500—ADVANCED ECONOMIC ANALYSIS—3 cr. (3 and 0)
   An extensive and critical examination of demand and supply, and marginal analysis. Some consideration is given to linear programming as an analytical tool in solving economic problems.
Econ 510—SEMINAR IN ECONOMIC ANALYSIS—3 cr. (3 and 0)
   Topics chosen to give the students experience in the analysis of actual economic problems and to develop the student's proficiency in economic analysis, research, and writing.
Econ 512—SEMINAR IN THE DEVELOPMENT OF ECONOMIC THOUGHT—3 cr. (3 and 0)
   Intensive study of selected topics concerning the historical development of economic ideas, doctrines, and theories. Students are expected to conduct original research in areas related to the topic of the seminar.
Econ 521—ECONOMIC THEORY I—3 cr. (3 and 0)
   A study of the use of theory in the analysis of problems and behavior of industries, firms, and consumers.
Econ 522—ECONOMIC THEORY II—3 cr. (3 and 0)
   A study of macroeconomic theory involving static and dynamic models and their use in the analysis of economic problems and policies. Also, a survey of welfare economics.
Courses are offered leading to the Master of Education degree with subject specialties in English, History and Government, or Science Teaching.

Ed 494T—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)
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 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 530—TECHNIQUES OF SUPERVISION—THE PUBLIC SCHOOLS—3 cr. (3 and 0)
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.

Ed 553—ADOLESCENT PSYCHOLOGY—3 cr. (3 and 0)
The development of the individual through the transitional stages between childhood and the adult years. Particular consideration will be given to the areas of intellectual, emotional, moral, and social maturity.

Ed 557—TEACHING OF REMEDIAL READING IN JUNIOR AND SENIOR HIGH SCHOOL—3 cr. (3 and 0)
Methods of determining reading levels of individuals. Methods of instruction for increasing reading ability; materials for secondary school reading programs.
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)**
Expressly designed for high school teachers. Lectures, demonstrations, and practical laboratory exercises are presented on an advanced level. Particular attention is given to the Vertebrata and the higher plant Phyla.

**Chem 450T—REVIEW OF GENERAL CHEMISTRY I—3 cr. (3 and 0)**
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)

Phys 501T—PHYSICS FOR HIGH SCHOOL TEACHERS I—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. 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)
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 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—I cr. (0 and 3)
EE 436—RADIATION AND WAVE PROPAGATION—3 cr. (3 and 0)
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 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 520—ELECTRONIC CIRCUITS—4 cr. (3 and 3)
Applications of tunnel diodes, masers, parametric amplifiers, and other recent developments in the field of electronics.
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.
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 in-
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.

EM 401—FLUID MECHANICS—3 cr. (3 and 0)
EM 403—FLUID MECHANICS LABORATORY—1 cr. (0 and 3)
EM 450—MECHANICAL VIBRATIONS—3 cr. (3 and 0)
EM 460—HYDROLOGY—2 or 3 cr. (2 or 3 and 0)
EM 462—WATER POWER ENGINEERING—2 or 3 cr. (2 or 3 and 0)
EM 464—FLOW IN OPEN CHANNELS—2 or 3 cr. (2 or 3 and 0)
EM 470—EXPERIMENTAL STRESS ANALYSIS—3 cr. (2 and 3)
EM 501—EXPERIMENTAL STRESS ANALYSIS—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: EM 304 and permission of instructor. Student may not receive credit for this course and EM 470.

EM 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: EM 304.

EM 503—THEORY OF ELASTICITY—3 cr. (3 and 0)

Analysis of stress, strain, and stress-strain relationship; stress functions; strain energy; two-dimensional problems in rectangular, polar, and curvilinear coordinates; torsion of prismatic bars, thermal stresses, and other applied problems. Prerequisites: EM 304, Math 306, and permission of the instructor.
EM 506—FLUID MECHANICS—3 cr. (3 and 0)
A 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:** EM 401.

EM 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:** EM 460.

EM 509—HYDROLOGY—3 cr. (3 and 0)
The principles concerning the occurrence of natural water and engineering, practices in dealing with it in the design of facilities for water supply, flood control, power development and other purposes. Also required is the conduct of an individual investigation and the preparation of a report of findings. **Prerequisite:** EM 401. A student may not receive credit for this course and EM 460.

