1963

Clemson Graduate School Catalog, 1963-1964

Clemson University

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CLEMSON

1963-1964
Clemson College

Record

Announcements of

The Graduate School

For

1963 - 1964

Published quarterly by Clemson College, Clemson, South Carolina.
Second-class postage paid at Clemson, South Carolina.
COLLEGE CALENDAR
SESSION 1963-1964

Matriculation, new students September 9
Registration, new students September 11
Matriculation and registration, current students September 11, 12
Late registration fee September 13
Classes begin, abbreviated schedule September 13
Last day for matriculation September 19
Last day to add a subject September 26
Graduate School foreign language examination September 28
Last day to drop a subject without record of drop October 10
Last day to order diploma for mid-year graduation October 12
Preliminary reports due October 28
Clemson-Carolina Game November 23
Thanksgiving Holidays November 28-30
Last day to withdraw from college without having grades recorded December 10
Christmas Holidays begin at 1 p.m.* December 18
Classes resume January 3
Last day for thesis and oral examination January 11
Examinations begin January 16

*Follow Thursday, Friday, Saturday schedule Monday, Tuesday, Wednesday, December 16, 17, 18.
Faculty meeting to consider candidates for graduation January 24

Mid-year graduation January 25

Matriculation, new students January 27

Matriculation and registration, all students January 29, 30

Late registration fee applies January 31

Classes begin, abbreviated schedule January 31

Last day for matriculation February 6

Last day to add a subject February 13

Graduate School foreign language examination February 15

Last day to drop a subject without record of drop February 27

Last day to order diploma for June graduation February 27

Preliminary reports due March 16

Easter Holidays begin at 1 p.m. March 26

Classes resume April 1

Last day to withdraw from college without having grades recorded April 28

Honors and Awards Day—classes suspended at 12 noon May 6

Last day for thesis and oral examination May 16

Examinations begin May 20

Faculty meeting to consider candidates for graduation May 29

Commencement May 30
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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 1964

Paul Quattlebaum, Jr. ................................................. Charleston
W. Gordon McCabe, Jr. ............................................... Greenville
T. Kenneth Cribb ..................................................... Spartanburg

Term Expires 1966

A. M. Quattlebaum ................................................... Florence
L. D. Holmes ............................................................ Johnston
E. Oswald Lightsey .................................................... Hampton

G. E. Metz, Secretary ..................................................... Clemson
OFFICERS OF ADMINISTRATION

Robert Cook Edwards, B.S., LL.D.  President

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

William Henry Wiley, Ph.D.  Dean, School of Agriculture

Jess Willard Jones, Ph.D.  Director, Agricultural Teaching

Harlan Ewart McClure, M.Arch.  Dean, School of Architecture

Howard Louis Hunter, Ph.D.  Dean, School of Arts and Sciences

Linvil Gene Rich, Ph.D.  Dean, School of Engineering

Wallace Dabney Trevillian, Ph.D.  Dean, School of Industrial Management and Textile Science

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.  Director of Admissions and Registration
THE GRADUATE COUNCIL

1962-1963

Hugh Holleman Macaulay, Ph.D., Professor of Economics and Dean of the Graduate School. Chairman ex officio.

Forrest Christopher Alley, Ph.D., Assistant Professor of Chemical Engineering.

Wilbert Preston Byrd, Ph.D., Associate Professor of Agronomy.

Richard James Calhoun, Ph.D., Associate Professor of English

Alvon Creighton Elrod, Ph.D., Associate Professor of Mechanical Engineering.

James Edwin Halpin, Ph.D., Associate Plant Pathologist.

Harold Foschone Landrith, Ed.D., Associate Professor of History and Education.

Malcolm John Skove, Ph.D., Assistant Professor of Physics.

Harold Garth Spencer, Ph.D., Assistant Professor of Chemistry.

James Marvin Stepp, Ph.D., Professor of Agricultural Economics.

Clinton Howard Whitehurst, Jr., Ph.D., Associate Professor of Industrial Management.

Howard Louis Hunter, Ph.D., Professor of Chemistry and Dean, School of Arts and Sciences. Ex officio.

Linvil Gene Rich, Ph.D., Professor of Civil Engineering and Dean, School of Engineering. Ex officio.

Wallace Dabney Trevillian, Ph.D., Professor of Economics and Dean, School of Industrial Management and Textile Science. 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 forty graduate curriculums under the Schools of Agriculture, Architecture, Arts and Sciences, Engineering, and Industrial Management and Textile Science 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 1963-1964 charges for regular full-time students are shown below:

**First Semester**

<table>
<thead>
<tr>
<th></th>
<th>South Carolina Student</th>
<th>Non-Resident Student</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Men</td>
<td>Women</td>
</tr>
<tr>
<td>Tuition (Semester)</td>
<td>$ 75.00</td>
<td>$ 75.00</td>
</tr>
<tr>
<td>Matriculation Fee</td>
<td>(Non-Refundable)</td>
<td>5.00</td>
</tr>
<tr>
<td>Maintenance and Activities</td>
<td>Fee (Semester)</td>
<td>121.00</td>
</tr>
<tr>
<td></td>
<td>Medical Fee (Semester)</td>
<td>15.00</td>
</tr>
<tr>
<td></td>
<td>Library Fee (Semester)</td>
<td>12.00</td>
</tr>
<tr>
<td></td>
<td>Room Fee (½ Semester)</td>
<td>50.00</td>
</tr>
<tr>
<td></td>
<td>Board (½ Semester)</td>
<td>90.00</td>
</tr>
<tr>
<td>Total Entrance Payment</td>
<td>$368.00</td>
<td>$373.00</td>
</tr>
</tbody>
</table>

Second Payment:
- Room and Board (Due November 10) | 140.00 | 145.00 | 140.00 | 145.00 |

Total First Semester | $508.00 | $518.00 | $633.00 | $643.00 |

**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, diploma fee, fee for rental of cap and gown, and fee for publication of dissertation abstract are not included in the above charges.

**Part-Time Students.** Graduate students taking less than 12 credit hours during a semester will be charged for each of the items in 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>9.00</td>
</tr>
<tr>
<td>Library Fee (per semester hour)</td>
<td>.75</td>
</tr>
</tbody>
</table>

10
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 $15. 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 pay total charges of only $4.75 per semester hour during regular semesters and one-half the summer school rate during summer sessions. 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.

**Income Tax Deductions.** According to Treasury decision 6291, under Section 162 of the 1954 Internal Revenue Code, income tax deductions are allowed in many instances for tuition and other educational expenses. Students are referred to the the federal ruling on income tax deductions for teachers and other professional people seeking to maintain or improve skills required in their employment.

**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 $1,900 to $4,000 and tuition is reduced. Application forms are obtainable from the Dean of the Graduate School or from department heads and should be completed and filed early in the academic year before the student expects to enroll in the Graduate School. Recipients of assistantships are selected by the respective academic departments and will be notified on or before April 15.
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.** A $350 award for study in the biological sciences.

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

**Babcock and Wilcox Award.** A $650 award to a student in Engineering.

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

**Chemstrand Fellowships.** Two awards of $2,000 to students in Chemical Engineering.

**Clay Products Service Fellowship.** A $1,500 award to a student in Ceramic Engineering.

**Coker's Pedigreed Seed Company Award.** A $2,400 award to a student in Agricultural Education.

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

**Eastman Kodak Fellowship.** An award of $1,500 plus tuition and fees to a student in Chemical 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 Defense Education Act Fellowships. Three-year fellowships for doctoral study in particular areas are awarded annually by the College on behalf of the Department of Health, Education, and Welfare. Announcement of the availability of these fellowships is made in early December. Inquiries should be addressed to the Graduate School.

National Aeronautics and Space Administration Traineeship Grants. Fellowships for from one to three years study in space-related fields are awarded annually by the College on behalf of the National Aeronautics and Space Administration. Announcement of the availability of these fellowships will be made during the fall semester. Inquiries should be addressed to the Graduate School.

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.

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

Vanadium Project Fellowship. A $1200 award plus supplies to a student in Ceramic Engineering.

Wade Stackhouse Loan Fund. Income from a fund donated by Dr. Wade Stackhouse in memory of his father is used to assist graduate students at Clemson and 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, Clemson Student Loan Funds, and National Defense Student Loan Programs. Contact the Student Aid Office for further information.

COMPUTING CENTER

The Clemson College Computing Center operates an RPC 4000 digital computing system with an RPC 4600 auxiliary input/output unit and an RPC 4410 protoelectric reader. Input and output is through a typewriter-paper tape system with card capability provided by a K-177 card-to-tape converter. The Computing Center is available for graduate research on an open shop basis. Instruction in programming and the use of the equipment is available.

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 215,000 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 3,300 serial titles — periodicals, reports, bulletins and the like — are received regularly. Six hundred 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 AND COSTS**

**Dormitories.** Cost per semester, $100 for men and $110 for women.

Life in the student dormitories is under the direction of dormitory supervisors who are responsible to appropriate Deans in the Office of Student Affairs. Students are required to comply with published dormitory rules and regulations.

Residence hall accommodations are rented on a semester basis and rent on all dormitories is $100 per semester for men and $110 per semester for women. Before assignment to a room can be made, an advance payment for one-half of a semester's rent 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 one-half a semester's rent is made during the established priority period. Assignment after this date will be made on a first-come, first-served basis. New students and former students not currently enrolled will be sent necessary room application forms with the notification of acceptance.

