

# Graduate Student Manual



## Department of Mechanical Engineering

Fluor Daniel Engineering Innovation Building  
Clemson University  
Clemson, SC 29634-0921  
(864) 656-0999

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## INTRODUCTION

This manual has been prepared to inform graduate students in the Department of Mechanical Engineering of departmental regulations and procedures governing the granting of graduate degrees. Graduate students should become familiar with the information presented here, as well as with general Graduate School requirements outlined in the Graduate School Announcements ([www.grad.clemson.edu](http://www.grad.clemson.edu)). If the answer to a question cannot be obtained from this manual or the GS Announcements, the answer should be sought by asking: the Assistant Graduate Coordinator, your major advisor, or the Graduate School, preferably in that order.

Students must read this manual and return FORM 15 signed (see last page) to the Assistant Graduate Coordinator.

## DEPARTMENTAL POLICY ON ETHICS

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 they have done**. The Department of Mechanical 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 attribute credit when we utilize the work done previously by others. In particular, we must guard against any activity that calls into question our integrity. In this regard, we affirm the following:

- information in a research program will be truthfully presented,
- the work of others will never be misrepresented as our own,
- information will be obtained only if access is authorized.

## THE HONOR CODE

This Honor Code was initiated by engineering students in the College of Engineering and Science with the advice and approval from the faculty. The document reflects a mutual trust between the students and faculty at Clemson University. By living under the guidance of the Code, we are contributing to our personal success as well as the success of all engineers associated with the College of Engineering and Science.

As members of the College of Engineering and Science, we recognize that lasting excellence is achieved only through honor, demanding standards for personal integrity that reflect the standards of conduct expected of all engineers. All undergraduate and graduate engineering students, faculty members, and administrators in the College of Engineering and Science are expected to abide by the ethical standards defined herein. These standards are based on the following principles:

*Engineers, both students and professionals, must be of honorable and trustworthy character. It is dishonest to claim credit for work, which is not the result of one's own efforts.*

*Students, faculty members, and administrators are bound by a mutual trust to uphold the principles and enforce the policies of the Honor Code. This makes it the duty and responsibility of all members of the*

*College of Engineering and Science to report promptly any suspected violations of the Code.*

The Honor Code establishes a standard of academic integrity. As such, this code demands a firm adherence to a set of values. This Honor Code requires that all graduate students exercise honesty and ethical behavior in all their academic pursuits, whether these undertakings pertain to study, coursework, research or teaching.

We recognized that our graduate students have very diverse cultural backgrounds. Because of this, the term ethical behavior is defined as conforming to accepted professional standards of conduct, such as codes of ethics used by professional societies in the United States. This regulates the behavior in which their professions are conducted. The knowledge and practice of ethical behavior is the full responsibility of the student. Graduate students may, however, consult with their advisor, department head, the International Student Office, or the Graduate School for further information of what is expected of them.

### **GRADUATE PROGRAM COORDINATOR(S)**

Members of the Graduate Research Committee (GRC) are responsible for the graduate coordination in our Department. Thus, the GRC serves as the Graduate Program Coordinator. The Assistant Graduate Coordinator is the initial contact for graduate students arriving on campus. The Graduate Coordinator and Assistant Graduate Coordinator is the authority on regulations and procedures pertinent to the graduate programs and should be contacted whenever questions or problems occur.

### **ORIENTATION FOR NEW STUDENTS**

Prior to registration for the first semester of study, beginning graduate students must attend the Departmental graduate orientation. The Graduate Program Coordinator will help them plan their initial program of study and identify a suitable major advisor(s), if an advisor has not been previously agreed upon.

### **REGISTRATION**

Particular attention should be paid to the requirements for registration. Any student pursuing any phase of his or her graduate program must be registered. Students are expected to make continuous progress toward their degrees and, therefore, to be enrolled for graduate credits each semester during the academic year until requirements are completed.

Full-time student status is at least 9 hours, although students should normally enroll in 12 hours during the academic year and 6 hours during each summer session. Graduate research assistants and graduate teaching assistants are required to register for a minimum of 9 and a maximum of 12 credit hours during the academic year. The minimum registration for unsupported students is 1 credit hour.

Near the middle of each semester, students will be notified of the time and procedure for on-line registration by the University. By that time, students should have prepared a program of study with the counsel of their major advisor. This is accomplished by completing form GS-2 Graduate Degree Curriculum. The **GS-2 form must be submitted and approved prior to registration for the second semester of enrollment**. Students will be required to register for next semester's courses on the computer at this time. Any deviation from courses listed on form GS-2 must be approved by the student's advisor and a new GS-2 must be resubmitted and approved. The GS2 form can be found at [http://www.grad.clemson.edu/f\\_general.html](http://www.grad.clemson.edu/f_general.html) . The Department requires an earlier deadline for the GS2 form than the Graduate School.

