

*Department of
Materials Science and Engineering
Clemson University*

**GRADUATE STUDENT MANUAL
2013-2014**

Clemson, SC 29634-0971



POLICY ON RESEARCH ETHICS

DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING

The effectiveness of the research infrastructure throughout the world is based on the personal and professional integrity of the people involved. The basic assumption that is central to all research endeavors is that researchers have done what they say that they have done. The Department of Materials Science and Engineering is part of that infrastructure, and the research conducted here must withstand the highest scrutiny. Consequently, we must all ensure that our scholarly work is conducted and reported with the highest ethical standards. We must be careful in our record keeping and diligent in our efforts to always attribute credit where it belongs. In particular, we must guard against any activity that would bring the integrity of the department or the individuals within it into question. Among the activities to be avoided are:

- Falsification of Data – ranging from fabrication to deceptively selective reporting of results or methods, including the purposeful omission of conflicting data with intent to falsify results;
- Misappropriation of other’s Ideas – the unauthorized use of privileged information, however obtained; and
- Plagiarism – representation of another’s work as one’s own. The following website link has a great deal of information in defining and giving examples of plagiarism: www.plagiarism.org.

In the Clemson University graduate announcements plagiarism is described “as a form of academic dishonesty that includes copying of language, structure or ideas of another, and attributing the work to ones own efforts.”

Review the Graduate School’s academic integrity policy at :
gradspace.editme.com/AcademicGrievancePolicyandProcedures#integritypol

Note: there is no mention of intent or deceitful intent. This means that if you submit plagiarized work, **even if this is unintentional**, it is still plagiarism. Ignorance of the rules is no excuse for breaking them.

It is the responsibility of every member of Clemson University to enforce the academic policy (see Graduate Announcements).

Examples of plagiarism

- To use ideas (i.e., to steal them) from someone else and pass them off as if the ideas were your own is plagiarism.
- To take a source of material, words, diagrams or results and pass them off as your own is plagiarism.
- To copy someone else’s work and submit it as your own is plagiarism.
- To copy words and ideas without giving appropriate credit is plagiarism.
- If you quote someone but do not use quotation marks this is regarded as plagiarism.
- If you change the words in a sentence but do not change the structure this is regarded as plagiarism.
- If you take or copy a vast number of words or sentences or paragraphs from a paper, book, journal or any other literary source so that it makes up a large amount of your work whether you give credit or not is still plagiarism because this goes against United States government guidelines of “fair use”. Basically, if you have copied a text or diagram exactly as in the original source then this is unlikely to be considered fair use. If in some way you have creatively rewritten the material then this more than likely will be considered fair use. However, the more you use or borrow from other sources the less likely it is to be considered fair use.
- Anything directly taken from copyrighted material is plagiarism unless permission is granted to use those materials from the author/publisher.

The undersigned attests that s/he acknowledges receipt of this manual, has read and understood pages 2 and 3 of the manual, has reviewed the Graduate School’s policies on academic integrity, recognizes the importance of maintaining the highest ethical standards in research, and covenants with the other members of the department to conduct his/her research and professional life in a manner consistent with these details.

NAME (Print)

SIGNATURE

DATE



STATEMENT OF AGREEMENT

DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING

I, the undersigned, have reviewed this *MSE Graduate Student Manual* and agree to abide by all of the policies, procedures and guidelines discussed herein.

(Printed Name)

(Date)

(Signature)

TABLE OF CONTENTS

INTRODUCTION-----	6
QUICK REFERENCE GUIDE-----	7
GRADUATE PROGRAM PERSONNEL-----	8
<u>REGISTRATION</u> -----	10
<i><u>FINANCIAL SUPPORT</u></i> -----	11
<i><u>MSE GRADUATE COURSES</u></i> -----	12
<i><u>POLICIES AND PROCEDURES FOR MASTER'S DEGREES</u></i> -----	13
<i><u>Curriculum Development – Plan of Study – GS2 Form</u></i> -----	16
<u>POLICIES AND PROCEDURES FOR Ph.D. DEGREES</u> -----	21
<u>Ph.D. Comprehensive Examination</u> -----	24
<u>1. Ph.D. Comprehensive Exam Schedule</u> -----	26
<u>2. Guidelines for the Ph.D. Research Proposal</u> -----	27
<u>3. Oral Exam Preparation Guidelines</u> -----	31
<u>Pre-Defense Meeting and Final Graduation</u> -----	32
<u>PREPARATION OF THESIS OR DISSERTATION</u> -----	33
GRADUATE ASSISTANTSHIP AND FINANCES-----	34
GENERAL DEPARTMENT INFORMATION-----	37
GENERAL SAFETY AND HEALTH POLICIES-----	46
PURCHASING-----	50
GENERAL UNIVERSITY INFORMATION-----	51
 APPENDICES	
<u>TOPICS FOR PH.D. COMPREHENSIVE EXAMS</u> -----	53
<u>T.A. ASSESSMENT</u> -----	73
<u>MSE GRADUATE STUDENT ANNUAL REPORT</u> -----	74
<u>M.S. Student Checklist</u> -----	77
<u>Ph.D. Student Checklist</u> -----	78

INTRODUCTION

WELCOME to the Department of Materials Science and Engineering (MSE). This manual is intended to familiarize Graduate Students with the operational aspects of the Department of Materials Science and Engineering at Clemson University. As such, it serves as an informational source and a catalog of Department procedures and requirements that affect graduate students. The requirements specified here are in addition to those described in the "Graduate School Announcements," which may be found on the Clemson Graduate School Web Site at www.grad.clemson.edu.

The faculty of MSE adopted these policies. The policies in this manual apply to students joining MSE during the year for which this manual is valid.

All new students are required to attend orientations held by the Department of Materials Science and Engineering and the Graduate School. Information from these orientations helps students to select specific research areas and allows them to choose their advisory committee members more responsibly. Dates and times of orientation meetings are announced each semester.

We hope this manual is useful both to graduate students and their faculty advisors. Any inconsistencies or omissions should be brought to the attention of the Program Coordinator.

Jurisdiction/Authority

This document is subject to periodic review and revision by the MSE faculty. Each graduate student is subject to the policies in effect at the time of beginning their program. If policies change, a student may petition, in writing, the MSE faculty for approval, or disapproval, of changing to the new policies.

QUICK REFERENCE GUIDE

BUILDING KEYS

Student Services Coordinator, 162B Surrine Hall

COURSE SELECTION (1ST semester only, students without major advisor)

Graduate Program Coordinator, 161 Surrine Hall

GRADUATE ASSISTANTSHIPS

*Graduate Program Coordinator (students without advisor), 161 Surrine Hall
Administrative Assistant (in charge of assistantship forms), 161 Surrine Hall*

GRADUATE STUDENT FORMS

Student Services Coordinator, 162B Surrine Hall

PAYROLL

Administrative Assistant (in charge of finance), 161 Surrine Hall

PURCHASING

Administrative Assistant (dependent on type of order), 161 Surrine Hall

STUDENT RECORDS

Student Services Coordinator, 162B Surrine Hall

TRAVEL

Administrative Assistant (in charge of travel), 161 Surrine Hall

GRADUATE PROGRAM PERSONNEL

Dr. Raj Bordia (161 SIRRINE Hall, rbordia@clermson.edu)

Department Head, Materials Science and Engineering – decides matters involving resources available to graduate students; has final approval on assistantship and fellowship offers; has the authority on regulations and procedures pertinent to the Graduate Program.

Graduate Program Coordinators and Committee

Dr. Kostya Kornev (295 SIRRINE Hall, 656-6541, kkornev@clermson.edu)

Chairperson of MSE Graduate Committee – makes recommendations to the Department Head regarding graduate admissions offers along with other members of the Graduate Standards Committee; interacts with the Graduate School on other matters including student status, assistantships, and fellowships; coordinates graduate student recruitment activities; coordinates Ph.D. comprehensive exams.

Dr. Gary Lickfield (161 SIRRINE Hall, 656-5964, lgary@clermson.edu)

Graduate Program Coordinator – works with students that have been accepted and have officially entered the MSE graduate program; acts as the initial advisor in first semester course selection for those graduate students who have not yet selected a major advisor.

Program Assistance

OPEN POSITION (162B SIRRINE Hall, 656-1512)

Student Services Coordinator – distributes graduate student forms and building keys; maintains student records; coordinates classroom reservations in MSE buildings; sends email alerts for student meetings, fellowships and job opportunities.

Shelby Sheriff (161 SIRRINE Hall, 656-3187, sshelby@clermson.edu)

Office Manager, Administrative Assistant – assists the Director of MSE with her duties; coordinates fellow Administrative Assistants, schedules conference room.

Tonya Bledsoe (161 SIRRINE Hall, 656-6900, bledsoe@clermson.edu)

Administrative Assistant – in charge of assistantship forms, Payroll, Travel Vouchers and car rental, Purchase Orders/Requisitions for general orders and other graduate student financial matters; receives Research Proposals, accident reports and requests for military leave.

Technical Assistance

Kim Ivey (Lab G73 Sarrine Hall, 656-5968, ikimber@clemson.edu)

Analytical Lab Manager – manages daily operation of the chemical, chromatographic, spectroscopic and thermal analyses laboratories.

Dr. Kate Stevens (Lab 280 Sarrine Hall, 656-5972, ksteven@clemson.edu)

Technical Services Manager – manages daily operation of Physical Testing Facility. Supervises and schedules daily work of Technical staff (James Lowe, Stanley Justice, Paul Rowland and David White). Schedules industrial testing/trials in the fabric (nonwovens and woven) formation, finishing, and/or Physical Testing Facility. Makes recommendations to the Department Head regarding laboratory equipment and/or safety, computer, space needs.

Stanley Justice (Lab B16 Sarrine Hall, 656-5978, jstanley@clemson.edu.)

Laboratory Specialist – Design, modify, and/or install new or existing equipment to support teaching, research, and public service projects. Provides support of industrial projects in the fabric (nonwoven and woven) formation and/or finishing labs.

James Lowe (Lab G32 Sarrine Hall, jaelowe@clemson.edu)

Laboratory Technologist - maintains Chemical Inventory list for MSE laboratories and ensures that all MSE Labs housing Chemicals are meeting CUEH safety compliance (Sarrine, Olin, Rhodes & AMRL). Conducts safety training sessions for faculty, staff and students. Assists Physical Testing Facility and provides support of industrial projects in the fabric (nonwoven and woven) formation and/or finishing labs.

Paul Rowland (Lab G56 Sarrine Hall, rowlanp@clemson.edu)

Laboratory Specialist – supports research projects four days each week in Sarrine and Olin Halls and one day each week at AMRL with respect to maintenance and design of electrical components of equipment for research, teaching and public service projects. Provides support of industrial projects in the fabric (nonwoven and woven) formation and/or finishing labs.

David White (162C Sarrine Hall, w david@clemson.edu)

Systems Programmer - provides Computer and Electronics support to MSE faculty, staff and students (Sarrine, Olin and AMRL). Assists in solving IT problems. Designs electronic circuits for instrument interfacing. Updates MSE Website. Provides support of industrial projects in the fabric (nonwoven and woven) formation and/or finishing labs.

REGISTRATION

Registration for New Students

Prior to registration for the first semester of study, beginning graduate students must report to the Graduate Program Coordinator. S/he will be their initial advisor and will help them plan their initial program of study. See "Graduate Program Personnel" for current Coordinator.

Registration Procedures

The Office of Registration Services provides an online guide:
www.registrar.clemson.edu/

Enrollment Limits Maximum/Minimum Credit Hours

Student Category	Semester	6-week Session
Full-time students	18/12	6
Graduate assistants (¹ / ₄ time)	15/9	5
Graduate Assistants (¹/₂ time)	12/9	4/3
Graduate Assistants (³ / ₄ time)	12/9	3
Full-time Employees	9	3

Financial Support

Financial support is awarded based on several factors, which include academic merit and the availability of funds. Normally, eligible first year graduate students are awarded a Teaching Assistantship (TA) for the first two semesters. This assistantship includes a Stipend (pay) and a Graduate Assistant Differential (GAD), which is that portion of the tuition and fees paid by the university for the student. (The remainder of the tuition and fees paid by the student every semester and summer session is termed the Graduate Fee). In certain instances, first year students may be awarded a Research Assistantship (RA), or a combined RA/TA. In both cases, the assistantship includes the stipend and GAD. After the two semesters, most students will be placed on a RA or on a research stipend (which does not include a GAD).

Graduate students are eligible for continued financial support provided they are: (1) enrolled full-time; (2) in good academic standing, i.e., not on probation; (3) making satisfactory progress towards their degree based on their research and work ethic; and (4) the availability of funds. If a student changes his/her subject area after support has been extended, support eligibility will be reviewed and may be terminated.

MSE Graduate Courses

<u>GRADUATE COURSES</u>	<u>RECOMMENDED PRE-REQUISITES</u>
<u>MSE 8200</u> Deformation Mechanisms in Solids	<u>MSE 4220/6220</u> Mechanical Behavior of Materials
<u>MSE 8210</u> Fracture and Fatigue	
<u>MSE 8250</u> Solid State Materials Science	<u>MSE 4020/6020</u> Solid State Materials
<u>MSE 8260</u> Phase Equilibria in Materials Systems	<u>MSE 3260</u> Thermodynamics of Materials
<u>MSE 8270</u> Kinetics of Phase Transformations	<u>MSE 3270</u> Transport Phenomena
<u>MSE 8280</u> Phase Transformations in Materials Science	<u>MSE 3270</u> Transport Phenomena
<u>MSE 6570</u> Color Science	<u>MSE 4150/6150</u> Introduction to Polymer Sci & Eng
<u>MSE 8510</u> Polymer Science I	<u>MSE 4150/6150</u> Introduction to Polymer Sci & Eng
<u>MSE 8520</u> Polymer Science II	<u>MSE 4150/6150</u> Introduction to Polymer Sci & Eng
<u>MSE 8400</u> Analytical Methods in Textile and Polymer Science	
<u>MSE 8610</u> Fiber Physics I	<u>MSE 4610</u> Polymer & Fiber Science III
<u>MSE 8620</u> Fiber Physics II	
<u>MSE 8660</u> Fiber Formation	<u>MSE 4610</u> Polymer & Fiber Science III

Non-Clemson University courses cannot be revalidated irrespective of when they were taken.