EM 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:** EM 460.

EM 512—HYDRAULIC PROJECTS—3 cr. (3 and 0)
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:** EM 460, 464; must be accompanied or preceded by EM 506.

EM 591—RESEARCH—3 cr.
EM 592—RESEARCH—3 cr.

ENGLISH

H. M. Cox, Chairman

The department offers courses in support of the Master of Education program and as a minor for students majoring in other areas but does not at present award advanced degrees. Students who expect graduate credit in English should present at least six 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)
Engl 505—SEMINAR IN ENGLISH LITERATURE I—3 cr. (3 and 0)
An intensive study of a selected group of major British writers.
Engl 506—SEMINAR IN ENGLISH LITERATURE II—3 cr. (3 and 0)
Conducted on the same plan as Engl 505 with a different group of writers.

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.

*May be used for graduate credit under special conditions only.
**Ent 405 and 408 are taught in alternate years.
Ent 560—PRINCIPLES OF INSECT CONTROL—3 cr. (3 and 0)
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)
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—3 cr. (3 and 0)
Hist 406—AMERICAN ECONOMIC DEVELOPMENT—3 cr. (3 and 0)
Hist 408—INTERNATIONAL RELATIONS SINCE 1914—3 cr. (3 and 0)
Hist 410—HISTORY OF COLONIAL AMERICA—3 cr. (3 and 0)
Hist 411—UNITED STATES, 1783-1850—3 cr. (3 and 0)
Hist 412—UNITED STATES, 1850-1900—3 cr. (3 and 0)
Hist 413—UNITED STATES SINCE 1900—3 cr. (3 and 0)
Hist 501—SEMINAR IN SOUTH CAROLINA HISTORY—3 cr. (3 and 0)
Hist 502—SEMINAR IN UNITED STATES ECONOMIC HISTORY—3 cr. (3 and 0)

HORTICULTURE

T. L. Senn, Chairman

Courses are offered leading to the Master of Science degree.

*Hort 308—LANDSCAPE DESIGN—3 cr. (2 and 3)
*Hort 310—FLORICULTURE—3 cr. (2 and 3)
*Hort 352—COMMERCIAL POMOLOGY—3 cr. (2 and 3)
Hort 405—NUT TREE CULTURE—2 cr. (2 and 0)
Hort 406—NURSERY TECHNOLOGY—3 cr. (2 and 3)
Hort 407—LANDSCAPE DESIGN—3 cr. (2 and 3)
Hort 412—TURF MANAGEMENT—3 cr. (2 and 3)
Hort 451—SMALL FRUIT CULTURE—3 cr. (2 and 3)
Hort 456—TRUCK CROPS—3 cr. (2 and 3)
Hort 460—LANDSCAPE DESIGN—5 cr. (3 and 6)
Hort 464—FOOD PRESERVATION—3 cr. (2 and 3)

*May be used for graduate credit under special conditions only.
Hort 468—INTRODUCTION TO RESEARCH—2 cr. (1 and 3)

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.

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 504—SCIENTIFIC ADVANCES IN ORNAMENTAL HORTICULTURE—3 cr. (3 and 0)
Discussions on topics from current scientific periodicals and on other research and developments in ornamental horticulture.

Hort 505—QUALITY CONTROL FOR HORTICULTURAL CROPS—3 cr. (2 and 3)
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 506—POST-HARVEST HANDLING OF HORTICULTURAL CROPS—3 cr. (2 and 3)
Principles, developments, and application of research findings dealing with post-harvest handling of horticultural crops are emphasized. A concept of quality is formed through a study of the factors affecting physical and biological changes occurring in horticultural crops after harvest.

Hort 507—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 352.

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 509—SEMINAR I—1 cr. (1 and 0)
A review of current topics in horticulture with special emphasis on the preparation, organization, and presentation of material by the students.

Hort 510—SEMINAR II—1 cr. (1 and 0)
A continuation of Hort 509.

Hort 591—RESEARCH—3 cr.
Hort 592—RESEARCH—3 cr.
INDUSTRIAL EDUCATION
Everett Laitala, Chairman

Courses are offered leading to the Master of Education degree.