*Note: Registration may be blocked if the GS2 form is not completed. Also, funding may be delayed if the GS2 form is not completed.*

If you are not enrolled for more than one semester the Graduate School requires a re-entry form (GS36). You must complete this form and return it to the Graduate School prior to registration. You may download this form at [www.grad.clemson.edu](http://www.grad.clemson.edu)

### **MAXIMUM CREDIT LOADS**

The University sets upper limits on the number of credits graduate students may earn in a given semester. They are specified in the Graduate School Announcements ([www.grad.clemson.edu](http://www.grad.clemson.edu)). All requests for permission to exceed these limits must be requested by memo and approved by the Chair of the Department of Mechanical Engineering and the Dean of the Graduate School.

### **MECHANICAL ENGINEERING LECTURE & STUDENT SEMINAR SERIES**

The Department of Mechanical Engineering sponsors a series of typically 6-8 lectures per year by scholars in various areas of mechanical engineering. The Department also sponsors a Student Seminar Series, in which ME students will present their work-in-progress. Students are expected to attend and participate in the student series.

Since the primary purpose of graduate education is to foster scholarly development, **all graduate students are required to attend the lectures and seminars** in these series. Attendance will be taken.

### **FINANCIAL SUPPORT**

Financial support is awarded based on availability of funds and academic merit. If a student changes his/her subject area after support has been extended, support eligibility is reviewed and funding may or may not be provided. Ph.D. students and MS students pursuing research (thesis) are given priority for financial support. A student changing status from thesis to course option (non-thesis) may lose financial support.

Graduate students are eligible for financial support if they are (1) enrolled in full-time graduate studies, (2) in good academic standing, i.e., not on probation, and (3) making satisfactory progress toward their degree. Graduate Assistants receiving funding pay a flat fee for tuition and fees. To receive the reduced tuition and fees for a particular semester, a qualified student must be on the department payroll by end of the second week of that semester.

Graduate students must maintain a cumulative B average in all graduate-level courses (600-level and above). Students who fail to meet these requirements become ineligible for graduation and are placed on academic probation. The probationary status remains in effect until nine additional semester hours of graduate credit have been attempted. Students whose cumulative GPA is below a 3.0 will not receive any state funds. Also, a student who receives an "F" during any semester is not eligible for state funds for the next semester.

Supported students are required to fill out tax forms (federal and state) and the I-9 form which verifies citizenship. Two forms of identification are needed to fill out the I-9 form properly, a valid driver's license, a social security card, a passport and/or a birth certificate. The tax forms and I-9 forms are usually distributed during orientation but frequently, funding may begin at other times during the semester. If this is the case, you may pick up your tax forms and I-9 form in room 106 Fluor Daniel Building. It suggested

that you fill out all required forms in a timely manner. Paychecks cannot be distributed until all parties (Graduate School, International Office, Human Resources) have approved the paperwork.

#### **Graduate Research Assistantships (GRA)**

- GRA's are employed for up to a half-time basis (up to 20 hours per week) on a research project during a specified appointment period, as indicated on your offer letter.
- GRA's are employed to assist a professor in their research activities.
- Students must be enrolled full-time (12 hrs) to receive funding.
- International students who have applied for or received their OPT should contact the Assistant Graduate Coordinator or the Departmental Payroll Staff.

#### **Graduate Teaching Assistantships (GTA) and/or Graduate Laboratory Assistantships (GLA)**

- GTA's (GLA) are employed for up to a half-time basis (20 hours per week) to assist with the teaching of undergraduate courses in mechanical engineering.
- GTA's (GLA) are responsible for grading lab reports and attending GTA (GLA) meetings as needed.
- Students must be enrolled full-time (12 hrs) to receive funding.
- International students who have applied for or received their OPT should contact the Assistant Graduate Coordinator or the Departmental Payroll Staff.

#### **Graduate Grading Assistantships (GGA)**

- GGA's assist with grading for specific undergraduate and graduate courses in mechanical engineering.
- Hours are predetermined as stated in the duties memo presented at the beginning of each semester.
- International students who have applied for or received their OPT should contact the Assistant Graduate Coordinator or the Departmental Payroll Staff.

#### **Graduate Fellowships Holders**

- Students must be enrolled full-time (12 hrs).

#### **Offer Letter**

- Your responsibilities and details of your financial support are included in your official offer letter from our Department Chair. This letter requires your signature indicating an acceptance of the terms. GTA's (GLA's) will be notified at a later date of their teaching duties (specific course, etc). To maintain your assistantship, students must complete the duties in a satisfactory manner and make satisfactory progress towards their degree.

## **UNIVERSITY HARASSMENT POLICIES**

### **RACIAL HARASSMENT POLICY**

It is the policy of Clemson University to conduct and provide programs, activities and services to students, faculty and staff in an atmosphere free from racial harassment. Racial harassment is any behavior that would verbally or physically threaten, torment, badger, heckle or persecute an individual because of his or her race.

Racial harassment of University faculty, staff, students or visitors is prohibited and shall subject the offender to appropriate disciplinary action.

Students who feel that they have been subjected to racial harassment can seek advice from the Office of Access & Equity, E-103 Martin Hall, phone: 656-3181.