POLICIES AND PROCEDURES FOR MASTER'S DEGREES

Important: Please follow the “M.S. Student Checklist” on page 81 to make sure that you are on the track to complete your degree requirements.

Introduction

These policies supersede any policies written prior to the current semester. Academic regulations pertaining to the various degree programs are published in the “*Graduate School Announcements*” and on-line at <http://www.grad.clemson.edu>.

Selecting a Research Advisor

All beginning M.S. students are asked to confer with each MSE faculty member in whose general area they may have an interest. Upon having done so, the student selects a research advisor subject to the consent of the selected faculty member. The student subsequently begins to formulate research plans with the advice of their advisor.

Advisory Committee

The student, working with his/her advisor, selects an advisory committee. The advisory committee should be chosen during the student’s first semester. A Master’s advisory committee shall consist of a minimum of three (3) members who hold faculty appointments at Clemson University. A majority of the committee shall hold tenure track faculty appointments in the Department of Materials Science and Engineering. Part-time visiting and other nontenure-track faculty employed by Clemson University, Emeriti faculty, and Adjunct faculty may serve as advisory committee members but may not serve as chair. The chairperson of the committee is usually the research advisor and must hold a full time faculty appointment at Clemson University. If the student has declared a minor, at least one of the committee must be from the faculty of the program offering the minor.

The student’s advisory committee will perform the following functions:

- Provide advice and consent in the selection of course work by the student;
- Assist in supervision of the student’s thesis research program;
- Administer the final oral examination;
- Approve the Master’s thesis; and,
- Initiate recommendation to the Graduate School for awarding of the degree.

Minimum Degree Requirements for M.S. in MSE

Course Credit Hours	24 Hours *
Core + Other courses required	4 core + 4 other = 8
Thesis Research 8910	6-hour thesis (Grad School requirement)
Credit Requirement (Total Course Plus Research Credit Hours):	A minimum of 30 credit hours past the bachelors
Exams	Thesis Defense

* Does not include MSE 8000 Materials Research Seminar

COURSE DEFICIENCIES

The MSE Graduate Program is not designed to be a “remedial or entry-level” program; therefore, students are expected to have the appropriate technical background prior to entering these programs. If course deficiencies are identified and/or if remediation is specified as a condition of a student’s admission, it is important that the remediation requirements be met early in the program in order to provide the student with background for graduate level courses. Normally, these deficiencies are removed by taking and passing specified required courses during a normally scheduled course offering. However, these courses do not count toward the total number of semester hours of graduate credit (exclusive of the MSE 8000) required for graduation.

All students must enroll in MSE 8000 Materials Research Seminar every semester.

Core Courses

Students pursuing a M.S. in MSE, with a metals and/or ceramics specialization, are required to take four (4) from the following six (6) courses, chosen by the student in consultation with their supervisor and advisory committee.

- MSE 8200 Deformation Mechanisms in Solids
- MSE 8210 Fracture and Fatigue
- MSE 8250 Solid State Materials Science
- MSE 8260 Phase Equilibria in Materials Systems
- MSE 8270 Kinetics of Phase Transformations
- MSE 8280 Phase Transformations in Materials Science

Four (4) other courses are selected by the student and his/her advisor. A student has to maintain a minimum 3.0 overall GPA in order to graduate with a M.S. degree.

Students pursuing a M.S. in MSE, with a polymer specialization, are required to take four (4) core courses from the following, chosen by the student in consultation with the supervisor and advisory committee.

TWO FROM:

- MSE 8510 Polymer Science I
- MSE 8520 Polymer Science II
- MSE 8400 Analytical Methods in Textile and Polymer Science
- MSE 8610 Fiber Physics I
- MSE 8620 Fiber Physics II
- MSE 8660 Fiber Formation

AND TWO FROM:

- MSE 8200 Deformation Mechanisms in Solids
- MSE 8210 Fracture and Fatigue
- MSE 8250 Solid State Materials Science
- MSE 8260 Phase Equilibria in Materials Systems
- MSE 8270 Kinetics of Phase Transformations
- MSE 8280 Phase Transformations in Materials Science

Four (4) other courses are selected by the student and his/her advisor. A student has to maintain a minimum 3.0 overall GPA in order to graduate with a M.S. degree.

Students pursuing a M.S. in MSE with specialization in Polymer and Fiber Science require four (4) from the following six (6) courses, chosen by the student in consultation with the supervisor and advisory committee.

- MSE 8510 Polymer Science I
- MSE 8520 Polymer Science II
- MSE 8400 Analytical Methods in Textile and Polymer Science
- MSE 8610 Fiber Physics I
- MSE 8620 Fiber Physics II
- MSE 8660 Fiber Formation

Four (4) other courses should be selected by the student and his/her advisor. A student has to maintain a minimum 3.0 overall GPA in order to graduate with a M.S. degree.

The student's advisory committee must approve all the courses by signing the student's GS2 form.

Curriculum Development – Plan of Study – GS2 Form

All students are expected to develop an area of study with the advice and consent of their advisory committee.

The planned course of study, once approved, must be presented to the Graduate School via the completion of the GS2 Form. The GS2 Form must be completed as soon as the student talks with his/her advisor and determines the course of study s/he will pursue, but no later than the end of the first semester.

The GS2 is a form that serves to appoint the graduate advisory committee and notifies the Graduate School of the classes the student will take to fulfill the degree requirements. **It is important to note that any class listed on one's GS2 must be completed before graduation. If changes are necessary, a revised GS2 must be filed.** This form may be found at www.grad.clemson.edu/forms.php.

Procedure

1. Download GS2 form & Instructions
Use the anticipated graduation date for completion of research hours
2. Once completed, submit to Graduate Program Coordinator for approval
3. Obtain signatures from your advisor and committee
4. Submit signed form to Student Services Coordinator

MASTER'S THESIS

Purpose

The purpose of the M.S. thesis is to demonstrate the capability of the student to:

- Formulate a research problem;
- Demonstrate knowledge relevant to a meaningful resolution of a specific problem;
- Effectively plan the work leading to the completion of the problem; and,
- Report the results of the problem in a concise, precise professional style.

Selecting a Research Topic

Major advisors will assist students in the selection of an appropriate topic for their thesis. Students are expected to have selected a thesis topic by the end of their first semester of graduate study. By the end of second semester they must have prepared and presented to their advisory committee **a typewritten proposal containing a definition of the problem, the objective(s) of the problem, and a plan and schedule for the completion of the problem.** Proposals should also indicate any instruments, equipment, and materials that may be required. Each student's advisory committee will review his/her initial proposal and make appropriate recommendations. **Copies of the approved written proposal must be filed with the MSE Administrative Assistant before the end of the second semester of enrollment.** Failure of the graduate student to complete this requirement within the specified time frame will be ground for dismissal from the MSE graduate program.

Thesis Proposal

It is **recommended** that a M.S. student should complete the final draft of the proposal by the end of the second semester of enrollment in the M.S. degree program. A student's thesis proposal is a persuasive document intended to document the worthiness of his/her research. It should be a brief, concise document that is 5 to 15 pages when double-spaced, not including references.

Students develop their proposal with the help of their advisor and committee. The purpose of the proposal is to create a research plan. The student's actual activities may vary as conditions and initial results dictate. The research proposed should be worthwhile and tractable. At the center of the proposal, there should be a clear hypothesis to be tested and/or a set of objectives. The material discussed before the objectives should give the necessary background and lead to why the objectives are worth pursuing. After the objectives are stated, a research plan should be presented aimed at attaining the objectives. The student should go over the central parts of the proposal, especially the objectives, with his/her advisor and then produce an initial draft.

The student's advisor will review the first draft and offer suggestions or changes. Upon approval of the advisor, copies will be distributed to the student's committee members for comments. Students may be required to orally defend their proposal before their committee. The signed original is kept in the student's original departmental file, which is maintained by the student coordinator.

Proposal Text – Introduction

The introduction to the proposal should include some brief introductory remarks and a review of the literature that is relevant to the stated objectives. The literature review should be current and organized to support the research objectives.

Research Objective

This section should be written first. This section should contain a paragraph summarizing the major objective of the research. The major objective, whenever possible, should be stated as a hypothesis with tasks outlined for testing the hypothesis.

Experimental Plan and Methodology

This section should outline the experimental approach that will be used to accomplish the tasks listed in the objectives section. The approach should include the experimental design and a matrix of experiments to be conducted. The methodology should include procedures and analytical protocol or information about the development of those procedures. Information about the data to be collected and the use of the data should be provided, as well as final evaluation approaches.

Significance of the Proposed Work

This section should be a brief summary of why it is important to conduct the proposed research. What are the expected results and how will they benefit the Materials Science and Engineering community?

Helpful Hints

Students should use the recommended Graduate School format desired for references, font and other formatting items.

Whenever possible, use the active voice as the use of the first person is generally discouraged in technical writing.

Avoid starting sentences with numbers. Numbers less than or equal to ten should be spelled out. Numbers of 11 or more can be represented by Arabic numerals. However, if referring to an exact amount such as 1.0 mL, use numerals.

For additional information on technical writing, the following are recommended:

- *How to Publish a Scientific Paper* by Robert A. Day;
- *Scientific English: A Guide for Scientists and Other Professionals* by Robert A. Day; and
- *The ACS Style Guides: a Manual for Authors and Editors* edited by Janet S. Dodd.

Approval of Research Proposal

Master's students should have a research proposal approved before the end of their second semester. The proposal is developed with and approved by the research advisor. This is an optional requirement.

Pre-Defense Advisory Committee Meeting

Approximately 6 months before the expected final oral defense, an advisory committee meeting should be held. The purpose of this meeting is for the candidate and the committee to discuss the expectations for graduation.

Graduate Diploma Application – GS4 Form

The GS-4 form informs students of how to apply for graduation and order their diploma. The form is downloadable from the following web link:
www.grad.clemson.edu/forms/forms_graduating.php

Thesis Deadline

A first draft of the thesis should be completed well before the date of the final oral examination. A final draft (approved by the advisor) should be submitted to the advisory committee at least 2 weeks before the oral exam. Consult your advisory committee for specific requirements.

Final Oral Examination

The final oral examination is given at least three weeks before the date on which the degree is to be conferred. This is given under the authority of the student's advisory committee in accordance with Graduate School deadlines. The committee will have been given final draft copies of the thesis a minimum of two weeks prior to the exam.

The chair of the student's advisory committee will schedule the examination that is administered by the committee. During the examination, the student will be expected to orally present the findings of the research, support various aspects thereof, and be questioned on integrated knowledge of related coursework. The Graduate School will be notified of the date, time and place of the examination at least ten days prior to the date scheduled. At the same time, members of the MSE faculty, the Graduate Standards Committee, the Deans of the College of Engineering and Science and the

Graduate School, and MSE students will be invited to attend the examination. Procedurally, the examination consists of a 30-45 minute presentation made by the student followed by questions posed, first by those in attendance and second, by the members of the student's graduate advisory committee.

The results of the oral defense are submitted to the Graduate School via the GS7 form. This form must be filled out and taken to the defense by the student and signed by the Committee.

Unsatisfactory performance on the final examination, as determined by the advisory committee, will result in at least one of the following actions to be taken:

1. Additional work on the thesis and resubmission of the thesis to the advisory committee for further review; or
2. Additional study in their area of specialty.

In case of failure, the advisory committee is required to submit a written report to the Dean of the College of Engineering and Science and the Graduate School stating that the student failed the final examination. A second failure on the final examination shall result in the student being declared ineligible for a Master's Degree in MSE at Clemson University.

POLICIES AND PROCEDURES FOR Ph.D. DEGREES

Important: Please follow the “Ph.D. Student Checklist” on page 82 to make sure that you are on the track to complete your degree requirements.

Introduction

These policies supersede any policies written prior to the current semester. Academic regulations pertaining to the various degree programs are published in the “*Graduate School Announcements*” and on-line at <http://www.grad.clemson.edu>.

Selecting a Research Advisor

All beginning Ph.D. students should confer with each MSE faculty member in whose general area they may have an interest. Upon doing so, the student should select a research advisor subject to the consent of the selected faculty member. The student subsequently begins to formulate research plans with the advice of his/her advisor.

Advisory Committee

The student, working with his/her advisor, selects an advisory committee. The Ph.D. advisory committee shall consist of a minimum of four (4) members who hold faculty appointments at Clemson University. A majority of the committee shall hold tenure track faculty appointments in the Department of Materials Science and Engineering. Part-time visiting and other nontenure-track faculty employed by Clemson University, Emeriti faculty, and Adjunct faculty may serve as advisory committee members but may not serve as chair. The chairperson of the committee is usually the research advisor and must hold a full time faculty appointment at Clemson University. If the student has declared a minor, at least one of the committee must be from the faculty of the program offering the minor.

The student’s advisory committee will perform the following functions:

- Provide advice and consent in the selection of course work by the student;
- Assist in supervision of the student’s dissertation research program;
- Administer the comprehensive and final oral examinations;
- Approve the dissertation; and
- Initiate recommendation to the Graduate School for awarding the degree.

Curriculum Development – Plan of Study – GS2 Form

The student develops a plan of coursework with the assistance of the research advisor and input from the advisory committee. This should be done before the end of the first semester after beginning the program. This plan is formally submitted to the Graduate School on the GS2 Form (See **Curriculum Development – Plan of Study – GS2 Form** on page 16).

Minimum Degree Requirements for the Ph.D. in MSE

Total Hours of Courses	12 hours*
Core Courses Required	4
Doctoral Research – MSE 9910	18 hours (Grad School)
Credit Requirement (Total Course Plus Research Credit Hours):	A minimum of 60 credit hours past the bachelors or a minimum of 30 credit hours past the masters.
Exams	Comprehensive and Dissertation Defense (Final Examination)

* Does not include MSE 8000 Materials Research Seminar

Core Courses

Students pursuing a Ph.D. in MSE, with a metals and/or ceramics specialization, are required to take four (4) from the following six (6) courses, chosen by the student in consultation with his/her supervisor and advisory committee.

- MSE 8200 Deformation Mechanisms in Solids
- MSE 8210 Fracture and Fatigue
- MSE 8250 Solid State Materials Science
- MSE 8260 Phase Equilibria in Materials Systems
- MSE 8270 Kinetics of Phase Transformations
- MSE 8280 Phase Transformations in Materials Science

Other courses, which the supervisor/committee recommends to the student, may be taken; however, the grades in these courses will not be used in calculating the minimum GPA required to take the Ph.D. Comprehensive Examination. The student must maintain a minimum 3.0 overall GPA for all classes taken during his/her graduate study to be eligible for the Ph.D. degree.