In Ed 421—COORDINATION METHODS IN VOCATIONAL EDUCATION—2 cr. (2 and 0)
In Ed 446T—SHOP PLANNING AND LAYOUT—3 cr. (3 and 0)
In Ed 496T—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)
  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 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 591—RESEARCH IN INDUSTRIAL EDUCATION—3 cr.
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. Courses selected for a major or minor must have the approval of the adviser in the Department of Mathematics prior to registration in these courses.

A reading knowledge of French, German, or Russian is required for the Master's degree in Mathematics. This requirement should be met as early in the student's program as is possible.

*Math 302—THEORY OF EQUATIONS—3 cr. (3 and 0)
*Math 306—DIFFERENTIAL EQUATIONS—3 cr. (3 and 0)
*Math 307—ELEMENTARY PARTIAL DIFFERENTIAL EQUATIONS—3 cr. (3 and 0)

*May be used for graduate credit under special conditions only.
*Math 309—THEORY OF APPROXIMATIONS—3 cr. (2 and 3)
*Math 310—PROGRAMMING THE DIGITAL COMPUTER—2 cr. (1 and 3)
*Math 311—INTRODUCTION TO MODERN ALGEBRA—3 cr. (3 and 0)
Math 402—THEORY OF PROBABILITY—3 cr. (3 and 0)
Math 403—MATHEMATICAL STATISTICS I—3 cr. (3 and 0)
Math 404—MATHEMATICAL STATISTICS II—3 cr. (3 and 0)
Math 451—VECTOR ANALYSIS—3 cr. (3 and 0)
Math 453—ADVANCED CALCULUS I—3 cr. (3 and 0)
Math 454—ADVANCED CALCULUS II—3 cr. (3 and 0)

To be eligible for enrollment in a 500-series course, a student must have completed Math 453 and 454 or have the permission of the instructor.

Math 502—DETERMINANTS AND MATRICES—3 cr. (3 and 0)
Topics include determinants, polynomials and forms, transformations, system of linear equations.

Math 503—THEORY OF FUNCTIONS OF COMPLEX VARIABLES I—3 cr. (3 and 0)
A basic course in analysis. The topics include differentiation and integration of analytic functions, power series, residues, contour integration, analytic continuation, and conformal mapping. Prerequisite: Math 454.

Math 504—THEORY OF FUNCTIONS OF COMPLEX VARIABLES II—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 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.

*May be used for graduate credit under special conditions only.
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 515—PROJECTIVE GEOMETRY—3 cr. (3 and 0)
Pure geometry relating to properties unaltered by processes of projection and section. Principal topics include: Duality; Theorems of Desargues, Pascal, and Brianchon; Poles and Polars; Ruled Surfaces; and Involution.

Math 520—RESEARCH TECHNIQUES—3 cr. (3 and 0)
Designed for students preparing for scientific research. Emphasis is placed upon formulation and statement of problems, manipulation of data, error analysis, and presentation of results. Specific topics include: Elements of the Scientific Method, Search of the Literature, Numerical Processes, Graphical Representation of Results, Mathematical Models, Analogue and Digital Computer Solutions, Preparation of Manuscripts and Abstracts.

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.

ME 401—FUNDAMENTALS OF MACHINE DESIGN—3 cr. (3 and 0)
ME 402—DESIGN OF MACHINE ELEMENTS—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 407—HEAT TRANSFER—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 I—1 cr. (0 and 3)
ME 414—MECHANICAL ENGINEERING LABORATORY II—1 cr. (0 and 3)
ME 416—ENGINEERING ANALYSIS I—1 cr. (0 and 3)
ME 417—ENGINEERING ANALYSIS II—1 cr. (0 and 3)
ME 421—INTERNAL COMBUSTION ENGINES—3 cr. (3 and 0)
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 464—LUBRICATION—2 cr. (2 and 0)

ME 501—ADVANCED AIR CONDITIONING—3 cr. (3 and 0)
An analysis of the principles of air conditioning. Among the topics covered are enthalpy 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 or equivalent.