### **SEXUAL HARASSMENT POLICY**

Title VII of the Civil Rights Act of 1964, as amended, provides that it shall be unlawful discriminatory practice for any employer, because of the sex of any person, to discharge without just cause, to refuse to hire, or otherwise discriminate against any person with respect to any matter directly or indirectly related to employment. Harassment of any employee on the basis of sex violates this federal law. The Equal Employment Opportunity Commission has issued guidelines as to what constitutes sexual harassment of an employee under Title VII.

Unwelcome sexual advances, requests for sexual favors, and other verbal or physical conduct of a sexual nature constitute sexual harassment when the following occurs:

1. submission to such conduct is made explicitly or implicitly a term or condition of an individual's employment or academic standing; or
2. submission to or rejection of such conduct by an individual is used as a basis for employment or for arriving at academic decisions affecting an individual; or
3. such conduct unreasonably interferes with an individual's work or academic performance, or creates an intimidating, hostile, or offensive working or academic environment.

Sexual harassment of University faculty, staff or students is prohibited and shall subject the offender to dismissal or other sanctions after compliance with procedural due process requirements. In the event a claim of sexual harassment arises, the claimant may use University grievance procedures that have been established for faculty, staff and students as appropriate. This policy also prohibits an employee from sexually harassing a superior and a student from sexually harassing a faculty member. Employees or students who feel they are victims of this form of discrimination are encouraged to consult the Office Equity & Access, E-103 Martin Hall, (864) 656-3181, for advice and assistance in resolving complaints.

In the event a graduate student wishes to appeal the resolution of the Office of Access and Equity, the student must submit a written request for an appeal to the dean of the Graduate School, who in turn will convene an ad hoc committee that will review the process and/or sanction. The committee membership will come from faculty and students already appointed to the Graduate Council.

## **AMOROUS RELATIONSHIPS**

Amorous relationships that might be appropriate in other circumstances can be inappropriate when they occur between a faculty member, officer or supervisor of the University, and any student or subordinate employee for whom he/she has a professional responsibility.

Those in positions of authority inherently carry the element of power in their relationships with students or subordinates. It is imperative that those with authority neither abuse, nor appear to abuse, this power entrusted to them.

Officers, supervisors and members of the teaching staff should be aware that any romantic involvement with a student or subordinate employee could make them liable for formal action if a complaint is initiated. Even when both parties have consented to such a relationship, it is the officer, supervisor or faculty member who may be held accountable for unprofessional behavior. Difficulties can also arise from third parties who may feel that they have been disadvantaged by such relationships. Graduate assistants, resident assistants, tutors and undergraduate teaching assistants who are also professionally responsible for students, would be wise to exercise special care in their relationships with students they instruct or evaluate.

Any questions concerning these statements or Clemson University's Policy on Sexual Harassment should be directed to the Office Access & Equity, E-103 Martin Hall, 656-3181.

## **UNIVERSITY POLICY ON ACADEMIC MISCONDUCT**

A university is a community of scholars dedicated to the free inquiry of knowledge and truth. It follows as a basic tenet that scholars will conduct themselves with integrity in academic pursuits. In instances where the academic standards may have been compromised, Clemson University has a responsibility to protect this process and to respond appropriately and expeditiously to charges of academic misconduct. Academic misconduct includes, but is not limited to, submission of fraudulent admission credentials, academic dishonesty, falsification of data in research and plagiarism in theses, dissertations or other final projects.

### **I. General**

- A. Academic dishonesty includes giving, receiving or using unauthorized aid on any academic work.
- B. Plagiarism, a form of academic dishonesty, includes the copying of language, structure or ideas of another and attributing the work to one's own efforts.
- C. All academic work submitted for grading contains an implicit pledge and may contain, at the request of the instructor, an explicit pledge by the student that no unauthorized aid has been received.
- D. Academic dishonesty includes attempts to copy, edit or delete computer files that belong to another person or use Computer Center account numbers that belong to another person without the permission of the file owner, account number owner or file number.

## **II. Penalties**

- A. A student guilty of the first offense of academic dishonesty typically will receive a grade of F for the course. In flagrant cases, the student may also be suspended for one or more semesters or may be permanently dismissed.
- B. A student guilty of the second offense of academic dishonesty will receive a grade of F for the course, will be suspended for one or more semesters and may be permanently dismissed. Suspension and dismissal require approval of the president of the University.

## **III. Procedures**

Academic honesty is the individual responsibility of each student. Students should report violations of this policy either to the instructor of the affected course or to any member of the administration. When, in the opinion of an instructor, a student has committed an act of academic dishonesty, the following procedure must be followed:

1. The instructor will inform the student in private of the nature of the alleged charge of academic dishonesty and will simultaneously request in writing that the department chair verify from the registrar if the incident is a first offense.
2. When this information has been received, the instructor will notify the student in writing of the charge of academic dishonesty and the penalty recommended by the instructor and approved by the chair of the department in which the course is taught. The notification will further state that if the student regards the charge as unfair, the student has seven days from the date of receipt of notice to file a grievance with the Graduate Student Grievance Committee.
3. If no grievance is filed by the student, the instructor will forward copies of the written notification to the dean of the college and to the registrar.
4. Should the act of dishonesty not be in the college of the student's major, the registrar will notify the major department chair.