Students pursuing a Ph.D. in MSE, with a polymer specialization, are required to take four (4) core courses- two(2) from each of the following sets of courses, chosen by the student in consultation with the supervisor and advisory committee.

TWO FROM:

- MSE 8510 Polymer Science I
- MSE 8520 Polymer Science II
- MSE 8400 Analytical Methods in Textile and Polymer Science
- MSE 8610 Fiber Physics I
- MSE 8620 Fiber Physics II
- MSE 8660 Fiber Formation

AND TWO FROM:

- MSE 8200 Deformation Mechanisms in Solids
- MSE 8210 Fracture and Fatigue
- MSE 8250 Solid State Materials Science
- MSE 8260 Phase Equilibria in Materials Systems
- MSE 8270 Kinetics of Phase Transformations
- MSE 8280 Phase Transformations in Materials Science

Other courses, which the supervisor/committee recommends to the student, may be taken; however, the grades in these courses will not be used in calculating the minimum GPA required to take the Ph.D. Comprehensive Examination. The student must maintain a minimum 3.0 overall GPA for all classes taken during his/her graduate study to be eligible for the Ph.D. degree.

Students pursuing a Ph.D. in MSE with Polymer and Fiber Science specialization are required to take four (4) from the following six (6) courses, chosen by the student in consultation with the supervisor and advisory committee.

- MSE 8510 Polymer Science I
- MSE 8520 Polymer Science II
- MSE 8400 Analytical Methods in Textile and Polymer Science
- MSE 8610 Fiber Physics I
- MSE 8620 Fiber Physics II
- MSE 8660 Fiber Formation

Other courses, which the supervisor/committee recommends to the student, may be taken; however, the grades in these courses will not be used in calculating the minimum GPA required to take the Ph.D. Comprehensive Examination. The student must maintain a minimum 3.0 overall GPA for all classes taken during his/her graduate study to be eligible for Ph.D. degree.

If a student has completed comparable course work at another Institution, s/he still must complete the four (4) core classes in the Department of MSE (Clemson University). If student has already taken the courses from the Department for his/her M.S. degree, the student may proceed directly to the comprehensive examination.

PH.D. COMPREHENSIVE EXAMINATION

Qualifications for students to take exam and criteria for eligibility:

Doctoral students are required to have a minimum GPA of 3.2 in their four (4) core courses in order to be eligible to take the comprehensive examination. Students may repeat up to two courses from the core in order to obtain the 3.2 GPA. Upon completion, students must declare eligibility by submitting the form on the following page (p 25.).

Students who do not achieve at least a GPA of 3.2 after completion of the core coursework may not take the comprehensive examination and will be dismissed from the Ph.D. program. If the 4-core-course GPA is equal to or greater than 3.2, then the students will have TWELVE (12) MONTHS to prepare themselves and pass the candidacy/comprehensive examination. This 12 months period will start on the first day of the semester following the semester in which the GPA requirement is satisfied.

Those students not meeting this time deadline will be:

1. Required to complete the M.S. degree in MSE prior to seeking re-admission to the Ph.D. program; or
2. Dismissed from the Ph.D. program if they have already earned the M.S. degree at Clemson.

Content of Comprehensive Examination and Expectations

The candidacy/comprehensive examination will consist of: (1) a written dissertation proposal; and (2) an oral exam. The examination will be conducted and administered by the student's advisory committee plus one external examiner appointed by the graduate standards committee. The supervisor can advise the student on topic and general content of the proposal but has no say in the pass/fail outcome of either the written proposal or the oral examination. It is expected that the written document will be solely the work of the student.

Students will be expected to have an in-depth knowledge in their selected research area including relevant literature, experimental methods, and fundamental assumptions and limitations. In addition, students are expected to be ready to answer all pertinent questions in this topic area based on the courses taken at the time of the examination that the examining committee deems relevant to the area of proposed research. Students must also be prepared to answer basic questions about materials science and engineering or polymer and fiber science, which are representative of a senior undergraduate major in the area. Suitable texts that cover these concepts will be recommended to students when necessary. The students must also be able to critique approaches and methodologies used by them and others cited in the literature. If the outcome of the candidacy/comprehensive examination results in a "fail" the student will have one chance to retake the candidacy/comprehensive examination.

DECLARATION OF QUALIFICATION
for
PhD COMPREHENSIVE EXAMINATION

By (please print name) _____

Date _____

List Core Courses Taken and Grade Received in Each:

Core Course GPA: _____

I am hereby eligible to begin the PhD Comprehensive Examination, beginning (check one):

___ Fall Semester _____(year) - Form must be submitted prior to August 15th

or

___ Spring Semester _____(year) - Form must be submitted prior to December 15th

Student Signature _____

Advisor's Name (please print) _____

Advisor's Signature _____

Submit to Student Services Coordinator

1. Ph.D. Comprehensive exam Schedules

If a student starts his/her comprehensive exam in the Fall semester, the deadline dates for the following academic year will be:

- Submission of an intent to the MSE Graduate Committee Chair: before **Aug. 15**
 - An external examiner, who will chair the examination committee, will be assigned.
- Submission of a written proposal (the 1st attempt): before **Sept. 15**
- Feedback to the student on the written proposal by faculty (the 1st attempt of the written proposal): before **Oct. 15**
- Oral exam – the first attempt (if “pass” the written exam in the 1st attempt): before **Dec. 1**

- If the student receives a “fail” in the 1st attempt of the written proposal, he/she should complete the following--
 - Resubmission of a written proposal: before **Dec. 15**
 - Receive feedback from committee members (of the 2nd attempt of the written proposal): before **Feb. 1**
 - Prepare for the Oral exam – the first attempt (if “pass” the written exam in the 2nd attempt): before **Mar. 15**

- If the student receives a “fail” in the 1st attempt of the oral exam, the time for the second attempt will be suggested by the committee. This second attempt must be completed before **Sept. 15** of the following year, or less than one year from the start date (to satisfy a Graduate School Regulation).

If a student starts his/her comprehensive exam in the Spring semester, the deadline dates for the following academic year will be:

- Submission of an intent to the MSE Graduate Committee Chair: before **Dec. 15**
 - An external examiner, who will chair the examination committee, will be assigned.
- Submission of a written proposal (the 1st attempt): before **Jan. 15**
- Feedbacks to the student (the 1st attempt of the written proposal): before **Feb. 15**
- Oral exam – the first attempt (if “pass” the written exam in the 1st attempt): before **Apr. 1**

- If the written proposal receives a “fail”, resubmission of a written proposal: before **Apr. 15**
 - Feedbacks to the student (the 2nd attempt of the written proposal): before **May 15**
 - Oral exam – the first attempt (if “pass” the written exam in the 2nd attempt): before **Sept. 1**

- If the student receives a “fail” on their first attempt of the Oral exam, the 2nd attempt time should be suggested by the student’s committee. The exam must be completed before **Jan. 15** of the following year or less than one year from the start date.

Timeline for selection and approval of the three oral exam topics will be:

- The student should work with the major advisor and advisory committee to select three initial oral examination topics, and submit them along with the written proposal by **Sept. 15** or **Jan. 15**.
- Then the examination committee, led by the external chair, will discuss and confirm the three topics, and submit them to the Graduate Committee chair, along with the feedbacks of the written proposal by **Oct. 15** or **Feb 15**.
- The Graduate Committee chair will assemble all examination topics for all candidates, and submit them to the full faculty for approval.

MSE oral PhD exam procedures

- The day before the exam, it is the responsibility of the student to email the committee members the abstract of the research proposal and the three student-chosen subject questions;
- On the day of the exam, the committee members should arrive 10 minutes before the presentation and the exam should start on time;
- Before the presentation begins, the chair of the committee should hand out to all attending faculty members a list of procedures for undertaking the exam;
- The chair should ask the student if questions can be offered during or after the presentation;
- The authority of the chair of the committee to control discussions and exam progression should be recognized;
- The advisor of the student should not be allowed to enter into any discussion during the course of the exam without a clear indication by the chair that doing so is acceptable;
- The time period of the exam should be decremented in measurable milestones and the chair should indicate when discussions should end to insure exam progression; the entire exam should be kept to a two hour period;
- The voting for determining a Pass/Fail for the exam should be administered by secret ballot; it's the responsibility of the chair to bring the secret ballot box & scorecards to the exam.

2. Guidelines for the Ph.D. Research Proposal

An Important Note: Three oral examination topics should be submitted along with the written proposal to the examination committee (including advisory committee members, major advisor, and the examination chair/external evaluator) by **Sept. 15** or **Jan. 15**. See "Oral Exam Preparation Guidelines" for details.

Each member on the student's advisory committee (including the major research advisor), as well as an additional external faculty examiner appointed by the Graduate Committee, will evaluate the written proposal and provide a numerical score (0-100) and (optional) additional comments. The Graduate Committee chair will collect and average all scores. A proposal receives a "Pass" if the average score ≥ 60 . A proposal receives a "Fail" if the average score < 60 . The average numerical score, along with the verbatim comments, will be sent to the student.

The written document should reflect an effort by the student and not the research advisor. The advisor may work with the student on the direction of research, points of clarification, essential grammar and technical style and on improving the structure of the document. However, it is up to the student to

produce the majority of the document and the student is the one responsible for the final product. Specifically, the student is responsible for the writing of the document. The advisor may provide MENTORING guidance regarding formatting, and editing for clarity of the content.

The Research Proposal is intended to provide the students with the opportunity to:

1. Show they are capable of undertaking a specific **Research Project** on a chosen topic with minimum supervision in the area of specialization;
2. Demonstrate their ability and initiative to organize and plan such investigative work;
3. Undertake a literature survey and critically apply their findings;
4. Develop their ability to analyze and solve problems and produce or suggest rational solutions to such problems;
5. Interpret the data produced from their investigations and draw conclusions;
6. Present a concisely written research proposal;
7. Use appropriate information from the research proposal for the oral defense of said proposal; and
8. Communicate to faculty the basic problem and the experimental, practical or theoretical work undertaken, and to discuss the results and conclusions to date.

While Research Proposals will vary to some extent in quantity and type of information, the various sections of the proposal should be structured as close as possible in the following way:

1. Statement of Research Objective
2. Introduction
 - Motivation
 - Objective
 - Tasks within objective
3. Background
 - Literature review
 - Preliminary results
 - Analysis of preliminary results
4. Research Plan
 - Details on planned research
5. Potential Original Contribution and Broader Impacts for Science
6. Statement on Personal Contribution to the Formulation of Ideas and Plan of Research
7. References

1. Statement of Research Objective.

A well-stated objective leads one directly to the approach that must be taken to accomplish the objective. This initial statement should be written such that any informed scientist should be able to understand what you intend to do. The research objective may be written in the following forms (other variations are possible):

- The research objective of this proposal is to test hypothesis H .
- The research objective of this proposal is to measure parameter P to within an accuracy of A .
- The research objective of this proposal is to prove conjecture C .
- The research objective of this proposal is to apply method M from field F to problem X in field Y .

2. Introduction.

The introduction should explain why the project is considered to be of importance, be it from a financial, technological, environmental, or academic viewpoint. The reader should clearly understand your motivation for the work and why this research is necessary.

The goal of the project should be reiterated next. This should be followed with an outline describing the specific tasks necessary to accomplish this goal. This should be written as concisely as possible.

3. Background.

This section should consist of a literature survey describing what has been done previously to solve the

problem related to the research objective. Sufficient background should be given so that the reader will understand the techniques and approaches described in the research plan. This section should show evidence that the student is well read in the subject and can critically review the works of other authors.

Following the literature review, the author should present preliminary data and provide analysis of the findings. The data presented should support the research plan and provide additional motivation for the project.

4. Research Plan.

In this section, the work to be carried out should be described in detail. This will be an expansion upon the research tasks listed in the introduction. The student should demonstrate a clear plan that will have a high likelihood of accomplishing the research objective. The student should consult with the faculty advisor to insure that the presented plan will be meaningful and capable of producing reliable results. In addition, the student should comment on any limitations in the plan and alternative methods if the initial plan is unsuccessful.

5. Potential Original Contribution and Broader Impacts for Science.

This section should contain anticipated results and potential scientific merits and impacts. The proposal should indicate the student's potential for an original contribution to the field. The resulting impact of this work should be described from the prospective on how this particular work enhances our understanding of natural phenomena as scientists and engineers.

6. Statement on personal contribution to the formulation of ideas and plan of research.

A statement is required expressing the students contribution to the formulation of the ideas for this proposed work. The ideas of others should be noted alongside those of the student.

The student's advisor must sign a statement that they are in agreement with the credit allocation described by the student.

7. References.

Any references to books, journals, patents, and theses must be referenced. References to websites will not be accepted. Concrete website information is often based on more substantial papers, journal articles or internal industry research, and these should be located for reference.

The student may adopt a commonly used reference style in the field (please check professional journals in the field for examples). The full title of the articles should be included.

Formatting of Research Proposal

The proposal has a basic format and should be no more than 5,000 words as determined by Microsoft Word (approx. 15 pages long). This length is determined excluding appendices, graphs, charts, tables, and references. Proposals longer than this limit indicate that the student is unable and/or incapable of being brief enough to provide a proposal of a specified length. Proposals longer than those specified may be penalized, especially if content is judged to be 'padding' which could have been shortened or omitted.

The proposal must be typed, using standard 12 POINT typeface (Arial, Helvetica, Times New Roman), with double spacing on standard paper, leaving a margin of at least 25mm (1 inch) on the left side, 20mm (0.75 inches) on the right side and 25mm (1 inch) top and bottom of the sheet.

Any acronyms used should be initially defined by fully writing out with the acronym in parentheses following the text, e.g. *General Skewed Data (GSD)*. If several such abbreviations are to be used in the text, the student should also include a page with a glossary of terms.

Diagrams, graphs, charts, equations, etc. should be numbered consecutively throughout the proposal, or, better still, numbered consecutively within each section, e.g. Figure. 2.3 (denotes the third figure in section 2). Whenever possible, charts, tables, etc. should be included in an appendix with only summary versions in the text.

Plagiarism and Inadequate Referencing (IMPORTANT!)