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 such notification and request is not received, no refund of the advance payment will be made. When students are assigned and occupy a room at the beginning of a semester, they are obligated for the half semester’s rent and no refund will be made.
If a student's arrival on campus is to be delayed, the dormitory manager should be notified in order that the 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.

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

Completion of Clemson's first women's dormitory is scheduled for September 1963.

The attractive four-story building will accommodate 144 students. The living areas located on the second, third and fourth floors are arranged into suites; 6 rooms or 12 students being assigned each. Study rooms, baths and laundry rooms are conveniently located for each suite. The first floor consists of a large lounge, recreation room and apartment for a resident counselor.

The building will be carpeted throughout, each room having individual study desk, chest, closet and beds.

A passenger elevator will service all floors.

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

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

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

**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 during the quarter (one-half semester) is made on a daily pro rata basis, holidays excepted, provided the unused portion is more than 14 consecutive complete days.

Laundry—Dry Cleaning.

A new building with modern equipment is conveniently located on campus to service the laundry and dry cleaning requirements of students. Reasonable prices are charged for individual items on a cash-and-carry basis.

The College will not be liable for lost or damaged items unless reported within two days after delivery date, and then for not more than the actual depreciated value of such articles as have been lost or damaged.

For the convenience of those students who wish to pay in advance for laundry and dry cleaning, a $40 coupon book may be purchased at the Laundry. The amount should meet the student's laundry and dry cleaning requirements for a semester. For the protection of purchasers, the coupons will be valid only when presented with the student's identification card. Unused coupons may be redeemed only at the end of a regular semester, a summer session, or when a student is properly discharged from school.

Coin-operated washing machines and dryers are available in the laundry building and several of the dormitories.

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. Students assigned these units should be prepared to repaint the interior at their expense.

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 which maintains waiting lists and assigns units on the basis of date of application.

STUDENT HEALTH SERVICE

The Student Health Service maintains a complete outpatient department and a 40-bed infirmary. The staff consists of two full-time physicians, including the director, six full-time registered nurses and a full-time registered laboratory technician with X-ray experience. In addition, a sufficient number of nurses aides, secretarial workers, orderlies and maids for 24-hour-a-day operation are
also employed. The best of modern equipment is available for student use.

The chief function of the Health Service physicians is to substitute for the family physician while the student is away from home. Students who desire may consult one of these physicians during regular office hours or at any time in case of emergency.

Every effort will be made to keep the student in good health so that he may effectively pursue his school work. The medical fee paid by each student covers the services of the college physicians and health service staff for most illnesses and injuries occurring on the campus. There are certain things, however, that it does not include, such as fees for routine physical examinations for employment or transfer to another school and fees for outside physicians when called in for consultation, medical or surgical services performed away from the college or for accidents occurring off the campus. Though ambulance transportation to a general hospital for serious illness or injury occurring on campus will of course be arranged, the expense for this service is the responsibility of the student. Transportation for less urgent ailments and routine visits can be arranged through the health service at the expense of the student.

The right of the Director of the Student Health Service, with the approval of the proper college authority, to obtain any of these extra services in behalf of any student under his care is hereby expressly reserved.

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. The prospective student sends a letter of inquiry to the Graduate School or Department Head.

2. The Graduate School mails information and forms to the student.

3. Completed application forms, transcript, and Graduate Record Aptitude Test scores are 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 the test.

4. Application information is sent to the Department Head for study.

5. The Department Head and Dean of Graduate School act on the student’s application and the Dean notifies the 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 advisor and/or advisory committee. (See page 32.)

2. Submit Plan for Graduate Study (G. S. Form 2) (See page 28.)

3. If necessary, submit request for changes in Plan for Graduate Study. (See page 29.)

4. Satisfy any prescribed foreign language examination and other qualifying examinations prerequisite to admission to candidacy. (See page 30.)

5. Apply for admission to candidacy for a 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 29.)
6. Place formal order for diploma with the Director of Admissions and Registration and pay diploma fee within 4 weeks following opening of final semester prior to graduation. (See page 31.)

7. Submit completed thesis to advisory committee chairman and arrange for final examination by the advisory committee. (See page 29.)

8. Pay binding fee to the Bursar and submit approved copies of thesis to the Dean of the Graduate School. Doctoral candidates pay for abstract publication in Dissertation Abstracts. (See page 30.)

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 Engineering, Agronomy, Animal Science, Bacteriology, Ceramic Engineering, Chemical Engineering, Chemistry, Civil Engineering, Dairy Science, Electrical Engineering, Engineering Mechanics, Entomology, Horticulture, Industrial Management, Mathematics, Mechanical Engineering, Physics, Plant Pathology, Poultry Science, Textile Chemistry, Water Resources Engineering, and Zoology.

The Master of Arts degree is offered in Economics and in English.

The degrees of Master of Agricultural Education, Master of Industrial Education, and Master of Education in the teaching areas of English, history, and sciences are offered.

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, Bio-engineering, Chemical Engineering, Chemical Physics, Chemistry, Entomology, Materials Engineering, Physics, Plant Pathology, and Water Resources Engineering.

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. or M. S. degree in a given field, received at another institution, become a candidate for a different Master'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 at the outset of their work, confer with the head of the Department of Social Sciences, in which Education courses are taught.

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.

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 Director of Admissions and Registration 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.

*Students with grade-point ratios of 3.0 or higher may enroll in graduate-level courses during their senior year and may choose to use these courses to meet requirements for the bachelor's degree. However, courses used for this purpose may not later be counted toward an advanced degree. Alternatively, students may request that these courses be included as a part of their graduate program if they are subsequently admitted to the Graduate School at this institution. The student must receive permission from the Graduate School to enroll in graduate-level courses.
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.

Students who have been admitted to the Master's program but subsequently desire to enroll in a Ph.D. program must apply for admission to the Graduate School in the Ph.D. program.

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. Students who fail to do so may be dropped from the Graduate School.

**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.** Applicants for admission to a degree program are required to submit their scores on the Aptitude Test of the Graduate Record Examinations.

This test is prepared and scored by the Educational Testing Service, 20 Nassau Street, Princeton, New Jersey. The Graduate Record Examinations are administered at many centers throughout the United States and several foreign countries five times each year, usually in January, March, April, July, and November. The test is given at Clemson November 16, 1963, April 25, 1964, and July 11, 1964.
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 two weeks in advance of the actual test date.

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

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

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

Courses primarily for graduate credit are those numbered 500 or above. Graduate credit may be received for a grade of C on these courses; however, the grade on a credit hour basis for all such work taken 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. A student will receive a mid-term grade of unsatisfactory in any course in which his average at that time is below B. 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 re-examination in the course is not permitted.

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 Clem-
son 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. An employee actively working full time during the summer may carry no more than four semester hours during the two summer sessions and not more than three semester credits during either session.

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 regularly enrolled student may audit one additional course a semester, provided approval is obtained from the professor offering the course, 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 Office of Admissions and Registration. Graduate assistants and graduate students enrolled for more than twelve hours will not be charged for auditing. Other part-time students will be charged (1) one-half
tuition fee and one-half maintenance and activity fee or one-half summer school fee (where applicable), (2) full library fee charged part-time students, but (3) no matriculation fee.

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, with the help of 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 be 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 student's major adviser and the head of his major department. 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 one academic year or eight months, before the date on which the degree is expected.

The Thesis and Thesis Abstract. Each candidate for an advanced degree in each curriculum requiring a thesis must prepare this 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

*Multilith or Xerox copies are as a rule acceptable.
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 delivered to the student's advisory committee at least two weeks prior to the final examination. The three copies of the thesis must be submitted to the Dean of the Graduate School at least one week prior to the date on which the degree is conferred. A binding fee of $9 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 additional copies of his thesis bound for himself at a cost of $3 a copy. 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 one additional copy of the abstract and title sheet of his thesis to 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 scheduled for September 28, 1963, and for February 15 and June 20, 1964. The language examinations are taken from sources supplied by the student's major department to the Language Department a week before the date of the test.
A student who takes the examination in a given language more than twice will be charged $10 for each examination after the second.

**Application for a Diploma.** A formal application for a diploma must be placed by the student with the Director of Admissions and Registration within 4 weeks following the opening of the final semester or Summer Sessions 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.

**ADDITIONAL REQUIREMENTS FOR THE MASTER OF SCIENCE AND MASTER OF ARTS DEGREES**

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 five weeks. All course work which is to be credited toward a Master of Science or Master of Arts 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 out-

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

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

Final Examination. Each candidate for a Master’s degree, after the completion of the thesis, if required, 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 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 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 THE MASTER OF INDUSTRIAL EDUCATION DEGREE

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 semester hours, distributed as follows:

1. Six to twelve hours in education methods.

2. Eighteen to twenty-four hours in subjects that contribute to the student's technical ability.

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 one or more 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 committee will be designated as chairman and normally he will direct the student’s dissertation. The advisory committee will aid the student in planning his course work to achieve the required competence. This planning will include the selection of specific courses, their number, and their sequence. Work in the minor field or fields should normally consist of from 12 to 24 semester hours in courses carrying graduate credit. If the direction of the student’s study or research interest should change as his work progresses, he may request the appointment of a new major adviser. The committee will also arrange for the student’s preliminary and final comprehensive examinations and initiate the recommendations 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 31 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. Normally a combination of two Romance languages will not be approved. 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 are invited to participate. The Graduate School office and members of
the Graduate Council 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 Director of Admissions and Registration.
AGRICULTURAL ECONOMICS

G. H. Aull, Chairman

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

It is fundamental in the philosophy of those who administer the graduate programs in agricultural economics that the agricultural economist should be well grounded in economics. For this reason the department encourages application by students with bachelor's degrees in other fields that provide this background. In many cases, such students may be admitted to full graduate status without prerequisites other than those required of all graduate students. In all cases principal consideration is given to high scholastic ability and good moral character.