A charge of academic dishonesty in a course must be made within 45 calendar days of the date printed on the grade report for the semester or session in which the course is completed. For grades that replace an original grade of I (incomplete), the 45 days begin the day the I is converted to the final grade.

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# PROCEDURES FOR STUDENTS SEEKING GRADUATE DEGREES

## GENERAL

### TYPICAL MINIMUM DEGREE REQUIREMENTS

The typical requirements for M.S. and Ph.D. programs in Mechanical Engineering are outlined in Table 1.

### ACADEMIC REQUIREMENTS

Academic regulations pertaining to the various degree programs are published in the Graduate School Announcements ([www.grad.clemson.edu](http://www.grad.clemson.edu)). Specific questions concerning academic requirements should be directed to the Graduate Program Coordinator or his Assistant.

### CORE COURSE REQUIREMENTS

Each Subject Group requires specific courses to satisfy its core requirements. The required core courses for each program are listed on the table below. Core course requirements must be met. Core courses will be listed on your Plan of Study (GS2).

Any changes to course requirements, such as waivers or substitutions, must be approved by the Department Chair. Requests should be made in a timely manner and should be pre-approved by the Department Chair. Courses taken prior to the request are subject to rejection by the Chair.

### DEPARTMENTAL EXPECTATIONS FOR GRADUATE WORK FORM

The purpose of this "release form" is to help avoid misunderstandings between advisor and graduate student concerning expectations for degree completion. Part I of the form should be completed, signed by the advisor and student, and filed with the GS2 form. The advisor must sign Part II before a student can receive a graduate degree in the Department of Mechanical Engineering.

The goal should be to complete most of these topics in a continuous manner, while the research is being conducted, rather than waiting until the end. One important point is that computer programs written, data generated, discoveries made, derivations developed, etc., by a Clemson graduate student are the property of Clemson University, not of the student.

Publications and other methods for disseminating research results are expected activities of graduate students. Doctoral students, and in most cases, MS students in the Department are expected to publish one or more archival journal papers. In many ways, the quality of an MS or Ph.D. program is measured by the publications. This release form puts this and related topics into the proper perspective.

This form is located in the back of this manual. (Form 14)

## MINIMUM DEGREE REQUIREMENTS

Program	MS Thesis	MS Non Thesis	PhD
Total Hours of Courses*	24 hours	Typically 33 hours	Typically 30 hours beyond MS
Core Courses Required**	EM – 4 courses MMS – 3 of 9 courses TFS – 5 courses	EM – 4 courses MMS – 3 of 9 courses TFS – 5 courses	**EM – 4 courses MMS – 3 of 9 courses TFS – 5 courses
Written Requirements	6 hour Thesis (Grad School)		18 hour Dissertation (Grad School)
Exams	Thesis Defense	Comprehensive	Qualifying Comprehensive Dissertation Defense

\*At least half of the courses must be above the 600 level (i.e., 800 & 900 level). 50% or more of the courses must come from EM/ME. At least 50% of ME courses must be above 600.

\*\*For students not having an MS degree

**The Department of Mechanical Engineering requires that all MS graduate students take three of the following nine courses:**

ME 801	Foundations of Fluid Mechanics	ME 831	Convective Heat Transfer
ME 810	Macroscopic Thermodynamics	ME 837	Theory of Elasticity I
ME 818	Intro to Finite Element Analysis	ME 846	Intermediate Dynamics
ME 820	Modern Control Engineering	ME 861	Material Selection for Design
ME 829	Energy Methods	ME 870	Design Methodology

\*\*Each Subject Group requires specific courses to satisfy its core requirements. The require core courses for each program are:

Engineering Mechanics (EM)	Mechanical Systems (MMS)	Thermal/Fluid Sciences (TFS)
ME 837; ME 846 or ME 801; ME 818 or ME 852; an approved Math or Physics course	Students are required to satisfy The department core listed above.	ME 801; ME 810; ME 812; ME 831; MTHSC (600 and above) or Physics 811 or Phys 812 *

\*Thermal Fluid Sciences graduate students shall take no more than one 600 level graduate course in fulfillment of their degree requirements unless a specific exception is approved by his/her faculty committee.

## **DESCRIPTION OF COURSES**

**ME 607: Applied Heat Transfer. 3(3,0).** Application Oriented Extension of ME 304, considering topics in transient conduction, flow of fluids, energy exchange by radiation, and mass transfer. Applications in heat-exchanger design with emphasis on economics and variation of operating conditions from the design point. *Prerequisites:* ME 304 and consent of instructor.

**ME 617: Mechatronics System Design. 3(3,0).** Mechatronics is the study which integrates control, sensors, and computers to create a variety of electromechanical products or machines. Course study includes concepts of design, appropriate dynamic system modeling and analysis, sensors and transducers, actuating devices, and real time microprocessor interfacing and control. Case studies, simulation, and projects are used to exemplify the system design principles. *Prerequisites:* ME 305 or consent of instructor.