Plagiarism is strictly prohibited. Please refer to the pages 2-3 in "MSE Graduate Student Manual" and any relevant Clemson academic regulations for the definitions of *plagiarism*. *Inadequate referencing* is where students have indicated that they are quoting another person's work but fail to reference it adequately in the discussion, resulting in confusion as to where their own work began and the cited work ended. The penalties for plagiarism and inadequate referencing are severe. Normally, it is a failed Project and possible expulsion from the MSE program and Clemson University. No further warnings on violation of this type will be provided to the student.

Delivery of Written Proposal to Committee Members

Enough printed copies should be produced so that the student has one (1) for himself/herself and one (1) for each committee member who will examine the proposal including the student's supervisor. The proposal topic should be logically expressed and the proposal written in clear, unambiguous English.

3. Oral Exam Preparation Guidelines

Each oral exam should take between 1.75 and 2.5 hours. This time will be used for presentations and questions.

Approximately 20-30 slides should be prepared on the proposed dissertation research and should be about 30 minutes in length.

Three topic examination presentations will also be given by the student at their oral exam. The student should prepare 5-15 slides on each topic (including a discussion of *how the basic theories in these topical areas are related to the proposed dissertation research*). The total presentation for the three topics should not exceed 30 minutes.

The procedure to formulate the three examination topics will be the following:

- The Ph.D. student should initiate discussion with each of his/her advisory committee members (other than major advisor and the examination chair/external evaluator) to formulate at least one topic.
- The Ph.D. student should then work with his/her major advisor to assemble the three topics (and make necessary revisions if there are topical overlaps).
- Finally, the three examination topics should be forwarded to the whole committee (including advisory committee members, major advisor, and the examination chair/external evaluator) for final approval (or to be further revised), along with the written proposal by **Sept. 15** or **Jan. 15**.
- The external chair will be the coordinator and make the decision on the selection of these topics (based on the committee's opinions). The three examination topics will be then submitted to the chair of the MSE Graduate Committee by **Oct. 15** or **Feb. 15**, along with results of written exam.
- The Graduate Committee chair will assemble all examination topics for all candidates, and submit them to the full faculty for approval.

Students will be asked questions about their thesis proposal, the three examination topics and also any other questions that the committee deems relevant. The Question & Answer period is expected to range from 45 minutes to 1.5 hours in the examination.

Questions may be asked on

- The thesis proposal;
- The three (3) examination topics;
- Any other "fundamental" MSE questions that a Ph.D. in MSE is expected to know (undergraduate MSE knowledge plus core courses)

The advisory committee may divide Q&A into different sections or conduct them in any order that the committee sees appropriate.

The oral examination will emphasize the candidate's capability as well as basic knowledge.

At the end of all the presentations and once the committee has asked all questions that they desire, the candidate will be asked to leave. The committee will use that time to fill out a rubric to help determine the "pass" or "fail" status of the presentation. The committee (plus the major advisor) will then vote by secret ballot. The committee chair will then collect the ballots and determine the outcome of the exam

PRE-DEFENSE ADVISORY COMMITTEE MEETING **(Important!)**

Approximately 12 months before the expected final oral defense, an advisory committee meeting should be held. This purpose of this meeting is for the candidate and the committee to discuss the expectations for graduation.

APPLICATION FOR GRADUATION AND DIPLOMA

Early in the semester that the student plans to defend his/her dissertation and expects to graduate, the GS4 form (Application for Graduation and Diploma) must be submitted to the Graduate School.

Dissertation

A first draft of the dissertation should be completed well before the date of the final oral examination. A final draft (approved by the advisor) should be submitted to the advisory committee at least 2 weeks before the oral exam. Consult your advisory committee for specific requirements.

Final Oral Examination

An oral examination, to be given at least three weeks before graduation, will serve to examine the student on his/her dissertation research. A broad and penetrating interpretation of the research project and conclusions is required of the student. The committee will have already received final draft copies of the dissertation ten (10) business days prior to the examination. This examination will be conducted under the authority of the Ph.D. advisory committee. All MSE faculty members will be invited to participate in the examination and to provide advisory comments to the committee.

Successful completion of this examination will result in a recommendation (GS7 Form, www.grad.clemson.edu/forms/forms_graduating.php) by the advisory committee to the Graduate School that the Ph.D. degree be awarded. Unsatisfactory performance on the final examination will require either complete re-examination (with or without recommendations for additional work) or dismissal.

PREPARATION OF THESIS OR DISSERTATION

Planning

The deadlines for the tasks depend on the date of anticipated graduation and are posted at the Graduate School website (www.grad.clemson.edu/deadlines.php). A list of the deadlines also can be obtained by contacting the Graduate School. **Failure to meet any of these deadlines will result in postponement of graduation.**

Sufficient time must be allotted for writing the thesis or dissertation. It is required that the student fully complete his/her thesis/dissertation before leaving the university. Experience shows it is very difficult to complete a thesis or dissertation after leaving the university.

Writing the Thesis or Dissertation

The writing process usually begins toward the end of the research period. The document must be written in a format that is acceptable to the Graduate School (M.S. or Ph.D.) The formatting rules that should be followed are outlined at the following website: www.grad.clemson.edu/manuscript

Review and Approval

As a result of the final oral examination and review of the written document by the advisory committee, the student may be required to do more work. After a successful final oral examination, the committee members will provide any comments or corrections that must be made to the thesis or dissertation.

Duplication

The student must decide how many copies of the dissertation s/he wants. A minimum of three copies must be made: one hardbound copy and one soft unbound copy for the Department of MSE; and one hardbound copy for the major advisor. It is courteous to offer each committee member the opportunity to obtain a hardbound copy. Additional copies can be made for the student's personal use. Once the student determines the number of copies needed, s/he should call to schedule an appointment with the Printing Service Center. Unbound copies are produced at the Printing Services Center, but the student must pay for the binding of hardbound copies at the Bursar's Office, located in Sikes Hall. At the appointment, the student will need to pay the duplication fees and describe any special services required (offset printing, photos, etc.). The student can pay for duplication by personal check either directly to the Printing Services Center or at the Bursar's Office and then present a receipt for that payment to the Printing Services Center. The cost for duplication depends on the length and the number of copies requested. Duplication usually takes no longer than one week.

For all current policies, procedures, deadlines, and regulations regarding theses and dissertations, consult the Graduate School website: www.grad.clemson.edu

GRADUATE ASSISTANTSHIP AND FINANCES

Assistantship Award Policy

Assistantships are awarded based on many factors, including but not limited to: GPR, GRE scores, recommendations, previous schools, discipline, Statement of Purpose, and English language ability.

Assistantship Funding

The Department of MSE uses two different sources for funding graduate students: State of South Carolina monies and funds from contracts, grants and donations. Students supported by state funds normally are assigned teaching assistant duties while those supported by research contract funds are assigned research duties. All assistantships may be subject to time limits as described below (depending upon the degree being pursued) and are contingent upon satisfactory performance and progress toward the degree by the student.

- Assistantships for M.S. students will normally last for a maximum of two years. The same time limit applies to fellowships awarded by the Department of MSE. Assistantships for Ph.D. students will normally last for three years beyond the M.S. degree. The same applies to fellowships awarded by the Department.
- Continuation of assistantships and fellowships is contingent upon satisfactory academic performance, as well as satisfactory performance of assigned duties associated with the assistantship.
- All research contract and grant supported graduate assistantships are subject to continued funding by the contracting agency. If a research contract or grant is terminated before a student has completed his/her degree program, the Department will endeavor (on an individual basis) to provide financial support to allow completion of the student's program. The foregoing statement should not be construed as an assurance of funding. The student is expected to complete his/her degree program in a timely fashion.

Work Load

The normal half-time (50%) graduate assistantship workload is 20 hours per week (average). Students are sometimes hired for 25% (10 hrs), 37.5% (15 hrs) and 75% (30 hrs) of full-time work, under appropriate circumstances. Students should be aware of both their academic and work obligations and are encouraged to discuss any problems with faculty.

Vacations

In addition to days off when the University is closed, students are allowed up to two weeks of vacation time each year. These days should be scheduled with approval of their advisor.

Start of Pay

Students are appointed to a graduate assistantship at the beginning of the first semester if the student is present and available for a work assignment at that time. Otherwise, pay will begin when the student is available for work. Students with research assignments should report to their research advisor. All other students should report to the Graduate Program Coordinator.

New graduate assistants must report to a departmental Administrative Assistant and complete the following: information sheet, tax forms (federal and state), and I-9 form. Students will need to provide proof of nationality, social security number, age, etc.

International students should have their offer letter with them upon arrival. They should then go to the Social Security Administration in Anderson, SC for a Social Security Number or meet with the Social Security Administration representative in Martin Hall on the dates indicated by the Graduate School. The student should then see the appropriate Administrative Assistant in 161 Sistine Hall. The Administrative Assistant will provide them with the paperwork that they must take with their signed Social Security card to the Foreign National Payments Coordinator (call for appointment: 656-5589, E-208 Martin) who will complete the necessary paperwork to assist them with getting on the payroll. When making the appointment, students should ask what forms they should complete prior to the appointment.

For complete information on employment requirements for international students, make an appointment at the Office of International Affairs (656-3614, E-301 Martin Hall) or visit their website: www.clemson.edu/ia/. Electronic forms are available under the "Forms and Documents" tab in the sidebar.

Termination of Pay

Pay for any session will end when the student leaves Clemson or is no longer available for work assignments. Normal termination dates for the Spring and Fall semesters for students not continuing into the next session is graduation day. The student's research advisor or the Department Head must approve any deviations from these dates.

Reduction of Pay

Normally, 20 hours per week will be submitted on each payroll for each half-time graduate assistant. However, less than 20 hours may be submitted for a student, with the pay reduced accordingly, if the amount of time worked by the student consistently deviates from the required 20 hours per week average. Due to the procedure in which time sheets are currently used, it may be necessary to implement any pay reductions in the pay period following the one in which the work deficiency actually occurred. Pay

also may be withheld from students who violate the vacation policy, as stated above in the section on "Vacations."

Summer Enrollment

Students receiving any assistantship or fellowship must enroll in three credit hours for the first and three credit hours for the second Summer Session. Any student not on an assistantship but using faculty time and/or university facilities (including any student actively working on a thesis or dissertation) must register for a minimum of one credit hour each session. Only students not active and not physically present at Clemson need not register.

Students *without* Assistantships

Students who enter a graduate program in the Department of MSE without an assistantship can apply for future consideration with the Director.

Deferment of Graduate Fees

Graduate assistants may choose to defer tuition and fees. This is accomplished easily on the day of registration. Persons in the fee assessment area will have a list of all graduate assistants. Anyone listed may sign a note to defer these costs and these costs will be deducted from the first six full paychecks of the semester. It is not possible to defer fees for summer sessions. The student must pay these for each summer session.

GENERAL DEPARTMENTAL INFORMATION

Information

Students should not hesitate to ask questions concerning MSE policies and procedures. The Graduate Program Coordinators' task is to assist students with such questions.

Notices

Notices of interest to graduate students will be emailed directly to the students and often posted on the MSE bulletin boards in Surrine and Olin Halls as well. To ensure receipt of MSE mailings, each student should have a current address and telephone and cell phone number on file with the Department. MSE also maintains a mail slot for each graduate student, the location of which will be shown to him or her upon beginning with the Department.

Paychecks

Students must set up a direct deposit for stipend checks through the University system. **This action is mandatory!** Please obtain an "Authorization for Deposit of Net Pay" Form from the Administrative Assistant located in 161 Surrine. New students going on the payroll for the first time will have a two-week lag before they will be paid. This will be paid out after their termination from the University.

Keys

The key(s) issued to students are for their use only. Keys must never be loaned to anyone else, even another graduate student. Failure to observe this rule may result in withdrawal key privilege. See the "Quick Reference Guide" for the current key distributor. There is a deposit required for every key issued.

Building Security

It is necessary to maintain the security of the buildings at all times. During normal working hours all entrances will be kept unlocked. At all other times all outside doors will remain locked and should not be propped open. All students entering or leaving the building should ensure that the outside doors remain locked. The computer rooms and labs should always be locked when unoccupied.

Parking

Ample parking is available. Parking on campus requires a permit that can be purchased at Parking Services (656-2270).

Emergencies

The Clemson University Police Department (656-2222) is to be called for all major emergencies: fire, medical, police. They will ensure that the proper authorities are dispatched.

- In case of tornado warning, take appropriate shelter. Use stairwells; **do not** use the elevators.
- In case of fire, exit the building immediately. Use stairwells; **do not** use the elevators.

Desks

It is the goal of the Department of MSE to provide a desk for each graduate student. However, due to the limited available space, it may not be possible to accommodate each student. Therefore, a priority system is used that first assigns a desk to each graduate assistant and graduate fellow, then to each unsupported M.S. thesis student. Remaining desks are allocated to all other students on a temporary use basis.

NOTE: Study facilities for graduate students are intended solely for studying and interacting with students. They are not to be used for socializing or temporary housing. Students abusing these privileges will forfeit them.

Room Use Policies

Certain classrooms and conference rooms are to be used by reservation only. For classroom reservations contact the Student Services Coordinator. To reserve the Department's conference room, SIRRINE 158, contact an Administrative Assistant in the main office.

Computer Laboratories

Well-equipped computer laboratories maintained by CCIT are located throughout campus. In addition, the Department maintains computers for our students' use in Olin 204 and in the room accessed via SIRRINE 490. These computers allow access to the Clemson University's mainframe computer and a local area network that hosts many software packages. The doors to Olin 204 and SIRRINE 490 should be kept closed and the doors locked after normal business hours.

Clemson Computing and Information Technology (CCIT)

Visit their website www.clemson.edu/ccit for help, details, and computing short courses

Office Supplies

The Department does not furnish office supplies to graduate students for personal use. The faculty advisor must authorize all research contract-related use of office supplies, including letterhead stationery.

Mail

All personal mail is to be directed to the student's home address. The Department is not to be used as one's mailing address. Outgoing mail, both U.S. and campus mail, can be placed in the appropriate receptacle in the reception areas.

MSE Copy Machines

Teaching assistants required to make copies for class may use this machine with an account number specific to the course provided by the instructor. Otherwise, Department copy machines may not be used for personal copies.

MSE Seminars

During the fall and spring semesters, the Department of MSE sponsors a weekly seminar. Students and faculty give presentations about their research or other topics of interest to the department. Invited speakers from industry, government, and other academic departments are also included. All students are required to attend the seminars and faculty is expected to attend. If a student cannot attend a particular seminar, s/he should inform his/her advisor ahead of time. The MSE curriculum requires that all students enroll for this seminar each semester.