ME 510—ADVANCED THERMODYNAMICS—3 cr. (3 and 0)
A critical review of the first and second laws, entropy, and general thermodynamic 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 512—BOUNDARY LAYER THEORY—3 cr. (3 and 0)
Fundamental concepts of viscosity, boundary layer, and separation. The Navier-Stokes equations; the momentum and energy equations for the boundary layer; exact solutions for special cases; approximate methods; thermal boundary layers. Prerequisites: Math 307 or 453 or equivalent.

ME 524—ADVANCED GAS POWER DYNAMICS—3 cr. (3 and 0)
A study of thermochemical reaction processes employing both the microscopic and macroscopic method of analysis. Detail study of the chemical reaction process and the associated effect of chemical dissociation in the field of thermal jets and rockets. Prerequisite. ME 411 or equivalent.

ME 532—APPLIED HEAT TRANSFER—3 cr. (3 and 0)
A 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 407 or 6 credits in heat transfer; Math 306 or equivalent.

ME 534—ADVANCED HEAT TRANSFER—3 cr. (3 and 0)
Physical properties; conduction, in simple bodies; convection with and without phase changes; radiation in simple systems; luminous and non-luminous gaseous radiation; applications. Prerequisites: ME 407 or 6 credits in heat transfer; Math 306 or equivalent.

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

NUCLEAR ENGINEERING

L. C. Adams, Chairman

Courses are offered leading to the Master of Science degree. In the main the graduate program includes courses from the departments of Chemistry, Mathematics and Physics. A description of the program is found on page —of this Bulletin.

NE 501—NUCLEAR REACTOR ENGINEERING I—3 cr. (3 and 0)
Reactor Theory and especially the engineering aspects thereof. Topics include Scope of Reactor Engineering, Reactions and Radiations, Steady State Theory, Dynamic Theory, Instrumentation, and Control. Prerequisite: Physics 451.

NE 502—NUCLEAR REACTOR ENGINEERING II—3 cr. (3 and 0)
A continuation of NE 501 with emphasis on materials of reactor engineering, radiation protection, shielding, and applications of nuclear energy in war and peace. Prerequisite: NE 501.

PHYSICS

L. D. Huff, Chairman

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

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. Language requirements: for Master of Science degree—reading knowledge of one modern foreign language; for Doctor of Philosophy degree—reading knowledge of two modern foreign languages as approved. It is suggested that these students select a minor in mathematics, chemistry or one of the branches of engineering. Students
may choose a thesis or a non-thesis program. A student choosing the non-thesis option will complete such special requirements as are assigned by department advisers.

*Phys 321—MECHANICS I—3 cr. (3 and 0)
*Phys 323—EXPERIMENTAL MECHANICS—1 cr. (0 and 3)
*Phys 332—GEOMETRICAL OPTICS AND INTRODUCTION TO PHYSICAL OPTICS—3 cr. (3 and 0)
*Phys 341—ELECTRICITY AND MAGNETISM—3 cr. (3 and 0)
*Phys 343—ELECTRICAL MEASUREMENTS—2 cr. (1 and 3)
*Phys 351—INTRODUCTION TO MODERN PHYSICS—3 cr. (3 and 0)
*Phys 353—MODERN PHYSICS LABORATORY—1 cr. (0 and 3)
Phys 421—MECHANICS II—3 cr. (3 and 0)
Phys 432—PHYSICAL OPTICS AND INTRODUCTION TO ATOMIC SPECTRA—3 cr. (3 and 0)
Phys 434—EXPERIMENTAL LIGHT—1 cr. (0 and 3)
Phys 441—ELECTRICITY AND MAGNETISM—3 cr. (3 and 0)
Phys 452—INTRODUCTORY NUCLEAR PHYSICS—3 cr. (3 and 0)
Phys 454—NUCLEAR PHYSICS LABORATORY—1 cr. (0 and 3)
Phys 455—MODERN PHYSICS II—3 cr. (3 and 0)
Phys 465—HEAT AND THERMODYNAMICS—4 cr. (4 and 0)
Phys 471—ELECTRON MICROSCOPY—3 cr. (2 and 3)
Phys 505—SPECIAL PROBLEMS—3 cr. (0 and 9)

A special course for physics graduate students who have chosen the non-thesis optional curriculum. Emphasis will be on methods in research. This course requires the completion of a problem which demonstrates a basic knowledge of the application of research techniques.