**ME 620: Energy Sources and Their Utilization. 3(3,0).** Covers availability and use of energy sources such as fossil fuels, solar (direct and indirect), and nuclear; addresses energy density and constraints to use (technical and economic) for each source. *Prerequisites:* ME 303 and ME 304.

**ME 621: Introduction to Compressible Flow. 3(3,0).** Introductory concepts to compressible flow; methods of treating one-dimensional gas dynamics including flow in nozzles and diffusers, normal shocks, moving and oblique shocks, Prandtl-Meyer Flow, Fanno Flow, Rayleigh Flow, and reaction propulsion systems. *Prerequisites:* EM 320 and ME 303.

**ME 622: Design of Gas Turbines. 3(3,0).** Guiding principles in gas turbine cycles are reviewed. Turbine and compressor design procedures and performance prediction for both axial and radial flow machines are presented. Methods of design of rotary heat-exchangers and retrofitting gas turbine for regenerative operation are presented. Design projects are used to illustrate the procedures. *Prerequisites:* EM 320.

**ME 623: Introduction to Aerodynamics. 3(3,0).** Basic theories of aerodynamics are presented with the purpose of accurately predicting the aerodynamic forces and moments which act on a vehicle in motion. *Prerequisites:* EM 320.

**ME 625: Kinematics and Dynamics of Machinery. 3(3,0).** Graphical, analytical, and numerical techniques are used in the dynamic analysis and synthesis of machines. Emphasis on the application of the analysis techniques to cams, gears, and other mechanisms. *Prerequisite:* ME 202, EM 202.

**ME 629: Thermal Environmental Control. 3(3,0).** Mechanical vapor compression refrigeration cycles, refrigerants, thermoelectric cooling systems, cryogenics, thermodynamic properties of air, psychrometric charts, heating and cooling coils, solar radiation, heating and cooling loads, insulation systems. *Prerequisites:* EM 320 and ME 303.

**ME 630: Mechanics of Composite Materials. 3(3,0).** Fundamental relationships for predicting the mechanical and thermal response of multi-layered materials and structures are developed. Micromechanical and macromechanical relationships are developed for laminated materials with emphasis on continuous filament composites. The unique nature of composites and the advantages of designing with composites are discussed. (Previously EM 630) *Prerequisite:* EM 304.

**ME 632: Advanced Strength of Materials. 3(3,0).** Topics in mechanics of materials not covered in EM 304. Three-dimensional stress and strain transformations, unsymmetrical beam bending, shear center, curved beams, beams on elastic foundations, Hertzian contact, thick-walled cylinders, torsion, introduction to plate theory. *Prerequisites:* EM 304 and senior standing. (Previously EM 625)

**ME 650: Mechanical Vibrations. 3(3,0).** Mathematical analysis of physical problems in the vibration of mechanical systems. Topics include linear-free vibrations, forced vibrations, and damping in single degree of freedom systems, transient vibrations, critical speeds and whirling of rotating shafts, dynamic balancing, and multidegree of freedom systems with lumped parameters. (Previous EM 650) *Prerequisites:* EM 202, EM 304, MTHSC 208.

**ME 653: Dynamic Performance of Vehicles. 3(3,0).** Introduces techniques for analyzing the dynamic behavior of vehicles. Types of vehicles to be considered will be chosen from aircraft, surface ships, automobiles and trucks, railway vehicles, and magnetically levitated vehicles. *Prerequisites:* ME 205 or 208 and ME 305 or consent of the instructor.

**ME 654: Design of Machine Elements. 3(3,0).** Design of common machine elements including clutches, brakes, bearings, springs, and gears. Optimization techniques and numerical methods are employed as appropriate. *Prerequisites:* ME 306 or consent of instructor.

**ME 655: Design for Manufacturing. 3(3,0).** Concepts of design for manufacturing and assembly (DFM and DFA) are considered through a team and project learning environment. Study focuses on the best practices in manufacturing and assembly as related to the Product Realization Process (PRP). The production processes of injection molding, die casting, sheet-metal stamping and welding are studied as examples of DFM/A and PRP. Team design and learning are based on two major projects, which exemplify the DFM/A methodology. *Prerequisites:* Senior Standing.

**ME 656: Fundamentals of Robotics. 3(3,0).** Considers the mechanics and control of industrial robots and their application to manufacturing problems. Topics covered include robot geometry, kinematics, and dynamics; servomechanisms, control and process application; programming; and integration into manufacturing applications. *Prerequisites:* ME 416 or consent of instructor.

**ME 671: Computer Aided Engineering Analysis and Design. 3(3,0).** Students are exposed to geometric and solid modeling, finite elements, optimization, and rapid-prototyping. Students design an artifact, represent it on the computer, analyze it using FEA, then optimize before prototyping it. Emphasizes the use of computer-based tools for engineering design. The World Wide Web is used for reporting. *Prerequisites:* Numerical methods and programming experience or permission of instructor.