A New Seminar Course MSE 801 is under consideration by the MSE faculty. If adopted it will be required for all students entering our graduate program beginning in Fall 2012.

Fax Machines

Students may use The Department facsimile machines for official MSE business purposes with authorization from their advisor.

Telephones

Graduate students making research-related long distance calls at the request of an advisor should use the advisor's nine-digit authorization code. Students are authorized to place long distance telephone calls only with the permission of the appropriate advisor or with their own personal calling card.

Telephone Numbers to Know

Registration Services (E-205 Martin Hall)	656-2305
Graduate School Office	
Admissions (Sikes Hall)	656-3195
Enrolled Student Services (E-209 Martin)	656-5339
International Student Services (E-307 Martin)	656-3614
Payroll Office (Adm. Service Bldg.)	656-5585
Student Development (707 Edgar Brown University Union)	656-2582
Graduate Student Govt. (702 Edgar Brown University Union)	656-2697
CCIT Computer Center (Ground Floor of Student Union)	656-3494
Campus Police (Orange Aid Building, near Gate 10)	656-2222
Student Locator (Edgar Brown University Union)	656-3311

Files

Graduate students should not access Department files. Students should contact the Student Services Coordinator if they need information from an MSE file.

Photos

At the start of each semester, photos of beginning students are taken for the MSE directory, and also, more importantly, for the potential recommendations later in life.

MSE Library

The Department libraries in 158 Serrine and 204 Olin Hall are available for use by all students, staff and faculty of the Department of MSE.

Receiving Supplies

Supplies will normally be delivered to 161 Serrine. When they are checked in, the student's name will be indicated on the outside of the package. It is helpful to the Administrative Assistant receiving supplies if students let them know they are expecting a package(s).

Note: Do not pick up any box that has not been checked in.

Recycling and Resource Recovery

MSE faculty, staff, and students, out of a spirit of environmental sensitivity, collect and recycle white paper and cardboard. All recycle containers are located in various areas of both facilities. White paper waste is stored in marked containers. The recycling containers will be checked several times monthly to ensure that all is well and to determine whether the storage containers have filled faster than normal.

Professional Memberships

Application forms for membership in various Materials Science & Engineering professional organizations may be obtained from appropriate faculty.

Student travel

Department-specific travel information and guidelines from the Clemson University Travel Policy and Guidelines have been incorporated into this section. The complete Policy and Guidelines, including authority references and guidelines specific to university administration, is available at

<http://www.clemson.edu/cfo/procurement/travel/studentguidelines.html>, under the "Travel" tab in the sidebar. Any questions regarding travel should be directed to the Administrative Assistant in charge of travel in 161 Surrin. Summarized MSE procedures are as follows:

1. Complete Request to Travel form, obtain appropriate signatures (faculty member responsible for the account number to which it will be charged) and submit to the Administrative Assistant.
2. Enter travel status according to guidelines outlined herein.
3. Upon completion of travel, complete Travel Worksheet, obtain appropriate signatures, and submit to the Administrative Assistant for reimbursement.

Note: Hardcopies of all travel forms are located in the copy/work room in 161 Surrin. If students have trouble using the electronic forms, please see one of the Administrative Assistants for assistance.

Traveler's Responsibilities

When individuals file for reimbursement of travel expenses they are stating:

- They have followed the University's travel policies;
- They have not nor will not receive reimbursement for these expenses from any other entity outside the University;
- None of the expenses are of a personal nature; and,
- All supporting documentation is on file with the Department.

Under the Progressive Discipline Policy of the University, any employee who falsifies records or documents or willfully violates written rules, regulations or policies can be suspended or terminated from his/her job.

Reimbursement will be made upon completion of the travel. All travel vouchers must be submitted within the same fiscal year (July 1-June 30) in which the trip occurred.

All travel vouchers submitted for reimbursement are required to have the signature of the traveler and one other person authorized to spend funds from the account numbers that appear on the travel voucher. All signatures must be original. No stamped signatures will be accepted.

Travelers are expected to exercise the same judgment when making travel arrangements and expenditures that a prudent person would exercise if traveling on personal business and expending personal funds.

Excess costs, circuitous routes, delays or luxury accommodations unnecessary or unjustified in the performance of an assignment are not considered exercising prudence.

Travel by commercial airlines will be in coach or tourist class.

Transportation to or from points of arrival and departure will be by the most economical method.

Expenses for Spouses or Other Individuals

Reimbursements to an individual may cover only those expenses pertaining to that individual. It may not include expenses pertaining to other individuals, regardless of who paid the expense. Travel expenses for spouses, friends, or other individuals not traveling on official University business are not reimbursable.

Unauthorized Costs

Employees will be responsible for unauthorized costs and any additional expenses incurred for personal preference or convenience. No reimbursement for reduced fare advance purchase tickets charged on a personal credit card will be made to employees prior to the completion of travel since direct payment by the University is available using the Department Purchase Card.

Meals

Maximum expense reimbursement rates are variable. There are two maximums: first, for official travel within the State of South Carolina; second, for official travel outside of the State of South Carolina. See the Administrative Assistant for current, applicable maximums.

When the daily limit for meals is exceeded due to the cost of an official banquet, the excess will be allowed provided that a receipt and proper explanation for the banquet charge accompanies the travel voucher.

If an individual on non-overnight travel receives reimbursements for meals, this amount could be considered income and be reported on their W-2 tax form. For instance, meals on day trips are subject to tax withholding except when a business purpose for the meal can be documented. If claiming reimbursement for such business meals,

documentation should include the name and affiliation of the person sharing the meal and the nature of the business discussed.

An individual must be in travel status (more than 10 miles from their residence or official headquarters) to be eligible for reimbursement of meals.

Lodging

Lodging expenses will be allowed subject to the following limitations, provided an original, itemized receipt is furnished. Lodging arrangements and any required deposits are the responsibility of the traveler and will be reimbursed as part of the travel expenses upon completion of the trip.

Actual lodging expenses will be reimbursed; however, the more moderately priced accommodations must be requested when a choice is available. Employees should request a state or government rate when available.

No reimbursement will be made for overnight lodging within 50 miles of the employee's official headquarters or residence.

The expense for shared lodging may be reimbursed to one employee if only one original itemized receipt is obtained. If the room is shared with other than a University employee, the single room rate will apply.

All necessary and reasonable tips for baggage handling will be reimbursed.

Miscellaneous Expenses

Movies, bar bills, laundry, room service, safes and security insurance, health or spa fees, etc. will not be subject to reimbursement on the travel expense report. These are considered personal in nature and should be paid by the traveler.

Foreign Travel

Travel outside the continental United States, Alaska, Hawaii, Canada, Puerto Rico or the Virgin Islands requires approval prior to departure. A Foreign Travel Request must be filled out and approved before travel. Foreign travel funded from sponsored program activities must be approved in advance by Sponsored Programs Accounting.

While on foreign travel, actual lodging expenses will be reimbursed. Fees for the purchase of traveler's checks, passports and visas will be reimbursed provided a receipt is furnished. All expenses claimed must be converted to U.S. dollars and the conversion rate and computation should be shown on each receipt.

When an employee is on foreign travel, meal expenses not exceeding federal rates will be reimbursed. These rates are listed by country under the "Per Diems" tab at: www.state.gov/travelandbusiness/

Travel by Automobile

Automobile transportation may be used when common carrier transportation cannot be arranged satisfactorily, or to reduce expenses when two or more University employees are traveling together.

University employees may use their own automobile for official travel provided the University would incur no added expenses above that of other forms of transportation available. See the Administrative Assistant for current mileage rates for personal vehicles.

Taxi fares and reasonable tolls will be reimbursed to the individual. Receipts must be furnished if claiming airport, hotel or parking garage parking of more than \$5.00.

No reimbursement will be made to operators of state owned vehicles who must pay fines for moving or non-moving violations.

Rental Cars

The contract for Rental Cars varies from year to year. Please check with the Administrative Assistant in charge of travel before renting a car. If there is no rental agency on state contract, students are encouraged to shop *cost efficiently* for a rental car just like for anything else. Charges for automobile rental are allowed when it is more economical than alternative methods of transportation or is the only practical means of transportation.

If it is necessary to rent an automobile while in travel status outside the United States, it is recommended the collision damage waiver insurance be obtained. The charge and the applicable tax will be included on the automobile rental statement submitted with the request for reimbursement. **DO NOT obtain additional coverage while in travel status inside the United States.**

Conference/Convention Registration Fees

Registration fees in the amount necessary to qualify individuals to attend conventions, meetings, conferences, etc. are allowed. These fees can be paid using the Department Purchase Card or by completing a Direct Purchase Voucher and sending it to Accounts Payable ten days to two weeks before the deadline of the meeting. If registration fees are not prepaid, and rather are paid at the time of the meeting registration, reimbursement will be made after the trip is completed.

Receipts

Students must submit a receipt per expenditure of \$5 or more, except for meals, tolls and portage. All receipts and paid bills should be originals. If originals are not available, a memorandum, approved at the next level in the approval process, must accompany the travel voucher when it is submitted.

Final Checkout

Graduate students leaving for any reason should do as follows:

- Turn in all keys to current key manager (see “Quick Reference Guide”)
- Return all equipment and supplies to appropriate locations
- Clean assigned laboratory space
- Submit an unbound copy of the thesis or dissertation
- Return all books and journals to the department library
- Inform the Department Head of the impending departure and schedule an exit interview

No student will be cleared to leave until these procedures have been completed.

GENERAL SAFETY AND HEALTH POLICIES

Chemical Hygiene Plan

The Chemical Hygiene Plan details MSE policy and regulations concerning health and safety. This plan is required reading for all laboratory personnel. After reading the plan all laboratory personnel must sign a copy of the Chemical Hygiene Plan Awareness Certification form. In addition, all personnel must fill out the employee/student safety checklist. Direct any questions on safety to the research advisor. New students will attend a safety seminar at the beginning of the fall semester each year. This will be conducted by MSE faculty and staff.

Laboratory Operating Policies

The following laboratory operating policies are designed to ensure a safe and secure working environment, and to provide a research environment that nurtures the acquisition of experimental results of the highest quality:

- No food or drink is to be brought into or consumed in any laboratory.
- To facilitate cleaning, nothing is to be stored on laboratory floors.
- Only scientific charts and similar educational or reference materials are to be hung from laboratory ceilings or walls.
- Suitably sized posters or photos may be affixed to walls using non-damaging tape or hangers.
- Nothing is to be affixed to the laboratory doors.
- No laboratory doors including the exterior doors are to be propped open.
- Nothing, including carts, is to be stored or left in the hallways.
- All laboratory chairs are to be cleaned weekly, more frequently if required.
- All laboratories are to be left clean and orderly prior to departing for the day.
- When conducting wet research in the laboratories, plastic containment trays are to be used, insofar as possible, to capture spills.
- All samples, bottles, standards, etc. are to be dated and identified as to contents and person responsible. The contents are to be properly disposed of and the bottles cleaned when no longer needed.
- Material Safety Data Sheets should be requested from chemical vendors. These need to be kept in the lab where the chemical is stored.
- Chemicals in the laboratory should be segregated and safely stored.
- A record of use is to be maintained for all hazardous chemicals in laboratory.
- All analytical balances are to be left clean after each use.
- Avoid working alone in a building; do not work alone in a laboratory if the procedures being conducted are hazardous.
- Lights are to be turned off whenever vacating a room.
- All memos, notices, etc. are to be posted on the official bulletin boards.
- All areas are to be maintained clean and free of refuse.
- All refuse that cannot easily be placed in a trash receptacle is to be carried to and placed in the appropriate dumpster.

- Any key codes to the exterior doors are to be kept strictly confidential within the MSE community. Any hint of a breach in confidentiality is to be reported immediately.
- Recycled paper and cans are to be placed in the appropriate containers.

PERSONAL PROTECTIVE EQUIPMENT

Eye and Face Protection

Eye and face protection devices which meet OSHA requirements and American National Standards for industrial eye protection should be the minimum eye protection used for activities where there may be flying or falling particles or chemical splashes. Either safety or prescription glasses with side shields must be worn in any laboratory at all times, unless the departmental representative has made an exception. Visitors to any laboratory must wear safety or prescription glasses, preferably with side shields.

The wearing of contact lenses is strongly discouraged. Soft contact lenses are susceptible to absorption of vapors and may aggravate some chemical exposures, particularly if they are worn for extended periods. Manufacturers of soft lenses generally recommend they not be used in certain atmospheres.

Body Protection

Protection of the body from contact with solid and liquid contaminants requires some protective clothing. Such protective clothing may include boots, gloves, pants, coats, and head covers. Complete protection of the skin from contact with gases and vapors requires full-body protection such as an encapsulating suit.

Whenever in a laboratory, all MSE students, faculty, and staff must ensure that arms, legs, and torso are covered at all times. For example, one can wear: long pants and a long-sleeved shirt; a knee-length, long-sleeved laboratory coat; or long pants and a waist-length laboratory coat. In addition, rubber and plastic aprons must be used whenever corrosive or irritating chemicals are handled. Because plastic aprons can accumulate static electricity, their use must be avoided in areas where flammable solvents could be ignited. Protective clothing will have to be discarded and replaced if it cannot be effectively decontaminated.

Clothing materials should be selected for resistance to the chemicals to which they will be exposed and for appropriate resistance to permeation.

Footwear

Closed-toed shoes must be worn at all times. Sandals, thongs, and bare feet are not permitted. Shoes made of impermeable material such as leather are strongly recommended. Sneakers offer little protection against falling objects or chemical spills. High-heeled shoes pose a hazard and shall not be worn when working in laboratories.

Hazardous Waste Management

The concern for safe disposal of chemical wastes has increased dramatically in recent years. Legal and regulatory requirements, reinforced by public opinion, spurred the handling of hazardous wastes in a responsible way. Even laboratory personnel who work with relatively small amounts of chemicals have begun to recognize that the chemical wastes generated during their experiments are their responsibility and that waste management systems are necessary.

The Resource Conservation and Recovery Act (RCRA) of 1976 mandated a system for managing hazardous waste. Regulations adopted by the Environmental Protection Agency (EPA) carry out that mandate and now extend through South Carolina State Law to those who generate, store, transport, treat, and dispose of hazardous waste. The Department of Health and Environmental Control (DHEC) is the South Carolina agency responsible for enforcing EPA regulations.