*Ag Ec 352—PUBLIC FINANCE—3 cr. (3 and 0)
*Ag Ec 357—CONSERVATION OF NATURAL RESOURCES—3 cr. (3 and 0)
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 501—ADVANCED FARM MANAGEMENT—3 cr. (2 and 3)

Study and appraisal of methods of assembling and analyzing information concerning the business of farming. Prerequisite: 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.

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

Ag Ec 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 591—THEESIS RESEARCH—3 cr.
Ag Ec 592—THEESIS RESEARCH—3 cr.

Ag Ec 610—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 611—RESEARCH PROBLEMS IN FARM MANAGEMENT—3 cr. (3 and 0)
Continuation and extension of Ag Ec 610.

Ag Ec 616—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 617—RESEARCH PROBLEMS IN MARKETING—3 cr. (3 and 0)
Continuation and extension of Ag Ec 616.

Ag Ec 691—DOCTORAL RESEARCH—Credit to be arranged.
(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 467—ADULT EDUCATION IN AGRICULTURE—3 cr. (2 and 3)**

**Ag Ed 503—EVALUATION IN AGRICULTURAL EDUCATION—3 cr. (2 and 3)**

Application of principles in evaluation to agricultural education. Major emphasis on development and use of instruments for appraising educational outcomes. **Prerequisite:** Experience in agricultural education.

**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 505—ADMINISTRATION AND SUPERVISION IN AGRICULTURAL EDUCATION—3 cr. (3 and 0)**

Emphasis given to developing a philosophy of education including the application of concepts of administration in supervising programs of agricultural education. **Prerequisite:** Experience in agricultural education.

**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
A. W. Snell, Chairman

Courses are offered leading to the Master of Science degree.

Courses AgE 352 through AgE 501 are offered for credit as a minor for graduate students in other curricula. Students majoring in Agricultural Engineering take two or more courses in the group of AgE 504 through AgE 582. All majors take AgE 591 and 592, Thesis Research.

Additional course work in the major is usually taken in other departments such as Mathematics, Engineering Mechanics, Mechanical Engineering, and Civil Engineering. Courses for a minor are taken in other engineering departments, Agronomy and Soils, or Statistics.

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

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.

*May be used for graduate credit under special conditions only.
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—WATER MOVEMENT IN SOILS—3 cr. (3 and 0)
A study of theory and principles of water movement in soils. 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 equivalent.

AgE 582—GINNING ENGINEERING—3 cr. (2 and 3)
Theory and principle in the 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. 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.

Opportunities exist for B.S. or B.A. degree graduates with majors in chemistry, biology, plant science, physics, geology, general science or soils. Graduate programs include courses in soil chemistry, soil physics, soil genesis, soil fertility, soil microbiology, plant breeding and genetics as well as fundamental research problems relating to these subjects. Unusual facilities include radioisotope equipment, a cytology laboratory, controlled environment chambers, and graduate student laboratories in an air-conditioned building.

Some agronomists are trained as chemists; others have strong training in physics and mathematics; some are plant physiologists, geneticists or microbiologists. An agronomist played a major role in the development of streptomycin.

*Gen 302—GENETICS—3 (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 407—PRINCIPLES OF WEED CONTROL—3 or (2 and 3)
Agron 409—COTTON AND TOBACCO—3 cr. (3 and 0)

Gen 451—GENETICS—3 cr. (3 and 0)
Gen 453—GENETICS LABORATORY—1 cr. (0 and 3)

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—THEORY AND METHODS OF PLANT BREEDING—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; reactions and interactions; deficiency diagnosis and remedies. Concepts and techniques for evaluating soil fertility problems will be studied.

Courses which may be used by students majoring in other fields.
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.

Agron 691—DOCTORAL RESEARCH—Credit to be arranged.

ANIMAL SCIENCE

R. F. Wheeler, Chairman

Courses are offered leading to the Master of Science degree.

An Sc 401—BEEF PRODUCTION—3 cr. (3 and 0)

An Sc 403—BEEF PRODUCTION LABORATORY—1 cr. (0 and 3)

An Sc 408—PORK PRODUCTION—3 cr. (3 and 0)

An Sc 410—PORK PRODUCTION LABORATORY—1 cr. (0 and 3)

An Sc 452—ANIMAL BREEDING—3 cr. (3 and 0)

An Sc 502—TOPICAL PROBLEMS—1-3 cr. (1-3 and 0)

A critical study of Animal Husbandry experiments and interpretation of their results.

An Sc 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.

An Sc 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.
An Sc 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: Dy Sc 403.

An Sc 591—RESEARCH—3 cr.

An Sc 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 II—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 of 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.

Graduate work in Bacteriology requires adequate undergraduate training in the biological and physical sciences. This training may be received in an undergraduate program in biology (botany or zoology), or chemistry, or in one of the agricultural sciences, such as food technology, agronomy, or entomology.

Undergraduate work in bacteriology is desirable but not necessary.

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

Bact 401—ADVANCED BACTERIOLOGY—4 cr. (2 and 6)

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

Bact 406—SANITARY BACTERIOLOGY—3 cr. (2 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.

*May be used for graduate credit under special conditions only.*
Bact 505—PHYSIOLOGY OF BACTERIA—3 cr. (2 and 3)
A study of bacterial cytology, enzymes, growth curves, respiration, aero-
biosis, anaerobiosis, nutrition of bacteria and degradation of proteins, carbo-
hydrates, 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.

**BIO-ENGINEERING**

L. G. Rich, Chairman

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

The program in bio-engineering offers a concentration in either the
fermentation field or the technology associated with artificial environ-
ments. Because of the interdisciplinary nature of the program, it is open
to students possessing degrees in engineering and to those with degrees in
science who have credits for certain prescribed courses in engineering.

The field of bio-engineering was formerly limited to the application of
engineering technology to the fermentation processes employed in the pro-
duction of pharmaceuticals and industrial chemicals. Now, however, use
of the field has been broadened to include the technology associated with
the design and maintenance of artificial environments for man. The estab-
lishment and control of such environments require the application of
engineering to biological systems producing the physiological necessities of
man. The educational preparation of a person entering the field of bio-
engineering must include, in addition to a strong background in the unit
operations of process engineering, a firm foundation in the principles of
chemistry and microbiology. Effective participation in the technology of
artificial environments requires also a knowledge of environmental hy-
giene.

Candidates for a degree in this field may choose certain courses from
those offered in bacteriology, botany, chemical engineering, chemistry, and
civil engineering. Candidates for the M. S. degree must take or have taken
the courses listed below; candidates for the Ph.D. degree must take or have
taken the same courses plus Bact 401—Advanced Bacteriology.
Bact 301—GENERAL BACTERIOLOGY—4 cr. (3 and 3)
Bot 352—PLANT PHYSIOLOGY—4 cr. (3 and 3)
Ch 323—ORGANIC CHEMISTRY—3 cr. (3 and 0)
Ch 324—ORGANIC CHEMISTRY—3 cr. (3 and 0)
Ch 423—GENERAL BIOCHEMISTRY—3 cr. (3 and 0)
Ch 424—GENERAL BIOCHEMISTRY—3 cr. (3 and 0)
Ch 530—PHYSICAL CHEMISTRY—3 cr. (3 and 0)
Ch 531—PHYSICAL CHEMISTRY I—3 cr. (3 and 0)

BOTANY
W. M. Epps, Chairman

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

Students who desire to pursue graduate work in plant pathology should have sound undergraduate training in chemistry and botany. This training may be received in an undergraduate curriculum in botany, biology, or chemistry or in one of the agricultural plant sciences, such as agronomy, forestry or horticulture. Undergraduate courses in plant pathology are desirable but not necessary.

*Bot 352—PLANT PHYSIOLOGY—4 cr. (3 and 3)
*Bot 356—TAXONOMY—3 cr. (1 and 6)
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 456—PLANT VIROLOGY—3 cr. (3 and 0)
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

*May be used for graduate credit under special conditions only.
atmospheric humidity and radiant energy, and determinations of osmotic quantities, hydrogen ion concentration, and metabolic processes. **Prerequisites:** Bot 352; Ch 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, student reports, and laboratory work. **Prerequisite:** Bot 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 selected plant diseases incited by fungi, bacteria, viruses, nematodes, and physiogenic factors; 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 in the development of plant diseases. 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—3 cr. (3 and 0)

A theoretical and practical coverage of all aspects of plant disease control. Laboratory facilities are available for qualified students to conduct specialized investigations in plant disease control. **Prerequisites:** Bot 352, 401, Organic Chemistry.

Bot 591—RESEARCH—3 cr.

Bot 592—RESEARCH—3 cr.

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

G. C. Robinson, Chairman

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

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—ANALYTICAL PROCESSES—3 cr. (3 and 0)
CrE 412—RAW MATERIAL PREPARATION—3 cr. (3 and 0)
CrE 416—ELECTRONIC CERAMICS—3 cr. (3 and 0)
CrE 418—PROCESS CONTROL—3 cr. (3 and 0)
CrE 419—SCIENCE OF ENGINEERING MATERIALS—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 micro-
   scope 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.
CrE 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, en-
   amels, glass, elements, or raw materials processing.
CHEMICAL ENGINEERING

C. E. Littlejohn, Chairman

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

Graduate students will be accepted with backgrounds in chemistry, physics, or branches of engineering other than chemical engineering. Special programs will be laid out for non-chemical engineering graduates. Minors may be taken in chemistry, physics, mathematics, life science, or other branches of engineering. There is no language requirement for the Master’s degree; however, a reading knowledge of two foreign languages is required for the Ph.D. degree. A thesis is required for all graduate degrees in chemical engineering.