## **DESCRIPTION OF COURSES CONTINUED**

**ME 801: Foundations of Fluid Mechanics 3(3,0).** Derivations of basic equations for multi-dimensional flow fields; analytical techniques for solving problems in laminar viscous flow and laminar inviscid flow; theories of similitude. *Prerequisites:* Graduate standing and permission of instructor.

**ME 810: Macroscopic Thermodynamics. 3(3,0).** First, second and third laws of thermodynamics with engineering applications; thermodynamic property relations; chemical equilibrium. *Prerequisite:* ME 303 or equivalent.

**ME 811: Gas Dynamics. 3(3,0).** Concepts from thermodynamics, one-dimensional gas dynamics, one-dimensional wave motion, normal and oblique shocks; flow in ducts and wind tunnels; two-dimensional equation of motion; small perturbation theory. *Prerequisite:* Undergraduate course in fluid mechanics.

**ME 812: Experimental Methods in Thermal Science. 3(2,2).** Theories of measurements, instrumentation and techniques for measuring temperature, pressure and velocity on a practical graduate engineering level; mathematical presentation of data uncertainty analysis, data acquisition techniques, and theory and state-of-the-art measuring system.

**ME 814: Concepts of Turbulent Flow. 3(3,0).** Concepts of fluid turbulence; turbulent transport mechanisms, dynamics of turbulence and experimental techniques pertinent to existing theories; classification of shear flows and their prediction methods. *Prerequisite:* ME 801.

**ME 815 (PHYS 815): Statistical Thermodynamics I. 3(3,0).** Fundamental principles of kinetic theory and quantum statistical mechanics; Boltzmann statistics, Fermi-Dirac statistics and Bose-Einstein statistics. *Prerequisite:* A course in thermodynamics or permission of instructor.

**ME 818: Introduction to Finite Element Analysis. 3(3,0).** Introduction to the finite element method; applications to heat transfer, fluid flow and solids; introduction to transient analysis; analysis strategies using finite elements; introduction to solid modeling, finite element modeling and analysis using commercial codes. *Prerequisite:* A numerical methods course or permission of instructor.

**ME 819: Computational Methods in Thermal Sciences. 3(3,0).** Numerical techniques as applied to the solution of fluid flow and heat transfer problems; use of finite difference methods. *Prerequisite:* Graduate standing.

**ME 820: Modern Control Engineering. 3(3,0).** Mathematical modeling of engineering systems using differential and difference state equations; state variable time solutions using analytic and computer-aided analysis techniques; state control principles of controllability, observability, stability and performance specification; trade-offs between state variable and transfer function techniques. *Prerequisite:* An undergraduate controls course or permission of instructor.

**ME 821: Advanced Control Engineering. 3(3,0).** Concepts in multivariable, nonlinear, stochastic and optimal control engineering; design and analysis considerations related to physical machines and processes; mathematical method as as needed. *Prerequisite:* An undergraduate controls course or permission of instructor.

**ME 822: Computer Control of Automated Machines. 3(3,0).** Concepts for control of automated manufacturing machines, cells and processes; logic and switching control; programmable controllers; supervisory hierarchical and expert control systems concepts for manufacturing; closed-loop direct digital control design including sampling, stability and response of discrete system models; design and application of computer control algorithms; computer requirements; sensors and signal conversion. *Prerequisite:* ME 820 or permission of instructor.

**ME 829: Energy Methods and Variational Principles. 3(3,0).** Application of variational principles in solid mechanics problems; virtual work; Castigliano's theorems on deflection and rotation; stationary potential energy; energy stability criterion; Hamilton's principle. (Previously EM 829) *Prerequisites:* EM 831 or permission of instructor.

**ME 830: Conduction Heat Transfer. 3(3,0).** Analytical and numerical solutions of conduction heat transfer problems; steady one- and two-dimensional systems; extended surfaces; transient solutions; numerical solutions; transform methods. *Prerequisites:* ME 304 or equivalent and Graduate School enrollment.

**ME 831: Convective Heat Transfer. 3(3,0).** Derivation of continuity, momentum and energy equations for boundary layer flow; solutions for confined and external flow regimes in laminar and turbulent flow. *Prerequisites:* ME 304 or equivalent and MTHSC 208.

**ME 832: Radiative Heat Transfer. 3(3,0).** Radiation properties; enclosure theory; radiation exchange between solid bodies; radiation exchange in the presence of absorbing, transmitting and emitting media; combined radiation, conduction and convection exchange. *Prerequisites:* ME 304 or equivalent and permission of instructor.

**ME 833: Heat Transfer with Change of Phase. 3(3,0).** Nucleate boiling in a pool; film boiling in a pool; forced nucleate boiling; forced film boiling; effect of impurities on boiling phenomena; dropwise condensation; filmwise condensation; effect of noncondensable gases on condensation; boiling and condensing processes in systems. *Prerequisites:* ME 304 or equivalent and permission of instructor.

**ME 834: Principles of Structural Stability. 3(3,0).** Practical criteria for analysis of conservative and nonconservative systems' stability; methods of adjacent equilibrium, initial imperfections, total potential energy and vibration as applied to practical problems. (Previously EM 834) *Prerequisite:* EM 831.