The MSE labs, like most research laboratories, generate and store small quantities of hazardous waste. MSE has a Hazardous Waste Management Plan to ensure that laboratory wastes are properly managed to prevent harm to public health and the environment and to conform to the public's expectations and the government's requirements for proper waste management. All laboratory students are required to adhere to the regulations. Direct any questions concerning this to the faculty advisor.

Emergency and accident procedures

Redfern Health Center offers comprehensive preventive and basic health care services, primarily to the students of Clemson University. Redfern is open Monday through Friday from 8:00 - 5:00 PM. Four physicians, three nurse practitioners, and eleven registered nurses are available to provide continuous, quality medical care. Students are encouraged to make appointments to be seen for illness and injuries as they occur throughout their stay at Clemson. Although Redfern Health Center is not an emergency room or urgent care clinic, they offer acute and/or urgent care for minor illnesses and injuries via the nurse's clinic. In the nurse's clinic, a registered nurse sees the patient, assesses the problem, and takes appropriate action. If immediate physician intervention is needed, patients are referred to CU Now provider.

The following procedures should be followed in case of any accident or emergency that happens in our laboratories or anywhere on Clemson University's campus:

1. For all emergencies or accidents involving students, faculty, and/or visitors that happen anywhere on campus (laboratories, offices, sidewalks, parking lots, streets) at any time, any day of the week, dial either **911** or **656-2222** for University Police/Fire/EMS. Clemson University FIRE & EMS stands ready to respond and assist in handling any emergency medical needs and they are staffed with Emergency Medical Technicians (EMTs) 24 hours a day, 365 days

per year. Their primary response area is the main campus of Clemson University and they can be on site within minutes of an emergency or accident. Anderson County EMS will respond to our other center locations (AMRL, CAR, NBRC) if the victim calls 911. They will treat the injury and determine whether or not further treatment is necessary at Redfern or at one of the following facilities: Clemson's Urgent Care (Urgent Care will not accept patients requiring ambulance transport to their facility), Oconee Memorial Hospital, Easley Baptist Hospital, Anderson Memorial Hospital, or Greenville Memorial Hospital. The officials at Redfern do not encourage walk-ins for these types of emergencies or accidents.

2. For all emergencies or accidents involving **chemicals**, it is imperative that a copy of the MSDS on the chemical is available for the EMS personnel immediately upon their arrival to the site and that they are informed of any potential chemical contamination. Our EHS guidelines stipulate MSDS sheets be located in or immediately outside the laboratory.
3. As soon as possible, report any accident referred to above first to your supervisor and then to the Administrative Assistant in the main office. The Administrative Assistant will report the accident to CU Risk Management Department and Compendium Insurance Company (workman's compensation insurance carrier for Clemson University) who will determine whether or not the claim should be covered under workman's compensation. Should any accident occur outside of normal working hours, an accident report should be given to all parties concerned at the beginning of the next working day.

If you ever feel uncomfortable about a situation, contact EMS (911) or 656-2222 immediately for campus emergency services. Small problems can quickly turn into larger problems, so it's important to recognize when help is needed. CU EMS can provide a quick response and is able to assist in almost any emergency situation.

PURCHASING

All students will follow this procedure for purchasing chemicals and supplies.

Introduction

Advisors must approve orders for all research supplies and equipment required by MSE. An Administrative Assistant in 161 Surrine orders general office supplies, books, etc. Students may contact vendors in order to obtain prices, availability, technical help, or other information but may not place the order. Purchase orders (telephone orders) are limited to \$2,500 and under including freight and special handling, but excluding tax. Any order that exceeds \$2,500 (Purchase Requisitions) must be put on a Purchase Order and sent to the University Purchasing Department. All chemicals or supplies are to be ordered from primary vendors, if possible.

Primary Vendors

The State of South Carolina has awarded contracts for laboratory equipment and supplies to the following: **VWR Scientific Products**; and **Fisher Scientific Company** (limited items).

Purchase Orders and Purchase Requisitions

Any student wishing to order laboratory supplies, equipment, etc. must use Clemson buyWays. Detailed information is available in a handout located in Surrine 161 as well as at:

<https://solutions.scquest.com/apps/Router/Login?OrgName=Clemson&tmstmp=1374688582792>

GENERAL UNIVERSITY INFORMATION

Graduate Student Association (GSA)

The Graduate Student Association is a university-wide organization of all graduate students for promoting graduate student interests. At the start of the fall semester, GSA representatives are elected. The biweekly senate meetings are open to all graduate students. See the Graduate Student Handbook for more information or contact the GSA office at 656-2697.

Main Library

Located on campus adjacent to the reflecting pool, the main library (R.M. Cooper Library) is replete with MSE related books and journals. Periodicals can be checked out for a maximum of three days while books can be checked out for a maximum of six weeks. Late fees do apply; ask at the Circulation Desk for current fees. The card catalog is on-line and can be accessed via any departmental computer. Gratis on-line literature searches can be conducted at the main library. An appointment must be made to complete the on-line search.

Fike Recreation Center

Graduate assistants can use these facilities. Lockers are available at the recreation center.

Sporting Events

Graduate students may purchase season tickets for Clemson football and basketball games. If interested, students should report to the ticket office in IPTAY/ticket office complex (Gate 9, Memorial Stadium) to complete an application. Further information can be obtained from the ticket office, 656-2118. Baseball games are free with university ID. Tickets for soccer games may be purchased at the gate (discounts with university ID).

Military Leave

The Graduate School has ruled that a graduate student on military leave (e.g. summer camp) will not receive a stipend for the period of that leave. Students planning to take military leave should notify the Administrative Assistant of the inclusive dates. Short periods of approximately one week can be taken as regular vacation with no interruption in pay. Students leaving the campus for six weeks to attend summer camp must obtain written permission from the Dean of the Graduate School to be excused from the continuous enrollment provision.

Campus Parking

Parking on campus is restricted and requires a permit that can be purchased at Parking Services, located in G-01 Edgar Brown University Union (656-2270).

APPENDICES

TOPIC OUTLINE for MSE Comprehensive Exam

General MSE Topics:

ATOMIC STRUCTURE AND INTER-ATOMIC BONDING

Atomic Structure

- Fundamental Concepts
- Electrons in Atoms
- The Periodic Table

Atomic Bonding in Solids

- Bonding Forces and Energies
- Primary Inter-atomic Bonds
- Secondary Bonding or van der Waals Bonding
- Molecules

THE STRUCTURE OF CRYSTALLINE SOLIDS

Crystal Structures

- Fundamental Concepts
- Unit Cells
- Metallic Crystal Structures
- Density Computations
- Polymorphism and Allotropy
- Crystal Systems

Crystallographic Directions and Planes

- Crystallographic Directions
- Crystallographic Planes
- Linear and Planar Atomic Densities
- Close-Packed Crystal Structures

Crystalline and Non-Crystalline Materials

- Single Crystals
- Polycrystalline Materials
- Anisotropy
- X-Ray Diffraction: Determination of Crystal Structures
- Non-crystalline Solids

MATERIAL AND SURFACE CHARACTERIZATION

Microscopy and Microanalysis

- SEM
- TEM
- Specimen Preparation
- Electron Diffraction
- X-ray Compositional Analysis (EDS)
- STM and AFM

X-Ray Diffraction

- Basic Principles
- Phase Identification
- Quantitative Analysis
- Other Applications in Determining Crystal Orientation, Crystal Size and Texture

Basic Knowledge (Operation Principles and Applications)

Auger Electron Spectroscopy
X-ray Photoelectron Spectroscopy (XPS)
Low Energy Electron Diffraction (LEED)
Electron Energy Loss Spectroscopy (EELS)

IMPERFECTIONS AND SOLIDS

Point Defects

Vacancies and Self-Interstitials
Impurities in Solids

Miscellaneous Imperfections

Dislocations – Linear Defects
Interfacial Defects
Bulk or Volume Defects
Atomic Vibrations

Microscopic Examination

Microscopy
Grain Size Determination

DIFFUSION

Diffusion Mechanisms
Steady-State Diffusion
Nonsteady-State Diffusion
Factors that Influence Diffusion
Other Diffusion Paths
Materials Processing and Diffusion

MECHANICAL PROPERTIES OF METALS

Elastic Deformation

Stress-Strain Behavior
Anelasticity
Elastic Properties of Materials

Plastic Deformation

Tensile Properties
True Stress and Strain
Elastic Recovery During Plastic Deformation
Compressive, Shear, and Torsional Deformation
Hardness
Variability of Materials Properties
Safety Factors

DISLOCATIONS AND STRENGTHENING MECHANISMS

Dislocations and Plastic Deformation

Basic Concepts
Characteristics of Dislocations
Slip Systems
Slip in Single Crystals
Plastic Deformation of Polycrystalline Materials
Deformation by Twinning

Mechanisms of Strengthening in Metals

- Strengthening by Grain Size Reduction
- Solid-Solution Hardening
- Strain Hardening

Recovery, Recrystallization, and Grain Growth

- Recovery
- Recrystallization
- Grain Growth

FAILURE

Fracture

- Fundamentals of Fracture
- Ductile Fracture
- Brittle Fracture
- Principles of Fracture Mechanics
- Impact Fracture Testing

Fatigue

- Cyclic Stresses
- The S-N Curve
- Crack Initiation and Propagation
- Crack Propagation Rate
- Factors that Affect Fatigue Life
- Environmental Effects

Creep

- Generalized Creep Behavior
- Stress and Temperature Effects
- Data Extrapolation Methods
- Alloys for High-Temperature Use

PHASE DIAGRAMS

Definitions and Basic Concepts

- Solubility Limit
- Phases
- Microstructure
- Phase Equilibria

Equilibrium Phase Diagrams

- Binary Isomorphous Systems
- Binary Eutectic Systems
- Equilibrium Diagrams Having Intermediate Phases or Compounds
- Eutectoid and Peritectic Reactions

- Congruent Phase Transformations
- Ceramic and Ternary Phase Diagrams
- The Gibbs Phase Rule

The Iron-Carbon System

- The Iron-Iron Carbide (Fe-Fe₃C) Phase Diagram
- Development of Microstructures in Iron-Carbon Alloys
- The Influence of Other Alloying Elements

PHASE TRANSFORMATIONS IN METALS

Phase Transformations

- Basic Concepts
- The Kinetics of Solid-State Reactions
- Multiphase Transformations

Microstructural and Property Changes in Iron-Carbon Alloys

- Isothermal Transformation Diagrams
- Continuous Cooling Transformation Diagrams
- Mechanical Behavior of Iron-Carbon Alloys
- Tempered Martensite
- Review of Phase Transformations for Iron-Carbon Alloys

THERMAL PROCESSING OF METAL ALLOYS

Annealing Processes

- Process Annealing
- Stress Relief
- Annealing of Ferrous Alloys

Heat Treatment of Steels

- Hardenability
- Influence of Quenching Medium, Specimen Size, and Geometry

Precipitation Hardening

- Heat Treatments
- Mechanism of Hardening
- Miscellaneous Considerations

METAL ALLOYS

Fabrication of Metals

- Forming Operations
- Casting
- Miscellaneous Techniques

Ferrous Alloys

- Steels
- Cast Irons

Nonferrous Alloys

- Copper and Its Alloys
- Aluminum and Its Alloys
- Magnesium and Its Alloys
- Titanium and Its Alloys
- Refractory Metals
- Superalloys
- Noble Metals
- Miscellaneous Nonferrous Alloys

STRUCTURES AND PROPERTIES OF CERAMICS

Ceramic Structures

- Crystal Structures
- Silicate Structures
- Imperfections in Ceramics
- Ceramic Phase Diagrams

Mechanical Properties

- Brittle Fracture of Ceramics
- Stress-Strain Behavior
- Mechanisms of Plastic Deformation
- Miscellaneous Mechanical Considerations

APPLICATIONS AND PROCESSING OF CERAMICS

Glasses

- Glass Properties
- Glass Forming
- Heat Treating Glasses
- Glass-Ceramics

Clay Products

- The Characteristics of Clay
- Compositions of Clay Products
- Fabrication Techniques
- Drying and Firing

Refractories

- Fireclay Refractories
- Silica Refractories
- Basic Refractories
- Special Refractories

Other Applications and Processing Methods

- Abrasives
- Powder Pressing
- Cements
- Advanced Ceramics

POLYMER STRUCTURES

- Hydrocarbon Molecules
- Polymer Molecules
- The Chemistry of Polymer Molecules
- Molecular Weight
- Molecular Shape
- Molecular Structure
- Molecular Configurations
- Copolymers
- Polymer Crystallinity
- Polymer Crystals

CHARACTERISTICS, APPLICATIONS AND PROCESSING OF POLYMERS

Mechanical and Thermo-Mechanical Characteristics

- Stress-Strain Behavior
- Deformation of Semi-crystalline Polymers
- Melting and Glass Transition Phenomena
- Thermoplastic and Thermosetting Polymers
- Viscoelasticity
- Deformation of Elastomers
- Fracture of Polymers
- Miscellaneous Characteristics

Polymer Applications and Processing

- Polymerization
- Polymer Additives
- Polymer Types
- Plastics
- Elastomers
- Fibers
- Miscellaneous Applications

COMPOSITES

Particle-Reinforced Composites

- Large-Particle Composites
- Dispersion-Strengthened Composites

Fiber-Reinforced Composites

- Influence of Fiber Length
- Influence of Fiber Orientation and Concentration
- The Fiber Phase
- The Matrix Phase
- Fiberglass-Reinforced Composites
- Miscellaneous Fiber-Reinforced Plastic Matrix Composites
- Metal Matrix-Fiber Composites
- Hybrid Composites
- Processing of Fiber-Reinforced Composites

Structural Composites

- Laminar Composites
- Sandwich Panels

CORROSION AND DEGRADATION OF MATERIALS

Corrosion of Metals

- Electrochemical Considerations
- Corrosion Rates
- Prediction of Corrosion Rates
- Passivity
- Environmental Effects
- Forms of Corrosion
- Corrosion Environments
- Corrosion Prevention
- Oxidation