ChE 401—PRINCIPLES OF CHEMICAL ENGINEERING—3 cr. (3 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 423—THEORY OF BIO-OXIDATION PROCESSES—2 cr. (2 and 0)

ChE 430—CHEMICAL ENGINEERING THERMODYNAMICS—3 cr. (3 and 0)

ChE 450—CHEMICAL ENGINEERING KINETICS—3 cr. (3 and 0)

ChE 452—MOLECULAR AND TURBULENT TRANSPORT—3 cr. (3 and 0)

ChE 503—HEAT, MASS, AND MOMENTUM TRANSFER—3 cr. (3 and 0)

An advanced treatment of the fundamental mechanisms of molecular and turbulent transport of heat, mass and momentum.

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)
Formulation and solution of basic chemical engineering problems using statistical and post-calculus techniques.

ChE 507—CHEMICAL ENGINEERING CALCULATIONS II—3 cr. (3 and 0)
A continuation of ChE 506. Emphasis is given to the formulation and solution of more complex problems in the area of steady and unsteady transport.

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 520, 521, 522—UNIT OPERATIONS—3 cr. (3 and 0)
Selected advanced topics in the unit operations, including fluid flow, heat transmission, distillation, evaporation, extraction, absorption, etc. Special emphasis is placed on the application of theory and the results of recent research through the solution of comprehensive problems.

ChE 530—CHEMICAL TECHNOLOGY—3 cr. (3 and 0)
A study of those unit processes and operations that are of direct interest to the organic, inorganic, or electrochemical industries. Special emphasis is placed on the manner in which chemical engineering principles are used in solving the problems of these industries.

ChE 540—GRADUATE LABORATORY—3 cr. (0 and 9)
Graduate level laboratory experiments in kinetics, unit operations and thermodynamics. Emphasis will be placed on independent work. The stu-
dent will be required to plan the experiments to achieve a given objective, perform the experimental work and prepare a technical report on the work.

ChE 545, 546, 547—SELECTED TOPICS IN CHEMICAL ENGINEERING—
3 cr. (3 and 0)
A comprehensive study of any topic in the field of chemical engineering, not covered in the other courses. Special emphasis will be placed on studies of the current literature and the results of recent and current research. The topics covered will be expected to vary from year to year to keep pace with developments in the field. May be repeated for credit.

ChE 552—AIR POLLUTION CONTROL PROCESSES—3 cr. (3 and 0)
A course devoted to operational and design variables in equipment for removal of gas, liquid and solid phase pollutants from air. Basic theory of small particle dynamics. Performance and design are discussed.

ChE 553—INDUSTRIAL AIR HYGIENE—3 cr. (3 and 0)
Deals with the control of air contaminants in confined industrial areas. Application of maximum allowable concentrations in the design of air handling and cleaning systems in enclosed work areas. A survey of heat, noise, and other industrial hazards.

ChE 591 and 592—RESEARCH—3 cr.

ChE 603—TRANSPORT PHENOMENA—3 cr. (3 and 0)
A consideration of problems in transport phenomena from the current literature.

ChE 604—CHEMICAL ENGINEERING THERMODYNAMICS—3 cr. (3 and 0)
A continuation of ChE 504. Includes non-ideal behavior of mixtures, statistical thermodynamics and irreversible processes.

ChE 605—CHEMICAL ENGINEERING KINETICS—3 cr. (3 and 0)
A continuation of ChE 505.

ChE 645, 646, 647—SELECTED TOPICS IN CHEMICAL ENGINEERING—
3 cr. (3 and 0)
Study of any advanced topic in chemical engineering. Intended primarily for more comprehensive study of topics first covered in ChE 545-546.

ChE 691—DOCTORAL RESEARCH—Credit to be arranged. (May be taken more than one semester).
CHEMICAL PHYSICS
F. I. Brownley, Chairman (Chemistry)
L. D. Huff, Chairman (Physics)

Courses are offered leading to the Doctor of Philosophy degree.

Chemical physics is an interdisciplinary field utilizing particular courses in chemistry and physics. Where physical chemistry is concerned with the physical and thermodynamic properties of materials in bulk, chemical physics studies the involved spatial structures and properties of matter on the atomic and molecular scale. The theoretical and experimental techniques of physics and physical chemistry are used in chemical physics.

Course work required of the student in this field is drawn principally from the offerings in chemistry, physics, and mathematics.

CHEMISTRY
F. I. Brownley, Jr., Chairman

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

REQUIREMENTS FOR ADMISSION

An entering chemistry graduate student should have a record of sound academic accomplishment and a major in chemistry from a department approved by the American Chemical Society.

Although such an undergraduate program is obviously best, it is recognized that capable students sometimes acquire an interest in chemistry too late to complete the minimum A.C.S. requirements, or have attended institutions where the complete program is not available. The department will carefully evaluate the undergraduate records of such students and, if the possibility of their doing satisfactory graduate work seems good, they may be admitted on a provisional basis. These students must make up any undergraduate deficiencies upon entering the graduate program. It must be realized by an individual admitted under these conditions that it will take him somewhat longer to obtain his degree than if he had completed an A.C.S. approved program.

In addition to the 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 faculty advisers.

A comprehensive examination will be given in the major field. This examination will consist of a written examination, followed by an oral examination, both examinations to be held within a period of two weeks.

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

Teaching in undergraduate courses is an integral part of graduate work in chemistry and is required of all graduate students.

*Ch 310—AGRICULTURAL BIOCHEMISTRY—4 cr. (3 and 3)
*Ch 323—ORGANIC CHEMISTRY—3 cr. (3 and 0)
*Ch 324—PRINCIPLE OF ORGANIC CHEMISTRY—3 cr. (3 and 0)
*Ch 331—PHYSICAL CHEMISTRY—3 cr. (3 and 0)
*Ch 332—PHYSICAL CHEMISTRY—3 cr. (3 and 0)
*Ch 333—PHYSICAL CHEMISTRY LABORATORY—2 cr. (0 and 6)
*Ch 334—PHYSICAL CHEMISTRY LABORATORY—2 cr. (0 and 6)
*Ch 339—PHYSICAL CHEMISTRY LABORATORY—1 cr. (0 and 3)
*Ch 340—PHYSICAL CHEMISTRY LABORATORY—1 cr. (0 and 3)
*Ch 402—INORGANIC CHEMISTRY—3 cr. (3 and 0)
Ch 411—INSTRUMENTAL ANALYSIS—4 cr. (2 and 6)
Ch 421—QUALITATIVE ORGANIC ANALYSIS—4 cr. (2 and 6)
Ch 423—GENERAL BIOCHEMISTRY—3 cr. (3 and 0)

*Courses which may be used by students majoring in other fields.
A study of atomic crystal and molecular structure and its relationship to inorganic chemistry.

Major topics presented are the physical and chemical properties of coordination compounds. Chemical properties include preparation and the nature of bonding exhibited by these compounds.

The inorganic chemistry of the non-metallic elements, especially nitrogen, phosphorous, silicon, oxygen, sulfur and the halogens.

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

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.

An intensive survey of modern organic chemistry with the emphasis on theoretical concepts and mechanisms.

A continuation of Ch 521. Prerequisite: Ch 521.

The mechanisms of organic chemical reactions, both aliphatic and aromatic.

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

Ch 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 in this phase of the subject. **Prerequisites:** Courses in organic chemistry and a working knowledge of calculus.

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

Ch 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:** Ch 530, or Ch 331 or its equivalent.

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

Ch 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 students.

Ch 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.

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

Ch 591—RESEARCH—3 cr.

Ch 592—HETEROCYCLIC COMPOUNDS—3 cr. (3 and 0)

Ch 621—HETEROCYCLIC COMPOUNDS—3 cr. (3 and 0)
The organic chemistry of heterocyclic compounds.
Ch 622—STEREOCHEMISTRY—3 cr. (3 and 0)
A study of all phases of stereochemistry as applied to organic compounds.

Ch 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: Ch 622 or permission of the instructor.

Ch 624—CHEMISTRY OF NATURAL PRODUCTS—3 cr. (3 and 0)
A continuation of Ch 623.

Ch 625—CURRENT TRENDS IN ORGANIC CHEMISTRY I—1 cr. (1 and 0)
A study of current trends and developments in organic chemistry.

Ch 630—ADVANCED PHYSICAL CHEMISTRY I—3 cr. (3 and 0)
This course is primarily a study of chemical kinetics and will include: rates and mechanisms, homogeneous and heterogeneous catalysis, and surface phenomena. Prerequisite: 534.

Ch 631—ADVANCED PHYSICAL CHEMISTRY II—3 cr. (3 and 0)
An advanced study of selected topics. Topics which may be included: irreversible thermodynamics, theory of liquids, electro-chemistry, or recent advances in other topics. Prerequisite: Ch 533.

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

Ch 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.

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

CIVIL ENGINEERING
J. H. Moore, Chairman

Courses are offered leading to the Master of Science degree.

Enrollment is limited to those with undergraduate backgrounds in civil engineering or the equivalent. A program of study may be followed which has a concentration in structures and engineering mechanics, soil mechanics, transportation, or sanitary engineering.