**ME 836: Fracture Mechanics. 3(3,0).** Fundamental elasticity-based course in the development of the basic concepts of engineering fracture mechanics; the Griffith criterion, Barrenblatt and Dugdale models, linear elastic fracture mechanics (L.E.F.M.), plane strain fracture toughness, the crack-tip stress and strain field, and plasticity and the J-integral. (Previously EM 836) *Prerequisite:* EM 831.

**ME 837: Theory of Elasticity I. 3(3,0).** Theory of stress and deformation for continuous media; linear stress-strain relations for elastic material; two-dimensional problems including Airy stress function, polynomial solutions, plane stress and plane strain in rectangular and polar coordinates, torsion and bending of prismatic bars and thermal stresses.

(Previously EM 831) *Prerequisites:* EM 320 and MTHSC 208.

## DESCRIPTION OF COURSES CONTINUED

**ME 838: Theory of Elasticity II. 3(3,0).** Continuation of EM 831 including topics from either three-dimensional problems associated with an infinite elastic medium, elastic half-space, contact stresses, symmetrically loaded sphere and circular cylinder, or complex variable methods in plane elasticity, stress concentrations problems, singular stresses and fracture, and composite materials. (Previously EM 832) *Prerequisites:* EM 831 and PHYS 812.

**ME 841: Advanced Engineering Design I. 3(3,0).** Design projects selected from industry or government addressed by a graduate student/faculty design team. Students are required to create and structure a problem solution, the solution being a preliminary design study encompassing analysis, synthesis, evaluation, economic cost/benefit considerations and engineering project organization. *Prerequisite:* Graduate standing or permission of instructor.

**ME 842: Advanced Engineering Design II. 3(3,0).** Case study method of individual design problems and projects; cases used as basis for problem formulation, problem analysis, design theory exemplification, and class discussion and evaluation; principles of mechanical and engineering sciences introduced and applied as required for case considerations. *Prerequisite:* ME 306 or equivalent or permission of instructor.

**ME 843: Nonlinear Dynamics of Mechanical Systems. 3(3,0).** Behavior of nonlinear mechanical systems analyzed with numerical, graphical and analytical methods; understanding nonlinear effects and methods of analysis. *Prerequisite:* Graduate standing and/or permission of instructor.

**ME 844: Random Vibration: Theory and Measurement. 3(3,0).** Analysis and measurement of random phenomena; description of random phenomena (probability theory, response of systems to random phenomena and digital signal processing theory); use of spectrum analyzer and other digital signal recording instruments. *Prerequisites:* ME 305 or MTHSC 208 and permission of instructor.

**ME 845: Vibration of Continuous Media. 3(3,0).** Fundamental principles of generation, propagation, absorption, reflection and scattering of vibrational wave in solids and fluids; free and forced oscillation of flexible strings, bars, membranes and plates; theory of wave motion in liquids and gases. *Prerequisite:* Permission of instructor.

**ME 846: Intermediate Dynamics: 3(3,0).** Kinematics and dynamics of particles and rigid bodies. Lagrange and Hamilton's formulation of mechanics; two-body central force problem; rendezvous of two bodies in a central force field; rotation of rigid bodies about a fixed point in space; vector analysis and matrix methods as aids in mathematical analysis. (Previously EM 845) *Prerequisite:* EM 202 or permission of instructor.

**ME 852 (CE 852): Advanced Finite Element Analysis. 3(3,0).** Application of variational and weighted residuals methods; nonlinear analysis, steady-state and time-dependent problems; application of commercial finite element codes; advanced computational procedures. (Previously EM 852) *Prerequisite:* CE 808 or equivalent, or permission of instructor.

**ME 854: Analysis of Robotic Systems. 3(3,0).** Methods of designing and operating robotics systems for advanced automation; on-line identification and description of 3D objects by digitized images; off-line collision-free path planning and on-line collision avoidance traveling using artificial intelligence. *Prerequisite:* ECE/ME 456 or permission of instructor.

**ME 859 (ECE 859): Intelligent Robotic Systems. 3(3,0).** Integration and fusion of data from multiple sensors on multiple robots; intelligent decision making on motion planning and execution based on sensed data, involving mutual compliance; simultaneous force and position controls using computers. *Prerequisite:* ECE/ME 854 or permission of instructor.

**ME 893: Selected Topics in ME. 1-6(1-6 and 0).** Topics not covered in other courses. May be repeated for a maximum of six credits.

**ME 930: Advanced Topics in Heat Transfer. 1-6(1-6 and 0).** Topics not covered in other courses. May be repeated for a maximum of six credits.

**ME 931: Advanced Topics in Fluid Mechanics. 1-6(1-6 and 0).** Topics not covered in other courses. May be repeated for a maximum of six credits.

**ME 932: Advanced Topics in Thermodynamics. 1-6(1-6 and 0).** Topics not covered in other courses. May be repeated for a maximum of six credits.