Corrosion of Ceramic Materials/Degradation of Polymers

Swelling and Dissolution
Bond Rupture
Weathering

ELECTRICAL PROPERTIES

Electrical Conduction

Ohm's Law
Electrical Conductivity
Electronic and Ionic Conduction
Energy Band Structures in Solids
Conduction in Terms of Band and Atomic Bonding Models
Electron Mobility
Electrical Resistivity of Metals
Electrical Characteristics of Commercial Alloys

Semi-Conductivity

Intrinsic Semi-conduction
Extrinsic Semi-conduction
The Temperature Variation of Conductivity and Carrier Concentration
Semi-conductor Devices

Electrical Conduction in Ionic Ceramics and in Polymers

Conduction in Ionic Materials
Electrical Properties of Polymers

Dielectric Behavior

Capacitance
Field Vectors and Polarization
Types of Polarization
Frequency Dependence of the Dielectric Constant
Dielectric Strength
Dielectric Materials

Other Electrical Characteristics of Materials

Ferroelectricity
Piezoelectricity

THERMAL PROPERTIES

Heat Capacity
Thermal Expansion
Thermal Conductivity
Thermal Stresses

MAGNETIC PROPERTIES

Diamagnetism and Paramagnetism
Ferromagnetism
Anti-ferromagnetism and Ferrimagnetism
The Influence of Temperature on Magnetic Behavior
Domains and Hysteresis
Soft Magnetic Materials
Hard Magnetic Materials
Magnetic Storage
Superconductivity

OPTICAL PROPERTIES

Basic Concepts

- Electromagnetic Radiation
- Light Interactions with Solids
- Atomic and Electronic Interactions

Optical Properties of Metals/Optical Properties of Non-Metals

- Refraction
- Reflection
- Absorption
- Transmission
- Color
- Opacity and Translucency in Insulators

Applications of Optical Phenomena

- Luminescence
- Photoconductivity
- Lasers

KINETIC PROCESSES IN MATERIALS

MOTION OF ATOMS AND MOLECULES BY DIFFUSION

Irreversible Thermodynamics and the Coupling between Forces and Fluxes

- Entropy and Entropy Production
 - Entropy Production
 - Conjugate Forces and Fluxes
 - Basic Postulate of Irreversible Thermodynamics

- Linear Irreversible Thermodynamics
 - General Coupling between Forces and Fluxes
 - Flux/Force Relations when Components are constrained
 - Onsager's Symmetry Postulate

Driving Forces and Fluxes for Diffusion

- Diffusion in Presence of a Concentration Gradient
 - Self-Diffusion in a Chemically Pure Material
 - Self-Diffusion of Solute Particles in a Chemically Homogeneous Solution
 - Diffusion of Substitutional Particles in a Chemical Concentration Gradient
 - Diffusion of Interstitial Particles in a Chemical Concentration Gradient
 - On the Algebraic Signs of Diffusivities

- Mass Diffusion in the Presence of Stress
 - Effect of Stress on Mobilities
 - Stress as a Driving Force for Diffusion: Formation of Solute Atom Atmosphere around Dislocations
 - Influence of Stress on the Boundary Conditions for Diffusion: Diffusional Creep

- Mass Diffusion in an Electrical Potential Gradient
- Mass Diffusion in a Thermal Gradient
- Mass Diffusion Motivated by Capillarity

The Diffusion Equation

The Diffusion Equation: Flux and Divergence Revisited

D is constant

Geometrical Interpretation of the Diffusion Equation when D is Constant

Variational Interpretation of the Diffusion Equation

Scaling of the Diffusion Equation

Superposition

D as a Function of Concentration

D as a Function of Time

D as a Function of Direction: Tensors, Anisotropy, and the Relations between Vectors

Solutions to the Diffusion Equation

Steady-State Solutions

Constant Diffusivity

Variable Diffusivity

Nonsteady-State Diffusion (Time-Dependent Diffusion)

Instantaneous Localized Sources in Infinite Media

Solutions Involving the Error Function

Estimating the Diffusion Depth and Time to Approach Steady State

Method of Separation of Variables Diffusion on a Finite Domain

Method of Laplace Transforms

Diffusion in Multi-Component and Multiphase Alloys

Atomic Models for Diffusion

Atomic Jumping and Activated Processes

One-Particle Model with Square Potential-Energy Wells

One-Particle Model with Parabolic Potential-Energy Wells

Many-Body Model

Diffusion Resulting from Discrete Jumps

Relation of D to the Mean Square Particle Displacement

Diffusion and Random Walks

Diffusion with Correlated Jumps

Diffusion in Crystals

Atomic Mechanisms

Ring Mechanism

Vacancy Mechanism

Interstitialcy Mechanism

Interstitial Mechanism

Diffusion Mechanisms in Various Systems

Atomic Models for Diffusion Coefficients

Metals

Ionic Solids

Diffusion along Crystal Imperfections

The Diffusion Spectrum in Crystals with Imperfections

- Diffusion along Grain Boundaries
 - Regimes of Grain Boundary Short-Circuit Diffusion
 - Analysis of the Diffusant Distribution in the A, B, and C Regimes
 - Mechanism of Fast Grain Boundary Diffusion

- Diffusion along Dislocations
- Diffusion along Free Surfaces

Diffusion in Non-Crystalline Solids

- Diffusion in Liquids
- Diffusion in Amorphous Metals
 - Self-Diffusion
 - Interstitial Diffusion of Small Solute Atoms

- Diffusion of Small Atoms (or Molecules) in Glassy Polymers
- Diffusion of Alkali Ions in Network Oxide Glasses
- Diffusion of Polymer Chains
 - Structure of Polymer Chains
 - Diffusion of Isolated Polymer Chains in Dilute Solutions
 - Diffusion of Densely Entangled Polymer Chains by Reptation

MOTION OF DISLOCATIONS AND INTERFACES

Motion of Dislocations

- Forces on Dislocations
 - Force due to Stress
 - Osmotic Force
 - Curvature Force
 - The Total Force on a Dislocation

- Dislocation Glide
 - Uniform Glide Motion in a Linearly Elastic Continuum
 - Frictional Forces Opposing Glide
 - Some Experimental Observations
 - Supersonic Glide Motion

- Dislocation Climb
 - Models for Climb
 - Diffusion-Controlled versus Source/Sink-Controlled Climb Kinetics
 - Experimental Observations
 - Analyses of Two Climb Problems

Motion of Vapor/Crystal and Liquid/Crystal Interfaces

- Driving Pressures for Interface Motion
- Motion of Vapor/Crystal Surfaces
 - Structure of Vapor/Crystal Surfaces
 - Crystal Growth from a Supersaturated Vapor
 - Surfaces as Sinks for Supersaturated Lattice Vacancies

- Motion of Liquid/Crystal Interfaces
 - Structure of Liquid/Crystal Interfaces
 - Crystal Growth from an Under-cooled Liquid

Motion of Crystal/Crystal Interfaces

Additional Driving Pressures for Crystal/Crystal Interface Motion

Conservative versus Non-conservative Interface Motion

Conservative Motion

 Glissile Motion of Sharp Interfaces by Glide of Interfacial Dislocations

 Thermally Activated Motion of Sharp Interfaces by Glide and Climb of Interfacial Dislocations

 Thermally Activated Motion of Sharp Interfaces by Atom Shuffling

Thermally Activated Motion of Diffuse Interfaces by Self-Diffusion

Impediments to Conservative Interface Motion

 Some Experimental Observations of Thermally Activated Motion

Non-conservative Motion: Interfaces as Sources and Sinks for Atomic Fluxes

 Source/Sink Action of Sharp Vicinal Interfaces by the Glide and/or Climb of Interfacial Dislocations

 "Diffusion-Controlled" versus "Source/Sink-Controlled" Kinetics

EVOLUTION OF MICROSTRUCTURE IN THE ABSENCE OF PHASE TRANSFORMATIONS

Morphological Evolution of Interfaces

Isotropic Surfaces

 Smoothing of Free Surfaces by Surface Diffusion

 Surface Rearrangements by Evaporation-Condensation

Anisotropic Surfaces

Sintering

Sintering of Systems of Simple Geometry

 Sintering Mechanisms

 Sintering Rates

Sintering of Powders

 Initial, Intermediate, and Final Stages of Powder Sintering

Sintering Mechanisms Maps

Competitive Growth

Coarsening of a Distribution of Particles

 Classical Mean-Field Theory of Coarsening

 Beyond the Classical Mean-Field of Coarsening

Grain Growth

 Grain Growth in Two Dimensions

 Grain Growth in Three Dimensions

THERMALLY ACTIVATED MECHANICAL DEFORMATION PROCESSES

Diffusional Creep

Diffusional Creep of Systems of Simple Geometry

Creep of Wire with “Bamboo” Grain Boundary Structure
Creep of Two-Dimensional Polycrystal with Hexagonal Grains

Diffusional Creep of Three-Dimensional Polycrystals

Anelasticity (“Internal Friction”)

Anelasticity due to Anisotropic Point Defects
General Formulation of Anelastic Behavior
Analogue Model for Standard Anelastic Solid
Frequency Dependence of the Logarithmic Decrement, δ
Determination of Diffusivities

Other sources of Anelasticity

PHASE TRANSFORMATIONS

Some General Features of Phase Transformations

Order Parameters and the Order of a Phase Transformation
One-Component Systems
Two-Component Systems

Conserved and Non-conserved Field Variables
Classification of Phase Transformations: Continuous Versus Discontinuous Transformations

Spinodal Decomposition and Order-Disorder Transformations

General Aspects of Spinodal Decomposition and Order-Disorder Transformations
Free Energy of Inhomogeneous Systems: Diffuse Interfaces and the Functional Gradient

Evolution Equations for Non-conserved and Conserved Order Parameters
The Allen-Cahn Equation
The Cahn-Hilliard Equation
Numerical Simulation

Spinodal Decomposition
Coherency Strain Effects
Solution to the Cahn-Hilliard Equation
The Later Stages of Spinodal Decomposition
Other Theoretical Developments
Spinodal Microstructures

Order-Disorder Transformations

Kinetics of Continuous Ordering: Early Stages
Kinetics of Continuous Ordering: Later Stages

Nucleation

Homogeneous Nucleation
Classical Theory of Nucleation in One-Component System without Strain Energy
Classical Theory of Nucleation in Two-Component System without Strain Energy
Effect of Elastic Strain Energy
Nucleus Shape of Minimum Energy
More complete Expressions for the Classical Nucleation Rate
Non-Classical Models for the Critical Nucleus

Heterogeneous Nucleation

- Nucleation on Grain Boundaries, Grain Edges, and Grain Corners
- Nucleation on Dislocations

Growth

Growth of Planar Layers

- Diffusion-Controlled Growth
- Growth Controlled by Heat Conduction and Mass Diffusion Simultaneously
- Interface Source/Sink-Controlled Growth

Growth of Isolated Particles

- Diffusion-Controlled Growth
- Interface Source/Sink-Controlled Growth

Morphological Stability of Moving Interfaces

- Stability of Pure Solid/Liquid Interface during Solidification
- Stability of α/β Interface During Diffusion-Controlled Particle Growth
- Stability of Liquid/Solid Interface during Alloy Solidification
- Analyses of Interfacial Stability

Concurrent Nucleation and Growth Transformation Kinetics

Cahn's Time-Cone Analysis

- Energy-Density Driven Growth: Recrystallization
- TTT- Diagrams

Solidification

Plane-Front Solidification

- One-Dimensional Solidification
- Zone melting and Zone Leveling

Cellular Solidification

- Formation of Cells and Dendrites
- Solute Segregation during Dendritic Solidification

Structure of Castings and Ingots

Precipitation

Some General Features of Precipitation

- Nucleus Morphology and Energy
- Loss of Precipitate Coherency During Growth
- Precipitation in Two Selected Systems
 - Cu-Co System
 - Al-Cu System

Martensitic Transformations

Introduction

Crystallographic Theory of Martensitic Transformations

- Definitions of Quantities in the Crystallographic Theory
- Mechanical Twinning
- Martensitic Transformations

Nucleation of Martensite

THERMODYNAMICS OF MATERIALS - CLASSICAL THERMODYNAMICS

The Laws of Thermodynamics

- The Zeroth Law
- Work and the First Law
- Heat Flow and the Second Law
- The Absolute Temperature
- The Third Law

Criteria for Equilibrium

- The Entropy Principle
- Definitions
- The Basic Equilibrium Postulate
- Additional State Functions
- Criteria for Equilibrium
- The Isolated System
- The Closed Isothermal System
- The Closed Isobaric System
- The Open Isothermal System

Useful Mathematical Relations

- Partial Derivatives
- Relation to Measurable Properties
- Evaluation of Partial Derivatives
- The Cross-Differentiation Identity
- Maxwell's Relations
- Integration of the State Function Equations

General Theory of Phase Stability

- General Relations
- Degrees of Freedom
- The Gibbs-Durham Equation
- Equilibrium in Multiphase Systems
- Thermal Equilibrium
- Hydrostatic Equilibrium
- Distributive Equilibrium
- Chemical Equilibrium
- General Criteria for Equilibrium
- The Gibbs Phase Rule

FUNDAMENTALS OF STATISTICAL THERMODYNAMICS

Basis of Statistical Thermodynamics

- What is Statistical Thermodynamics?
- Basic Approach
- Relation of Macroscopic to Microscopic Descriptions
- Ensembles
- Types of Ensembles
- Postulates

Evaluation of Probabilities

- Application of Postulates
- The Microcanonical Ensemble
- The Canonical Ensemble
- The Grand Canonical Ensemble

Statistical Mechanical Criteria for Equilibrium

- The Isolated System and the Function S'
- The Closed Isothermal System and the Function F'
- The Open Isothermal System and the Function $(PV)'$

The Connection Between Statistical Thermodynamics and Classical Thermodynamics

- The Canonical Ensemble and β
- Evaluation of the State Functions in Terms of Q
- The Grand Canonical Ensemble and γ
- Evaluations of the State Functions in Terms of Ξ
- Fluctuations

Evaluation of the Allowed Energies

- Models
- Quantum Mechanics
- Translational Motion
- Rotational Motion
- Motion in a Potential Field
- Degeneracy and Interparticle Effects
- Independent Particle Systems
- Relation of System Energy to Particle Energies
- Distinguishable Particle Systems
- Indistinguishable Particle Systems
- Independence of Modes of Energy Storage

SINGLE-COMPONENT SYSTEMS

Classical Thermodynamics of One-Component Systems

- Free Energy Surfaces
- Temperature Dependence of the Thermodynamic Functions
- Pressure Dependence of the Thermodynamic Functions
- The One-Component Phase Diagram
- Molar Properties
- The Clapeyron Equation
- Evaluation of the State Functions