Phys 513—THERMODYNAMICS AND STATISTICAL MECHANICS—3 cr. (3 and 0)


Phys 521—CLASSICAL MECHANICS I—3 cr. (3 and 0)

Dynamics of particles, variational principles and Lagrange’s equations,

*Courses which may be used by students majoring in other fields.
two body central force problems, dynamics of rigid bodies. Matrix formulations freely used.

Phys 522—CLASSICAL MECHANICS II—3 cr. (3 and 0)
Special relativity in classical mechanics, Hamilton's equations, canonical transformations, Hamilton-Jacobi theory, small oscillations.

Phys 541—ELECTRODYNAMICS—3 cr. (3 and 0)
The field theory of electromagnetism. Maxwell's equations and their application 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 phenomena is given.

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 phenomena.

Phys 551—INTRODUCTION TO QUANTUM MECHANICS—3 cr. (3 and 0)
The Schroedinger wave equation is used to solve some of the simpler problems of atomic physics. Emphasis is on physical interpretation of the results.

Phys 553—NUCLEAR PHYSICS I—3 cr. (3 and 0)
A study of selected topics in nuclear structure, nuclear forces and nuclear interaction processes. Shell structure, spins, and magnetic moments of nuclear particles.

Phys 554—NUCLEAR PHYSICS II—3 cr. (3 and 0)
High energy radiation processes, nuclear reactions including nuclear fission; scattering, natural and induced nuclear disintegration.

Phys 555—X-RAY DIFFRACTION—3 cr. (3 and 0)
A study of the properties of x-rays, the geometry of crystals and the theory of diffraction, experimental methods as applied to polycrystalline and single crystal specimens; order-disorder transformations, phase diagram determination and x-ray fluorescence analysis.

Phys 556—CRYSTALLOGRAPHY—3 cr. (3 and 0)
A systematic study of the external and internal symmetry of crystals as revealed by their physical properties.
Phys 575—SEMINAR IN CONTEMPORARY PHYSICS—1 or 2 or 3 cr. 
(1 or 2 or 3 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 585—COLLOQUIUM—1 cr. (1 and 0)
Selected topics. Required of all Physics graduate students each semester 
in residence.

Phys 591—RESEARCH—3 cr.

Phys 592—RESEARCH—3 cr.

Phys 622—HYDRODYNAMICS—3 cr. (3 and 0)
The mathematical theory of the motions of an ideal fluid including ef-
fects produced by moving submerged bodies; theory of waves, ripples and 
vortices; effects of viscosity.

Phys 651—QUANTUM MECHANICS I—3 cr. (3 and 0)
Review of wave mechanics; operator algebra and theory of representa-
tion; approximate methods for stationary problems; theory of scattering 
applied to atomic and nuclear problems.

Phys 652—QUANTUM MECHANICS II—3 cr. (3 and 0)
Continuation of Physics 651 including time dependent perturbations;
 radiation absorption and emission; relativistic quantum mechanics; intro-
duction to quantum electrodynamics.

Phys 655—ADVANCED MODERN PHYSICS I—3 cr. (3 and 0)
An application of quantum mechanics and relativity theory to selected 
topics of recent interest in physics; atomic and nuclear structure, radio-
activity and nuclear stability, molecular structure, and theory of solids are 
considered.

Phys 656—ADVANCED MODERN PHYSICS II—3 cr. (3 and 0)
A continuation of Physics 655. Topics of special interest to instructor and 
students will be considered.

Phys 666—RELATIVITY—3 cr. (3 and 0)
Gives 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 advance of the perihelion 
of Mercury (2) the bending of light rays in gravitational fields and (3) the 
gravitational shift of spectral lines.

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

PLANT PATHOLOGY
W. M. Epps, Chairman

Courses are offered leading to the Master of Science and Doctor of Phi-
losophy degrees. See Botany for a listing of courses available.
POULTRY
B. D. Barnett, Chairman

Courses are offered leading to the Master of Science degree.

*PH 352—POULTRY NUTRITION—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)

PH 501—POULTRY NUTRITION AND METABOLISM—3 cr. (2 and 3)
Nutrition of chickens and turkeys with emphasis on requirements for and metabolism of the various nutrients. Peculiarities of the fowl as compared with mammals will be emphasized. Laboratory techniques for quality control will be taught in laboratory section.