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CE 413—WATER AND WASTE TREATMENT TECHNOLOGY—3 cr. (2 and 3)

CE 434—CONSTRUCTION COSTS AND ESTIMATES—3 cr. (2 and 3)

CE 453—ADVANCED STRUCTURAL ANALYSIS—3 cr. (3 and 0)

CE 501—STRUCTURAL ENGINEERING I—3 cr. (2 and 3)
Analysis of statically indeterminate structures including gable bents, multi-story and multi-bay frames, continuous haunched beams, and continuous trusses. Applications of energy, slope deflection and moment distribution methods. Influence lines. Column analogy. **Prerequisite:** CE 453.

CE 502—STRUCTURAL ENGINEERING II—3 cr. (3 and 0)
Design of concrete structures by ultimate strength theory; design of prestressed concrete structural members. Composite design with concrete and metals. **Prerequisite:** CE 404, 407.

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 504—THEORY AND DESIGN OF THIN PLATES—3 cr. (3 and 0)
Elastic analysis and design of circular, rectangular, and continuous plates by both classical and numerical methods. **Prerequisite:** Math 306 and a knowledge of Fourier series.

CE 505—THEORY AND DESIGN OF SHELLS—3 cr. (3 and 0)
Elastic analysis and design of shell structures such as cylindrical shells, domes, roof structures with double curvature. **Prerequisites:** Math 306, CE 504.

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 406.

CE 511—HIGHWAY DESIGN—3 cr. (3 and 0)
Study of criteria controlling geometric design of highways and intersections. Geometric design of highways and intersections to satisfy traffic volume, design speed, vehicle requirements, and safety requirements. **Prerequisite:** CE 406.

CE 512—BITUMINOUS PAVING MATERIALS—3 cr. (2 and 3)
Manufacture of asphalt cements, road oils, asphalt emulsions, cutback asphalts, and tars; theory, design and evaluation of bituminous-aggregate mixes.
CE 513—HIGHWAY AND AIRPORT PAVEMENT DESIGN—3 cr. (3 and 0)
Structural design of rigid and flexible pavements; design of bases and subbases; theory of stresses and application of plate bearing, triaxial, and California Bearing Rates design methods to flexible pavements; Westergaard analysis for rigid pavements; pavement evaluation methods. Prerequisites: CE 406, CE 414.

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 404.

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 541—SANITARY ENGINEERING ANALYSIS—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 544—UNIT PROCESSES LABORATORY—1 cr. (0 and 3)
Graduate laboratory work in chemical and biological processes. Stress will be placed on the relation between theory and experimental results.

CE 545—UNIT OPERATIONS LABORATORY—1 cr. (0 and 3)
Graduate laboratory work in the unit operations of fluid flow, mixing, separation processes and the diffusional unit operations. Stress will be placed on the relation between theory and experimental results.

CE 589 and 590—SPECIAL PROBLEMS I AND 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.

DAIRY SCIENCE
W. A. King, Chairman

Courses are offered leading to the Master of Science degree.

The curriculum in dairy science emphasizes studies of a fundamental and technical nature superimposed upon a core of basic science courses. The student becomes familiar with the production of quality milk and its use as a raw material in the manufacture of many food products. The biological nature of foods makes a background in the chemical and biological sciences highly desirable for advanced study in this field. Several undergraduate courses in dairy sciences would be required of a student desiring to study for the M. S. degree in this field.

Majors in chemistry or biology would find an M. S. degree in Dairy a logical supplement to their undergraduate work, giving them the specialist's training now required in most industries. Because of the basic nature of the curriculum, such a degree would lead to employment opportunities in most food fields. Minors may be taken in zoology, bacteriology, chemistry, economics, statistics, physiology, nutrition, genetics, and food technology.

*Dy Sc 303—CHEMICAL AND PHYSICAL NATURE OF MILK—3 cr. (2 and 3)

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

Dy Sc 403—ANIMAL NUTRITION—3 cr. (3 and 0)

Dy Sc 404—DAIRY PLANT MANAGEMENT—3 cr. (2 and 3)

Dy Sc 405—DAIRY MANUFACTURES—4 cr. (3 and 3)

Dy Sc 407—CHEESE AND BUTTER MANUFACTURE—3 cr. (2 and 3)

*Courses which may be used by students majoring in other fields.

A study of the inheritance in dairy cattle, with emphasis on milk and butterfat production, methods used in proving sires and dams and in analyzing herds as aids to selection.

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Dy Sc 452—DAIRY CATTLE FEEDING AND MANAGEMENT—3 cr.  
(2 and 3)

Dy Sc 453—ANIMAL REPRODUCTION—3 cr. (3 and 0)

Dy Sc 458—ARTIFICIAL INSEMINATION OF FARM ANIMALS—3 cr.  
(2 and 3)

Dy Sc 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.

Dy Sc 502—GENETICS OF DAIRY CATTLE IMPROVEMENT—3 cr.  
(3 and 0)

Dy Sc 503—PHYSIOLOGY OF REPRODUCTION AND MILK SECRETION—3 cr. (3 and 0)  
The influence of the endocrine glands on reproduction and on milk secretion.

Dy Sc 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.

Dy Sc 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.

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

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

Dy Sc 591—RESEARCH—3 cr.

Dy Sc 592—RESEARCH—3 cr.

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ECONOMICS
R. S. Lambert, Chairman

Courses are offered leading to the Master of Arts degree.

Students desiring to enroll in this curriculum will need at least twelve hours of undergraduate economics including a course in intermediate price theory, a reading knowledge of a modern foreign language, and a comprehension of statistics. The statistics requirement may be met by satisfactory grades in undergraduate courses in statistics, by a special examination, or by graduate courses in statistics taken as part of the student's degree program.

Econ 403—DEVELOPMENT OF ECONOMIC THOUGHT—3 cr. (3 and 0)
Econ 404—COMPARATIVE ECONOMIC SYSTEMS—3 cr. (3 and 0)
Econ 407—NATIONAL INCOME AND EMPLOYMENT ANALYSIS—3 cr. (3 and 0)
Econ 412—INTERNATIONAL TRADE AND ECONOMIC DEVELOPMENT—3 cr. (3 and 0)
Econ 416—DEVELOPMENT OF THE MODERN ECONOMY—3 cr. (3 and 0)
Econ 420—ECONOMICS OF TAXATION—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.

Econ 591—RESEARCH—3 cr.
Econ 592—RESEARCH—3 cr.

EDUCATION

H. F. Landrith, Education Adviser
H. M. Cox, English Adviser
R. S. Lambert, History and Government Adviser
J. H. Hobson, Science Adviser

Courses are offered leading to the Master of Education degree with subject specialties in English, history and government, or science teaching.

Students seeking admission to the M. Ed. program should have:

a. A valid teacher's certificate; or

b. Eighteen hours in professional education, including directed teaching; or

c. At least twelve hours in professional education.

Students who enroll in the programs specializing in the teaching of English or history and government must demonstrate competence in the following four areas:

a. History and philosophy of education.

b. Educational tests and measurements; analysis of the individual.

c. Curriculum development; specialized or advanced methodology.

d. Introduction to research in education; educational source materials.

Courses previously taken at the undergraduate level or courses that are taken to meet the M. Ed. requirements will be accepted in satisfying this requirement.

Ed 406—HISTORY AND PHILOSOPHY OF EDUCATION—3 cr. (3 and 0)
Ed 494—SCHOOL AND COMMUNITY RELATIONSHIPS—3 cr. (3 and 0)
Ed 497—AUDIO VISUAL AIDS IN EDUCATION—3 cr. (3 and 0)
Ed 503—ADVANCED METHODS IN TEACHING—3 cr. (3 and 0)
The principles and practices involved in promoting effective learning.

Ed 505—PRINCIPLES OF GUIDANCE—3 cr. (3 and 0)
Principles, procedures, and policies of the guidance services. For all personnel workers.

Ed 508—EDUCATIONAL TESTS AND MEASUREMENTS—3 cr. (3 and 0)
Construction, use, and interpretation of tests, subjective and standardized. Familiarization with measurement applications.

Ed 509—ANALYSIS OF THE INDIVIDUAL—3 cr. (3 and 0)
Experience in gathering, interpreting and utilizing data as it relates to the individual. Especially significant to Counselors. Prerequisites: Ed 505, 508.

Ed 510—TECHNIQUES OF COUNSELING—3 cr. (3 and 0)
A study and use of counseling techniques (such as interviewing, testing, use of cumulative files, etc.). Prerequisites: Ed 505, 508, 509.

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 VOCATIONAL INFORMATIONAL SERVICE AND PLACEMENT—3 cr. (3 and 0)
Gathering, interpreting and utilizing educational, social, and occupational information. Techniques used in placement, survey, and follow-up. Prerequisites: Ed 505, 508.

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 evaluation instruction. Modern trends of supervisory practices will be emphasized.

Ed 590—INTRODUCTION TO RESEARCH IN EDUCATION—3 cr. (3 and 0)
A study of historical, descriptive, and experimental research methodology; tools of research; use of reference materials; interpretation and analysis of data; techniques of writing research reports; evaluation of source materials.
The following courses are applicable only to the Master of Education degree in Science Teaching.

Biol 450—BIOLOGY FOR HIGH SCHOOL TEACHERS—3 cr. (3 and 0)

Biol 500—PRINCIPLES OF BIOLOGY—3 cr. (2 and 3)
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.