The Monatomic Ideal Gas

- The Model
- Number of Available States
- Evaluation of q
- Evaluation of the Partition Function
- Evaluation of the Thermodynamic Functions
- Electronic Excitation
- The Zero of Energy
- Complete Expressions for the Thermodynamic Functions

The Polyatomic Ideal Gas

- The Model
- Evaluation of q
- Evaluation of the Thermodynamic Functions
- Polyatomic Molecules
- The Grand Canonical Ensemble

The Einstein Model of the Solid

- The Einstein Model
- Evaluation of the Partition Function

Limiting Values of q_v
Evaluation of the Thermodynamic Functions
High and Low Temperature Limits

The Debye Model of the Solid

The Debye Model
Evaluation of the Partition Function
Evaluation of the Thermodynamic Functions
Relation of Θ_D to Crystal Properties
High and Low Temperature Limits

Simple Liquids

The Model
Evaluation of the Partition Function
Evaluation of the Thermodynamic Functions
Evaluation of Parameters

Statistical Thermodynamics of Phase Equilibrium in One-Component Systems

Solid-Vapor Equilibrium
Liquid-Vapor Equilibrium
The Triple Point
Solid-Liquid Equilibrium
A Numerical Example

MULTI-COMPONENT SYSTEMS

Classical Thermodynamics of Multi-component Systems

Activity
Molar Properties
Partial Molar Properties
Relation of Partial to Total Molar Properties
Calculation of Partial Properties from Total Properties

Classical Thermodynamics of Solutions

Formation of a Solution
Ideal Gas Mixtures
Multi-component Condensed Phases
The Ideal Solution
Dilute Solutions
Concentrated Solutions
Excess Functions

Lattice Statistics

The Ideal Lattice Gas
The Einstein Crystal with Vacancies
Evaluation of the Thermodynamic Functions
The Langmuir Model of Adsorption
The Two-Dimensional Pressure
Evaluation of the Thermodynamic Functions
The Langmuir Adsorption Isotherm

The Lattice Gas with Interactions

The Model
Evaluation of the Partition Function
The Bragg-Williams Approximation
The Quasi-chemical Model

Statistical Thermodynamic Treatment of Solutions

- The Model
- Solid Solutions
- The Ideal Solid Solution
- The Bragg-Williams Model and Regular Solutions
- The Quasi-chemical Model
- Liquid Solutions
- The Partition Function
- Ideal Liquid Solutions
- Regular Liquid Solutions

Phase Equilibrium in Multi-Component Systems

- The Model
- The Two-Component Ideal Systems
- A Numerical Example
- Gas-Phase-Condensed-Phase Equilibrium
- Two-Component Non-ideal Systems
- Phase Separation
- A Numerical Example
- Solid-Liquid Equilibrium in Non-ideal Systems
- A Numerical Example

Chemical Equilibrium

- The Equilibrium Constant
- Dissociation of a Diatomic Molecule
- Isotopic Equilibrium
- General Gas-Phase Reactions
- Heterophase Reactions

QUANTUM SYSTEMS

The Perfect Electron Gas

- The Model
- Number of Available States
- Evaluation of the Partition Function
- Average Number of Particles per State
- Evaluation of the Thermodynamic Functions at 0 K
- The Fermi Energy and the Work Function
- Temperature Dependence of the Thermodynamic Functions

Blackbody Radiation

- The Model
- Evaluation of the Partition Function
- Evaluation of the Thermodynamic Functions
- The Spectral Energy Distribution

Polymer and Fiber Science Topics

Polymerization Principles

Introduction / Definitions
Polymer Classification, Nomenclature, Molecular Weights
Criteria for Polymer Formation

Step Growth Polymerization

Synthetic Requirements
Thermodynamics and Kinetics
Molecular Weight and Distribution
Fundamentals of Multichain Polycondensation: Branching & Crosslinking
Industrial Process Conditions
The Polymers: Polyesters, Polycarbonates, Polyamides, Polyimides, Polyurethanes,
Heterocyclics, Network Polymers, Misc. Processes and Classes

Chain Growth Polymerization

Synthetic Requirements
Thermodynamics
Free Radical Polymerization
Initiation, Propagation and Termination Mechanisms
Polymerization Kinetics
Chain Transfer, Molecular Weight Control and Distribution
Industrial Process Conditions and Polymers

Ionic Polymerization

Insertion Polymerization, Stereochemistry, and New Systems

Copolymerization

The Copolymerization Equations
Free Radical and Ionic Copolymerization

Ring Opening Polymerizations

General Characteristics
Thermodynamics and Kinetics
Polymer Systems

Polymer structure

Chain structure and configuration
Molecular weights and sizes
Polymer solutions and phase separation behavior
Amorphous and crystalline states
Glass-rubber transition behavior
Rubber elasticity
Polymer viscoelasticity and rheology
Mechanical behavior of polymers
Polymer surfaces and interfaces
Multicomponent polymeric materials

Polymers for Fibers General Commercial Materials

Polymer Terms and Definitions
Addition Polymers/Chain Growth Polymerization
Condensation Polymers/Step Growth Polymerization
Size

Polymolecularity
Polymer Structure
Constitution, Configuration, Conformation

Condensation Polymers
Polyester Formation Reactions
Poly (ethylene terephthalate) (PET)
Properties of PET
Polyester Variants
Saturated and Un-saturated Network Polymers
Liquid Crystalline Polyesters

Polyamide Formation Reactions
Nylon 6
Manufacture
Properties
Nylon 6, 6
Manufacture
Fiber and Polymer Properties
Stabilizers and Side Reactions in the Manufacture of Nylon 6 and 6, 6
Other Nylons of Commercial Interest

Aramids

Fiber Physics

Physical properties and their measurement (Listed in order of emphasis.)
Mechanical properties (tensile, torsional, fatigue, and aging)
Thermodynamic properties (e.g., phase transitions (incl. T_g & T_m). thermal conductivity, and moisture sorption)
Essential electrical properties (DC conductivity, dielectric behavior and optical properties)

Production methods (essential features)
Polymer fine structure models: micelles, folded chain crystals, crystalline- amorphous domain structures, spherulites,....
Theories of mechanical properties of oriented polymers: mathematical models of viscoelasticity; statistics and thermodynamics of rubber elasticity; structure-property relationships.
Theories of thermal behavior: kinetic and free volume theories of the glass transition; time-temperature equivalence; introduction to crystallization and diffusion in polymers.

Methods for structure determination

X-ray diffraction
Electron microscopy
Optical birefringence
Spectroscopy

Dyeing of natural and synthetic fibers

Direct Dyes: Their applications, structures, and products
Vat Dyes: General properties and application
Sulfur Dyes: General properties and application
Reactive Dyes: General properties and application
Azoic Combinations: Chemistry & applications

Dyeing Man-Made Fibers: Developments
Disperse Dyes: Applications to Polyester, Structures & Properties
Properties of Silk/Nylon/Wool/Sorption
Dyeing Nylon with Acid Dyes

Dyeing Acrylics & Other Fibers with Basic Dyes
Dyeing Polyester/Cellulosic Blends
Dyeing of Other 2 & 3 Fiber Blends
Pigments as Textile Colorants: Pigmenting
Physical Chemistry of Dyeing

Color: Basic Principles

Light, Detector, and Object
Spectrophotometry
Transmittance and Reflectance Measurement
Colorimetry and the CIE, X, Y, Z
Color Order Systems & CIE Lab 76
CMC (l:c) & Color Tolerances
Shade Sorting/Matching Prediction

Textile Finishing

Mechanical Finishing
Chemical Finishing
Durable Press and Crease Resist
Cross-linking of cotton
Water/Oil/Stain Repellency
Flame Retardancy
Nature of Dye Chemistry

Textile Structures

Yarn Production

Yarn Structure
Mechanics of Continuous Filament Yarns
Mechanics of Plied Yarns

Thermal analysis

Thermogravimetric Analysis - TGA
Differential Scanning Calorimetry - DSC
Thermomechanical and Dynamic Thermomechanical Analysis- TMA, DTMA
Other Thermal Methods - DTA - DMA - TEA - etc.

Microscopy and analysis

Optical Birefringence
Cross polarization
Electron Scanning
Atomic Force

Spectroscopic analysis

Infrared, Raman and NIR Analysis
Theory
Instrumentation
Spectral analysis
Qualitative analysis
Structural Analysis
Crystallinity
Orientation

TA assessment

Observation of TA teaching by the faculty in charge of the COURSE OR MODULE.

As a TA it is required that your performance has aided student learning. Your **overall** competence as a TA (as deemed by your course coordinator) is required to be satisfactory or better in order to maintain TA status.

Through your performance as a TA the class has:

Statement	Rating
1. been able to learn effectively, efficiently and independently	
2. been able to understand, analyze and synthesis substantial amounts of information	
3. been able to make use of concepts, some of them abstract	
4. been able to engage in critical evaluation of received information	
5. been able to become skilled in reasoning and argument	
6. been able to communicate opinions, clearly, and by giving evidence	
7. been able to recognize, and solve problems and been adaptable and flexible in applying theoretical understandings to problems encountered in the world around them	
8. been able to make well-founded judgments on the application of my knowledge	
9. been able to cooperate in team work	
10. been able to become confident in the use of IT as required for the academic discipline	
11. OVERALL Comment on the overall performance as Excellent, Very good, Satisfactory, Poor, or Very Poor	

1= strongly agree,
3= neither agree or disagree,
5 = strongly disagree

Action item for the TA student before starting the TA position

Before you start being a TA, you are required to get a description of your duties and responsibilities from the faculty member in charge of the course. Once you have received this document you should sign it, photocopy it to keep a copy for yourself and then file the original signed copy with the **Student Services Coordinator** in 162B Sirrine.

List Teaching Assistant Duties Performed (including course number and title, semester/year):

-

Publications and Presentations (at Clemson): Please provide all authors in the correct order (underline your name), article title, journal/conference name, vol. and start/end page #'s (for publications), year, and time/place (for presentations).

Please list your refereed journal publications and status (submitted, in revision, in press or published):

-

Please list other technical publications (e.g., papers in conference proceedings):

-

Please list your presentations at national and international conferences (talks or posters):

-

Please list any internal presentations:

-

To be completed by the student's research advisor: _____(name of the advisor)

This student's performance is (circle one):

Excellent

Very Good

Good

Fair

Poor

Additional Comments (Comments are optional for Very Good/Good performance ratings; and mandatory for Excellent and for Fair/Poor performance ratings)

_____ (signed)

_____ (date)

M.S. Student Checklist

If you are in the MS program, please complete/update the following table.

	WHAT	WHEN	HOW/WHO	DATES (fill these in yourself, for your own record)
1	Selection of major advisor	Before the end of the 1 st semester	Notify Graduate program coordinator and Admin. Assistant	
2	Appointment of advisory committee	Before the end of the 1 st semester	In consultation with advisor	
3	Preparation of plan of study	Before the end of the 1 st semester	In consultation with advisor and committee	
4	Filing of plan of study	Before the beginning of the 2 nd semester	GS2 Form by student	
5	Thesis proposal (optional but recommended)	Before the end of the 2 nd semester	In consultation with advisor and committee	
6	Advisory committee meeting before defense	~ 6 months before final examination (or consult your advisory committee)	In consultation with advisor and committee	
7	Apply for Graduation and Diploma	(Current deadlines can be found on the Graduate School website)*	GS4 Form by student	
8	Cap and Gown Rental	Early during semester in which degree is to be conferred (see website)*	By student	
9	Submittal of thesis	Submit your draft thesis to advisor for revision and approval before submission to the advisory committee. (Allow sufficient time; In consultation with advisor)	By student with review by research advisor	
		Submit a semi-final version of thesis (approved by the advisor) to the committee at least 2 weeks before final examination or consult your advisory committee		
10	Thesis Defense	At least 3 weeks prior to date on which degree is expected (see website)*	GS7 Form to be filed by advisor after examination is completed	
11	Approval of thesis by Graduate School	About 2 weeks before graduation (see website)*	By student	
12	Final Checkout (please refer to p. 44)	Before graduating or before leaving Clemson	By Student	
13	Duplication of thesis	At least 2 weeks before graduation (see website)*	By student	

* Graduate School Deadlines website: www.grad.clemson.edu/Deadlines.php

Ph.D. Student Checklist

If you are in the Ph.D. program, please complete/update the following table.

	WHAT	WHEN	HOW/WHO	DATE*
1	Selection of major advisor	Before the end of the 1 st semester	Notify Graduate program coordinator and Admin. Assistant	
2	Appointment of advisory committee	Before the end of the 1 st semester	In consultation with advisor and committee	
3	Preparation of plan of study	Before the end of the 1 st semester	In consultation with advisor and committee	
4	Filing of plan of study	Before the beginning of the 2 nd semester	GS2 Form by student	
5	Comprehensive exam: written proposal	After completion of core classes	Advising and graduate committee	
6	Comprehensive exam: oral exam	After written proposal is accepted	Advising and graduate committee	
7	Admission to Doctoral Candidacy	After completion of Comprehensive Exam	GS5 Form to be completed by graduate committee	
8	Dissertation committee meeting before defense	Typically ~12 months (at least 6 months) before final examination (or consult your dissertation committee)	In consultation with advisor and committee	
9	Apply for Graduation and Diploma	(Current deadlines can be found on the Graduate School website)*	GS4 Form by student	
10	Cap and Gown Rental	Early in semester during which degree is expected to be conferred (see website)*	By student	
11	Completion of draft of dissertation	Submit your draft dissertation to advisor for revision and approval before submission to the advisory committee. (Allow sufficient time; In consultation with advisor)	By student with review by research advisor	
		Submit a semi-final version of dissertation (approved by the advisor) to the committee at least 2 weeks before final examination or consult your advisory committee		
12	Dissertation Defense	At least 3 weeks prior to date on which degree is expected (see website)*	GS7 Form to be filed by major advisor after examination is completed	
13	Approval of dissertation by Graduate School	About 2 weeks before graduation (see website)*	By student	
14	Final Checkout (please refer to p. 44)	Before graduating or before leaving Clemson	By Student	
15	Duplication of dissertation	At least 2 weeks before graduation (see website)*	By student	

* Graduate School Deadlines website: www.grad.clemson.edu/Deadlines.php