PH 502—AVIAN PHYSIOLOGY—3 cr. (2 and 3)
Physiology of birds with special emphasis on domesticated species. Processes, of ingestion, digestion, secretion, excretion, respiration, circulation and metabolism. Physiology of reproduction will receive special attention. Comparisons will be made with physiology of man and other mammals.

PH 504—POULTRY PATHOLOGY—3 cr. (1 and 6)
Causes, prevention and treatment of specific poultry diseases. The laboratory methods will cover bacteriology, virology, serology, histology and other clinical-biochemical methods in the diagnosis of poultry diseases.

PH 505—SEMINAR—1 cr. (1 and 0)
Report on special topics or original research by students, staff and visiting speakers.

PH 591—RESEARCH—3 cr.
PH 592—RESEARCH—3 cr.

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 COMMUNITY—3 cr. (3 and 0)

*Courses may be used by students majoring in other fields.
RS 461—RURAL LEADERSHIP—3 cr. (3 and 0)

RS 501—RURAL SOCIAL SYSTEMS—3 cr. (3 and 0)
   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)
Soc 407—SOCIOLOGICAL THEORY—3 cr. (3 and 0)
Soc 408—SOCIAL STRUCTURE—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 462.

TC 591—RESEARCH—3 cr.
TC 592—RESEARCH—3 cr.

**TEXTILE MANAGEMENT**

T. A. Campbell, 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 454—MOTION AND TIME STUDY—3 cr. (2 and 3)
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)

**WATER RESOURCES ENGINEERING**

L. G. Rich, Chairman

Courses are offered leading to the Master of Science degree.

Ag Ec 401—STATISTICS—3 cr. (2 and 3)
Ag Ec 504—WATER RESOURCES POLICIES—3 cr. (3 and 0)
Bact 406—SANITARY BACTERIOLOGY—4 cr. (3 and 3)
ChE 422—INDUSTRIAL WASTE TREATMENT—2 cr. (2 and 0)
ChE 423—THEORY OF BIO-OXIDATION PROCESSES—2 cr. (2 and 0)
CE 410—MUNICIPAL AND SANITARY ENGINEERING—3 cr. (2 and 3)
CE 413—SANITATION CONTROLS—3 cr. (2 and 3)
EM 464—FLOW IN OPEN CHANNELS—3 cr. (3 and 0)
EM 509—HYDROLOGY—3 cr. (3 and 0)
CE 541—SANITARY ENGINEERING ANALYSES—3 cr. (2 and 3)

Theory and application of advanced analytical methods employed in evaluating design parameters for sanitary engineering processes and effects of pollutants on the quality of surface waters.
CE 542—SANITARY ENGINEERING PROCESSES—3 cr. (3 and 0)
Theory and design of chemical and biological processes employed in sanitary engineering.

CE 543—UNIT OPERATIONS OF SANITARY ENGINEERING—3 cr.
(3 and 0)
Theory and design of unit operations employed in sanitary engineering treatment processes.

CE 589—SPECIAL PROBLEMS I—1-3 cr.
Research design problems may be assigned from the fields of structures, soil mechanics, or water resources engineering. Subject matter will vary with interests and experience of student and instructor.

CE 590—SPECIAL PROBLEMS II—1-3 cr.
Research design problems may be assigned from the fields of structures, soil mechanics, or water resources engineering. Subject matter will vary with interests and experience of student and instructor.

CE 591—RESEARCH—3 cr.

CE 592—RESEARCH—3 cr.

ZOOGOGY

J. H. Cochran, Chairman

Courses are offered leading to the Master of Science degree.

*Zool 302—VERTEBRATE EMBRYOLOGY—3 cr. (2 and 3)
Zool 403—PROTOZOOLOGY—3 cr. (2 and 3)
Zool 456—PARASITOLOGY—3 cr. (2 and 3)
Zool 501—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 study of animals in relation to their natural environment. Typical animal habitats are visited to study the animal life and the ocean, shore, lakes, streams, cultivated fields, woodlands, and mountains.

*May be used for graduate credit under special conditions only.
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—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 Entomol-
   ogy. 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

Zool 556—ECONOMIC ZOOLOGY—3 cr. (2 and 3)
   A study of all phylla (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.