Ch 450—REVIEW OF GENERAL CHEMISTRY I—3 cr. (3 and 0)
Ch 550—REVIEW OF GENERAL CHEMISTRY II—3 cr. (2 and 3)
The lecture portion of this course deals with recent advances in the field of chemistry. Special selected topics will be considered with some emphasis being placed on those of current interest. The laboratory time will be devoted to the study of effective methods of presenting laboratory material.

Geol 550—EARTH SCIENCE I—3 cr. (2 and 3)
A study of the physics and chemistry of the earth and earth processes. The petrochemical cycle forms the nucleus about which the course is built. Theoretical considerations of the association of minerals and rocks which compose the earth's crust, their origins and transformations are emphasized, along with geological processes by which changes are produced on or in the earth. Common minerals and rocks are studied in the laboratory, and geomorphic features are interpreted in terms of geological processes from topographic maps and during field trips.

Geol 550—EARTH SCIENCE II—3 cr. (2 and 3)
A study of the earth, its origin and subsequent developments. The evolution of continents and ocean basins as well as the beginnings and development of life on earth in all its forms are considered. Laboratory instruction in the recognition of plants and animals which have left their record as fossils in the rocks of the earth's crust is planned. Emphasis in the laboratory is also placed upon geologic structures and the interpretation of geologic maps, and these principles remonstrated through numerous field excursions.

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

Phys 460—MODERN PHYSICS FOR HIGH SCHOOL TEACHERS—3 cr. (3 and 0)

Phys 501—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 502—PHYSICS FOR HIGH SCHOOL TEACHERS II—3 cr. (3 and 0)
A continuation of Physics 501 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.

Graduate students in electrical engineering normally complete a minor in mathematics or physics, although consideration will be given to minors in other fields. Since a thesis is required, each student is urged to consult with his adviser early in the program in order to facilitate the search for a suitable topic.

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—FEEDBACK CONTROL SYSTEMS—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—ELECTRONICS III—3 cr. (3 and 0)
EE 433—ELECTRONICS III LABORATORY—1 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 503—SEMINAR—1 cr. (1 and 0)
The graduate student's understanding of the interrelationships of physics, mathematics and engineering is probed by means of oral and written questions, and by student presentation of topics related to research problems.
EE 507—STATISTICAL THEORY OF COMMUNICATION—3 cr. (3 and 0)
An integrated study of information theory, system analysis with random excitations and system synthesis from a statistical statement of the desired performance. Elementary idealized systems are discussed rather than more detailed practical ones, and an effort is made to give an account of the present state of the art. Throughout the course basic principles are emphasized.
EE 510—ANALYTICAL DESIGN OF LINEAR FEEDBACK CONTROLS—3 cr. (3 and 0)
A study of procedures for optimizing feedback control system design. Performance indices and allowable errors are used as design specifications, and trial-and-error methods are avoided. The analysis is based upon principles of probability and statistics, and requires a familiarity with conventional design techniques.

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 512—ANALYTICAL DESIGN OF LINEAR FEEDBACK CONTROLS—3 cr. (3 and 0)
This is the second semester sequence to EE 510. The analysis is extended to limitation of saturation tendencies and minimum bandwidth requirements. Application is made to a practical problem.

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—SOLID-STATE ELECTRONICS—3 cr. (3 and 0)
The electron in solids is studied by the modern physics approach. This includes elementary quantum mechanics, statistics, plasmas and band theory. These principles are then applied to modern amplifiers; e.g., the traveling-wave tube, tunnel diode, masers and parametric amplifiers.

EE 530—PULSE TECHNIQUES—4 cr. (3 and 3)
Analysis of basic circuits applicable to pulse-modulation communication systems, computers, high-speed time measurements, and cathode-ray instrumentation. Principles involved in electronic instruments for nuclear measurements, nuclear reactor control, and other applications involving pulsed electrical energy.
EE 536—OPTICAL ELECTROMAGNETICS AND QUANTUM ELECTRONICS—3 cr. (3 and 0)

An advanced study of the theory and modern technology of physical optics including methods used to generate, guide, and detect coherent waves in the millimeter, infrared, and visual portions of the electromagnetic spectrum.

EE 545—SELECTED TOPICS IN ELECTRICAL ENGINEERING—3 cr. (3 and 0)

A comprehensive study of any topic in the field of electrical engineering not covered in the other courses. Special emphasis will be placed on studies of the current literature and the results of recent and current research. The topics covered will be expected to change from year to year in keeping with developments in the field.

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

ENGINEERING MECHANICS
R. W. Moorman, Chairman

The two general areas in which the graduate program may be concentrated are Mechanics of Solids and Hydraulics (Mechanics of Fluids). Some limitations are imposed on the selection of courses to reflect the particular concentration. The normal minor area of study is mathematics.

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—3 cr. (3 and 0)
EM 462—WATER POWER ENGINEERING—2 or 3 cr. (2 or 3 and 0)
EM 464—FLOW IN OPEN CHANNELS—3 cr. (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 con-
sideration 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.

**EM 521—CONTINUUM MECHANICS—3 cr. (3 and 0)**

A comprehensive, unified treatment of the mathematical theories of elastic solids. Introduction to tensor analysis; stress and strain tensors; invariants; deformations and flow; conservation of mass; momentum theorems; constitutive equations; equations of elastic solids. **Prerequisites**: EM 304, 306, 307; Math 306.

**EM 525—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 cylinders, contact stresses, energy methods, flat plates, elastic stability. **Prerequisite**: EM 304.

**EM 531—THEORY OF ELASTICITY I—3 cr. (3 and 0)**


**EM 532—THEORY OF ELASTICITY II—3 cr. (3 and 0)**


**EM 536—THEORY OF PLASTICITY—3 cr. (3 and 0)**

A general theory of the inelastic behavior of materials is developed. Specific topics included are: Stress-strain relations under plastic conditions, the prediction of initial yielding and rupture, the ideal plastic, and work hardening. The theoretical findings are correlated with experimental data. **Prerequisites**: EM 521, 531, and permission of instructor.

**EM 551—INTERMEDIATE 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 561—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:** Permission of instructor. A student may not receive credit for this course and EM 460.

EM 562—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 or EM 561.

EM 564—GROUND-WATER HYDROLOGY—3 cr. (3 and 0)

A study of the occurrence and movement of water beneath the earth’s surface, with emphasis on development and management of ground-water as part of the total resource. Topics include porous media, ground-water hydraulics, quality of ground-water, and relationship of surface-water and ground-water. The principles developed are applied to water supply, waste disposal, construction, and irrigation. **Prerequisite:** Approval of instructor.

EM 570—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 or EM 561.

EM 572—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 basins, reservoirs; inverted siphons. **Prerequisites:** EM 460 or EM 561, EM 464, EM 551.

EM 591—RESEARCH—3 cr.

EM 592—RESEARCH—3 cr.

**ENGLISH**

H. M. Cox, Chairman

Courses are offered leading to the Master of Arts degree.

Engl 405—SHAKESPEARE—3 cr. (3 and 0)
A student desiring to pursue graduate study with a major in English should present at least twelve hours of undergraduate credit in English above the sophomore level, including a course each in the English language, Shakespeare, and American literature. A student seeking the Master of Education degree with emphasis in English must present at least six hours of undergraduate credit in English above the sophomore level. A student who does not meet these requirements may seek admission as a provisional graduate student.

In addition to the requirements of the Graduate School, candidates for the Master of Arts degree in English must satisfy the following departmental requirements:

1. A reading knowledge of an approved foreign language.
2. Demonstrated proficiency in composition.

Engl 405—SHAKESPEARE—3 cr. (3 and 0)
Engl 406—SHAKESPEARE—3 cr. (3 and 0)
Engl 409—CHAUCEL—3 cr. (3 and 0)
Engl 415—INTRODUCTION TO DRAMA—3 cr. (3 and 0)
Engl 416—INTRODUCTION TO DRAMA—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 ROMANTIC REVIVAL—3 cr. (3 and 0)
Engl 427—VICTORIAN POETRY AND PROSE—3 cr. (3 and 0)
Engl 431—THE RESTORATION AND EIGHTEENTH CENTURY—3 cr. (3 and 0)
Engl 435—SOUTHERN LITERATURE—3 cr. (3 and 0)
Engl 436—MILTON AND HIS AGE—3 cr. (3 and 0)
Engl 438—CONTEMPORARY POETRY—3 cr. (3 and 0)
Engl 439—CONTEMPORARY FICTION—3 cr. (3 and 0)
Engl 440—LITERARY CRITICISM—3 cr. (3 and 0)
Engl 441—WORLD LITERATURE—3 cr. (3 and 0)
Engl 442—WORLD 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.
Engl 590—INTRODUCTION TO RESEARCH—1 cr. (1 and 0)
   Introduction to literary history and research; the use of libraries and bibliographical tools; the exposition of scholarship. Required of all candidates for the Master of Arts degree.
Engl 591—RESEARCH—2 cr.
Engl 592—RESEARCH—3 cr.

**ENTOMOLOGY**

**J. H. Cochran, Chairman**

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

*Ent 305—ECONOMIC ENTOMOLOGY—3 cr. (2 and 3)
*Ent 306—ECONOMIC ENTOMOLOGY—3 cr. (2 and 3)
**Ent 405—INSECT MORPHOLOGY—4 cr. (3 and 3)
**Ent 408—GENERAL AND TAXONOMIC ENTOMOLOGY—5 cr. (3 and 6)
Ent 468—INTRODUCTION TO RESEARCH—2 cr. (1 and 3)
Ent 508—TAXONOMY OF IMMATURE INSECTS—3 cr. (1 and 6)
   Identification of immature insects with particular emphasis on the Holometabola. Each student will make and submit an identified collection of immature insects.
Ent 556—MEDICAL ENTOMOLOGY—3 cr. (2 and 3)
   Disease vectors of animals with emphasis on insects and related Arthropod disease carriers. **Prerequisite: Ent 301.**
Ent 560—PRINCIPLES OF INSECT CONTROL—3 cr. (3 and 0)
   The mechanical, physical, cultural, biological, chemical and legal aspects of insect control.

*May be used for graduate credit under special conditions only.
**Ent 405 and 408 are taught in alternate years.
Ent 561—INSECT TOXICOLOGY—3 cr. (2 and 3)

History, development, application, chemical nature and mode of action of insecticides. **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.

**EXPERIMENTAL STATISTICS**

These courses are administered by the Departments of Agricultural Economics and Agronomy. The courses may not be used by themselves to meet the requirements for a major. A student may receive credit for a minor in Experimental Statistics at the Master's level provided he has had not less than twelve semester hours of statistics, at least six of which must be taken for graduate credit.

Ex St 401—STATISTICS—3 cr. (2 and 3)

Ex St 462—STATISTICS APPLIED TO ECONOMICS—3 cr. (3 and 0)

Ex St 501—STATISTICAL METHODS I—4 cr. (3 and 3)

Role of statistics in research. Statistical inference, concepts, estimation, tests of significance, linear regression, correlation, analysis of variance including multiple comparison techniques, covariance analysis, mean square expectations, and variance component analysis. **Prerequisite:** Ex St 401 or Math 303 or permission of instructor.

Ex St 502—STATISTICAL METHODS II—3 cr. (3 and 0)

Principles of scientific experimentation, design, analysis, and interpretation of experimental investigations, multiple regression, and covariance.
The application, analysis, efficiency, and limitations of the basic designs, factorial systems, and incomplete block designs will be considered. **Prerequisite:** Ex St 501.

Ex St 512—DESIGN OF EXPERIMENTS—3 cr. (3 and 0)

A course for graduate students in the experimental sciences in which detailed examination will be made of the basis of the techniques and scope of validity in the application of statistics to the design, analysis and interpretation of experiments. **Prerequisite:** Ex St 502.

**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)

Geol 411—RESEARCH PROBLEMS—3 cr. (0 and 9)

Geol 412—RESEARCH PROBLEMS—3 cr. (0 and 9)

**HISTORY AND GOVERNMENT**

R. S. Lambert, 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 402—MEDIEVAL HISTORY—3 cr. (3 and 0)
HOME ECONOMICS

The Master of Science degree in Home Economics with emphasis on nutrition is offered by the Department of Home Economics at Winthrop College in cooperation with Clemson College. The degree requires the completion of 15 semester hours in home economics, a thesis for which six semester hours of credit is given, and courses at Clemson in food technology, nutrition, and related areas. Twelve semester hours of work must be completed in courses for graduate students only.

Students interested in this program should write for further details to the Chairman of the Department of Home Economics, Winthrop College, Rock Hill, South Carolina.

HORTICULTURE

T. L. Senn, Chairman

Courses are offered leading to the Master of Science degree.

Graduate study in horticulture is designed to acquaint the student with the important biological principles underlying the production and post-harvest handling of horticultural crops. This includes not only the study of the economic product prior to harvest, but also through its harvesting storage, marketing and processing. Scientific knowledge obtained in horticultural research as well as that available in the related fields of botany, plant physiology, biochemistry and genetics serve to give the student a broad base for future work in his chosen field.

Graduate study is carried on in pomology, vegetable crops, floriculture and ornamental horticulture, and post-harvest handling. Prior to admis-
sion for graduate work, acceptable courses on the undergraduate level are recommended. While students need not major in horticulture as undergraduates, deficiencies in this respect must be made up by taking courses as directed by the departmental advisers and the graduate committee of the Department of Horticulture.

*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)
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—EXPERIMENTAL OLERICULTURE I—3 cr. (3 and 0)
A systematic study of sources of information on mineral nutrition and water relations of vegetable crops.
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)

*May be used for graduate credit under special conditions only.
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 401—INDUSTRIAL EDUCATION LABORATORY—3 cr. (1 and 6)**

**In Ed 405—TESTS AND MEASUREMENTS IN INDUSTRIAL EDUCATION—3 cr. (3 and 0)**

**In Ed 416—DESIGN AND OPERATION OF INDUSTRIAL EDUCATION LABORATORIES—3 cr. (2 and 3)**

**In Ed 422—VOCATIONAL EDUCATION PROGRAMS—3 cr. (3 and 0)**

**In Ed 425—TEACHING INDUSTRIAL SUBJECTS—3 cr. (3 and 0)**

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In Ed 432—ADVANCED WOODWORKING—2 cr. (1 and 3)
In Ed 435—ADVANCED WELDING—2 cr. (1 and 3)
In Ed 436—ADVANCED MATERIAL FORMING—2 cr. (1 and 3)
In Ed 438—ADVANCED MACHINING—2 cr. (1 and 3)
In Ed 441—COMPREHENSIVE GENERAL SHOP PRACTICES—2 cr. (1 and 3)
In Ed 446—SHOP PLANNING AND LAYOUT—3 cr. (3 and 0)
In Ed 447—CURRICULUM DEVELOPMENT IN INDUSTRIAL EDUCATION—3 cr. (3 and 0)
In Ed 496—PUBLIC AND INDUSTRIAL RELATIONS FOR VOCATIONAL TEACHERS AND SUPERVISORS—3 cr. (3 and 0)
In Ed 515—SEMINAR—1 cr. (1 and 0)
A joint study and discussion by graduate students and members of the faculty of new technological and professional advances.
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.

INDUSTRIAL MANAGEMENT
W. D. Trevillian, Chairman

Courses are offered leading to the Master of Science degree.

All students enrolled in this curriculum must take the core courses IM 501, 502, 503, and 504. Students selecting the non-thesis option will be required to earn six credits in courses at the 500 level to replace the thesis credits. These courses must be approved by the department chairman.

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One of the requirements for graduate students in the Industrial Management Curriculum is the demonstration of a proficiency in basic statistics before the end of his first semester of graduate work. This requirement may be met by completing a course in basic statistics approved by the student's advisor (preferably Experimental Statistics 401) or by passing a written examination. The examination is administered by a committee of three persons appointed by the Head of the Department of Industrial Management.

For the non-thesis program, at least one formal paper or report of substantial content evidencing the student's ability to write effectively is required for graduation. It may be written as a part of the requirement of a graduate level course in the "core" curriculum. It must be accepted as satisfactory by the graduate faculty of the Department of Industrial Management and filed in the Clemson Library.

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

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

**IM 405—PRINCIPLES OF TRANSPORTATION—3 cr. (3 and 0)**

**IM 406—THEORY OF INDUSTRIAL LOCATION—3 cr. (3 and 0)**

**IM 501—QUANTITATIVE ECONOMIC ANALYSIS—3 cr. (3 and 0)**

An application of quantitative techniques including an introduction to econometric models as a potential method for solving many of the problems arising in a modern industrial enterprise. **Prerequisite:** IM 404 or permission of instructor.

**IM 502—FINANCE—3 cr. (3 and 0)**

The analysis of the financial condition of business firms as a means of recognizing current and long-term financial needs. Emphasis on selection of the most feasible actions necessary to secure the best possible financing under varied circumstances.

**IM 503—PRODUCTION MANAGEMENT—3 cr. (3 and 0)**

An analysis of the problems facing an industrial enterprise in planning, organizing, directing, and controlling its production activities and a study of the literature of the scientific management movement. **Prerequisite:** IM 402 or permission of instructor.

**IM 504—MANAGERIAL POLICY—3 cr. (3 and 0)**

A course in management policy making. The course emphasizes determining objectives and developing sound policies for achieving them. Managerial Policy builds upon and integrates the other graduate courses. The case method is used extensively. Written and oral presentations.
IM 505—QUALITY CONTROL—3 cr. (3 and 0)
The organization and management of the quality control function in industry. Included are some advanced techniques in quality control. **Pre-requisite:** IM 304 or permission of instructor.

IM 591—THESIS RESEARCH—3 cr.

IM 592—THESIS RESEARCH—3 cr.

**MATERIALS ENGINEERING**

G. C. Robinson, Chairman

Courses are offered leading to the Doctor of Philosophy degree.

Attention in the materials engineering curriculum is focused upon materials utilized in electronic products, parts for spacecraft, and components of nuclear reactors. Courses provide an understanding of the behavior, analyses, and application of ceramics, metals, and plastics. Major emphasis is placed on the atomic, molecular, and crystalline structure of the materials for the explanation of their behavior.

Courses included in the curriculum are drawn from departments in four disciplines: chemistry, physics, ceramics, and metallurgy, and are grouped under five general headings:

1. The nucleus
2. Development of material properties from the nucleus
3. Laboratory techniques
4. Application and design
5. Auxiliary courses on production

Over sixty-five courses are offered under these headings.

**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 303—STATISTICS—3 cr. (3 and 0)
* Math 305—FOUNDATIONS OF ANALYSIS—3 cr. (3 and 0)
* Math 306—DIFFERENTIAL EQUATIONS—3 cr. (3 and 0)
* Math 308—COLLEGE GEOMETRY—3 cr. (3 and 0)
* Math 310—PROGRAMMING THE DIGITAL COMPUTER—3 cr. (2 and 3)
* Math 311—INTRODUCTION TO MODERN ALGEBRA—3 cr. (3 and 0)
* Math 312—LINEAR 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 407—PARTIAL DIFFERENTIAL EQUATIONS—3 cr. (3 and 0)
Math 409—THEORY OF APPROXIMATIONS—3 cr. (2 and 3)
Math 451—VECTOR ANALYSIS—3 cr. (3 and 0)
Math 452—LINEAR PROGRAMMING—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)
Math 455—LAPLACE TRANSFORMS—3 cr. (3 and 0)
Math 502—DETERMINANTS AND MATRICES—3 cr. (3 and 0)

Topics include determinants, polynomials and forms, transformations, system of linear equations.

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.

* May be used for graduate credit under special conditions only.
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.

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 516—TENSOR ANALYSIS—3 cr. (3 and 0)
Fundamental concepts and notation of tensor theory, including the calculus of tensors. Applications to physics as time permits.

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.

Students majoring in mechanical engineering must take the advanced calculus courses (Math 453 and 454) as their minor field. After meeting the minimum requirements for the major and minor fields, the student may schedule the remaining six hours with the approval of his major adviser.

ME 401—FUNDAMENTALS OF MACHINE DESIGN—3 cr. (3 and 0)
ME 402—MECHANICAL ENGINEERING DESIGN—3 cr. (1 and 6)
ME 403—GAS DYNAMICS—3 cr. (3 and 0)
ME 404—AUTOMATIC CONTROL ENGINEERING—3 cr. (3 and 0)
ME 407—HEAT TRANSFER II—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 421—PROPULSION SYSTEMS—3 cr. (3 and 0)
ME 422—PRINCIPLES OF TURBOMACHINERY—3 cr. (3 and 0)
ME 423—PROPULSION SYSTEM ANALYSES—1 cr. (0 and 3)
ME 424—ENGINEERING ANALYSIS—2 cr. (1 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—THERMAL ENVIRONMENTAL ENGINEERING—3 cr. (3 and 0)

A study of the effects of the thermal environment upon people, processes, and materials including a detailed analysis of the fundamental theories of
refrigeration, psychrometrics, heat and mass transfer processes with moist air, periodic heat transfer in buildings, solar radiation, and cryogenics.

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—GAS DYNAMICS II—3 cr. (3 and 0)
Concepts from thermodynamics, one-dimensional gas dynamics, one-dimensional wave motion, normal and oblique shocks. Flow in ducts and wind tunnels. Two-dimensional equation of motion. Small perturbation theory. **Prerequisite:** ME 403, ME 433.

ME 512—BOUNDARY LAYER THEORY I—3 cr. (3 and 0)

ME 513—ADVANCED GAS DYNAMICS III—3 cr. (3 and 0)
Rayleigh-Janzen method; Prandtl-Glauert method; Hodograph method and Karman Tsien approximation. Exact solutions in irrotational flow. The method of characteristics of supersonic flows and shock tubes. **Prerequisite:** ME 511.

ME 514—HYPersonics—3 cr. (3 and 0)
General features of hypersonic flow. The role played by the ratio of specific heats. Normal, oblique and curved shock relation; vorticity and shock curvature. Irrotational small-disturbance similitude. Boundary layer hypersonic flow interaction. The principle of equivalence. Blast wave theory. **Prerequisite:** ME 511, Math 454.

ME 524—PROPULSION SYSTEMS—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 540—KINEMATICS II—3 cr. (3 and 0)

ME 591—RESEARCH—3 cr.

ME 592—RESEARCH—3 cr.

ME 612—BOUNDARY LAYER THEORY II—3 cr. (3 and 0)
Continuation of turbulent and compressible boundary layer theories. Boundary layer stability study and boundary layer control. Prerequisite: ME 512.

ME 614—MAGNETOHYDRODYNAMICS—3 cr. (3 and 0)
Review of electrodynamics, conduction of electricity in gases. Equation of motion of magnetohydrodynamics. Solutions for special cases and various approximations. Magnetohydrodynamic waves and shocks. Application to propulsion. Prerequisite: Phys 541 or EE 521.

ME 630—CONDUCTION HEAT TRANSFER—3 cr. (3 and 0)
Physical properties; steady conduction in one and two-dimensional systems; periodic and transient systems; heat conduction with change in phase; moving heat sources. Prerequisite: ME 407.

ME 631—CONVECTION HEAT TRANSFER—3 cr. (3 and 0)
Analytical solutions for laminar and turbulent boundary layers; similarity relations for heat convection; heat convection including change of phase. Prerequisite: ME 407.

ME 632—RADIATION HEAT TRANSFER—3 cr. (3 and 0)
Radiation properties; analysis of radiation heat transfer; applications. Prerequisite: ME 407.

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 the following four courses as a part of their graduate program: Physics 521, 522, 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—LIGHT—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 SPECTROSCOPY—3 cr. (3 and 0)
Phys 434—OPTICS LABORATORY—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.

*Courses which may be used by students majoring in other fields.
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, 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 I—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—ELECTRODYNAMICS II—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 effects 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 representation; 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; introduction 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, radioactivity 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 Philosophy degrees. See Botany for a listing of courses available.

POULTRY SCIENCE
B. D. Barnett, Chairman

Courses are offered leading to the Master of Science degree.

Enrollment is not limited to holders of degrees from the poultry curriculum or from agriculture. Mathematics, chemistry, physics, economics and biology majors will find challenging course work and thesis problems utilizing their special knowledge.

A graduate student in poultry science will be delayed unless his previous training included chemistry and the biological sciences.

The department research program emphasizes pathology, physiology and nutrition. The student will select a minor in a related field.

*PS 352—POULTRY NUTRITION—3 cr. (2 and 3)
*PS 354—POULTRY BREEDING—3 cr. (2 and 3)
*PS 355—POULTRY GRADING AND PROCESSING—3 cr. (2 and 3)
PS 457—INCUBATION AND BROODING—3 cr. (2 and 3)

*Courses may be used by students majoring in other fields.
PS 458—POULTRY DISEASES AND PARASITES—3 cr. (2 and 3)

PS 460—SEMINAR—2 cr. (2 and 0)

PS 501—POULTRY NUTRITION AND METABOLISM—3 cr. (2 and 3)

A study of dietary requirements as they result from the biochemistry of animals. Poultry will be emphasized, but mammals and other animals will be discussed and comparisons made between species. Term papers will be required on specified areas of nutrition or biochemistry. Laboratory material will include development of nutritional imbalances with poultry and other appropriate species. Chemical and biological assays of nutrients will be performed using acceptable methods and species.

PS 502—AVIAN PHYSIOLOGY—3 cr. (2 and 3)

A comparative physiology course dealing with all classes of mammals and fowl. Processes of ingestion, digestion, secretion, excretion, respiration, circulation and metabolism. Endocrinology and reproduction will be reviewed briefly.

PS 504—POULTRY PATHOLOGY—3 cr. (1 and 6)

A study of the causes, prevention and treatment of poultry diseases. The laboratory material will include exercises in bacteriology, virology, protozoology, serology, and other means of diagnosing poultry diseases and studying disease-producing agents.

PS 505—SEMINAR—1 cr. (1 and 0)

Report on special topics or original research by students, staff and visiting speakers.

PS 591—RESEARCH—3 cr.

PS 592—RESEARCH—3 cr.

**SOCIIOLOGY**

G. H. Aull, Chairman (Rural Sociology)

R. S. Lambert, Chairman (General Sociology)

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

RS 459—THE COMMUNITY—3 cr. (3 and 0)

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

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

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)

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**TEXTILE CHEMISTRY**

Joseph Lindsay, Jr., Chairman

Courses are offered leading to the Master of Science degree.

The Textile School has excellent equipment for teaching and research. The laboratories have the best facilities available for chemical and physical testing, and the many semi-practical wet-processing units are designed to permit experimental work with a wide range of textile processes.

Graduate work in textile chemistry is open to students who have sufficient background in chemistry. Those without textile degrees must take selected undergraduate courses in this field to give them necessary background.

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. (3 and 0)

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. (3 and 0)

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.

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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 and Doctor of Philosophy degrees.

Water Resources Engineering is an interdisciplinary curriculum designed to prepare the student for a career in water conservation, water quality control, and treatment and disposal of municipal and industrial wastes. Enrollment is open to students possessing degrees in engineering and to those with degrees in science who have credits for certain prescribed courses in engineering.

Courses composing the major field of study may be selected from certain ones offered in agricultural economics, bacteriology, chemistry, civil engineering, engineering mechanics, chemical engineering, and experimental statistics. Minors may be taken in hydraulics and hydrology, mathematics, experimental statistics, chemistry, or bacteriology. The student's program will depend upon his particular background and interest.
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 458—CELL PHYSIOLOGY—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.
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 working 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 treatment 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 Entomology. 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.

*May be used for graduate credit under special conditions only.
Zool 513—EVOLUTION—3 cr. (3 and 0)

Covers the principles which have governed the evolution of plants and animals and also of the relationships of the Phyla and classes which are the results of this process.

Zool 552—PRINCIPLES AND METHODS OF SYSTEMATIC ZOOLOGY—
2 cr. (2 and 0)

Presents the problems which confront the taxonomist in the zoological sciences and the conventional practices which have been developed to handle them.

Zool 556—ECONOMIC ZOOLOGY—3 cr. (2 and 3)

A study of all phyla (exclusive of class insecta) to include those animals either beneficial or destructive to man. Prerequisites: Zool 101, 103.

Zool 591—RESEARCH—3 cr.

Zool 592—RESEARCH—3 cr.