## **APPOINTMENT OF THE ADVISORY COMMITTEE**

Students are expected to become familiar with the instructional and research activities within the department, particularly before the selection of an academic advisor. It is encouraged that you meet with faculty within your research area to gain information. An academic advisor should be selected prior to the fifth week of the first semester of graduate study for the master's degree and prior to the third semester of graduate study for the doctoral degree. Normally, the academic advisor also serves as the graduate research advisor for the student, as well as the chairman of the advisory committee. This person must be a faculty member in the program awarding the degree.

Each graduate student will have an advisory committee comprised of a majority of mechanical engineering department faculty. The student, in concert with the research advisor, will initiate a recommendation to establish the advisory committee. The advisory committee must consist of at least three faculty members for the MS degree and four for the PHD degree. If the student has declared a minor, at least one member of the committee must be from the faculty of the program offering the minor. The advisory committee must be appointed before registration occurs for the second semester of graduate study. This advisory committee will carry out responsibilities set forth in The Graduate School Announcements. These include approving study plans and giving final approvals of theses or reports.

## **PRELIMINARY STUDY PLAN**

All new students are required to attend orientations held by the Department of Mechanical Engineering and the Graduate School to acquaint themselves with instructional and research activities of the department as well as with general regulations. Information from these orientations will help the student select a more specific research area and will allow them to choose their advisory committee members more responsibly.

Departmental policy requires that MS students submit a GS2 at the time it is required by the Graduate School. The form should be filed near the beginning of each student's program of study. Candidates for master's degrees should submit the curriculum by the middle of their second semester and doctoral candidates no later than the beginning of their second year of study. Once the student receives the advisory committee signatures the GS2 form should be submitted to the Assistant Graduate Coordinator for the final signatures (Graduate Coordinator, Dean, and Graduate School). A copy will be returned to the student and the Assistant Graduate Coordinator after the form has been approved by the Graduate School. Students who do not properly file the GS2 risk failing to receive proper advice from their faculty committee members and may face undue difficulties, including fines or delays in graduating.

The Plan of Study (GS2) represents a contract between the student, the advisor and the University. The Graduate School will use the Plan of Study in determining whether or not the student has met the graduation requirements when the application for a degree is made. It should be noted that study plans can be changed as degree programs proceed. The form is available at [www.grad.clemson.edu](http://www.grad.clemson.edu). Approval of change in the Plan of Study (GS2) is required, and the procedure followed is the same as for the original study plan. Requests for changes in the plan of study must be processed before the requested change actually takes place. Retroactive change requests may not be acceptable. The GS2 may be revised as needed, but the final form must be approved and signed by all committee members and the appropriate department chair. Revised forms must be on file in the Enrolled Student Services Office in the term in which the student plans to graduate.

## **MASTER'S DEGREE PROGRAM**

### **M.S. THESIS**

The purposes of the M.S. thesis is to demonstrate the capability of the student to: (1) formulate engineering problems; (2) demonstrate engineering knowledge relevant to a meaningful resolution of a specific problem; (3) effectively plan the work leading to the completion of the project; and (4) report the results of the project in concise, precise professional style.

### **MS NON-THESIS OPTION**

Final exam requirements are at the discretion of the advising committee, although the PhD Qualifying Exam cannot be used. It is recommended that the student complete a technical report and present a document to the committee before the scheduled date for final examination.

A GPA of  $\geq 3.2$  in GS2 courses and successful completion of the final exam constitute the exit examination and candidacy for graduation.

### **THESIS OR PROJECT PROPOSAL**

Research advisors will assist students in the selection of appropriate topics for theses. Students are expected to have selected a thesis research topic by the end of their first semester of graduate study. Before the end of the second semester of enrollment (excluding summer sessions), students must electronically prepare and present to their advisory committee a proposal containing a definition of the problem, the objective(s) of the project, and a plan and schedule for the completion of the project. Proposals should also indicate any instruments, equipment, and materials that may be required. Specific content requirements are determined by the advisory committee chairperson. Each student's advisory committee will review and approve the initial proposal and make appropriate recommendations. A copy of the approved proposal must be maintained on file by the chairperson of the student's advisory committee until graduation. Also, the Graduate Program Coordinator should be notified in writing when the proposal has been completed.

### **ADMISSION TO CANDIDACY FOR THE M.S. DEGREE**

A student must be admitted to candidacy for the Master of Science degree before the third week of the semester in which the degree is expected to be conferred (check Graduate School announcements for exact date). Admission to candidacy is secured when the student presents the proposal and the advisory committee signs Form GS-4. A late fee will be assessed a student whose Form GS-4 is submitted after the deadline dates specified in the Graduate School Announcements ([www.grad.clemson.edu](http://www.grad.clemson.edu)). The fee will increase daily thereafter (excluding Saturday, Sunday and University holidays). If the student requests the mailing of their diploma, there is a nominal fee and must be paid when the form is submitted. **THIS FORM MUST BE COMPLETED FOR EACH SEMESTER IN WHICH THE STUDENT MAY EXPECT TO GRADUATE.** If you have questions about graduation, or you're not certain about what is required of you for graduation, please call Graduate Enrolled Services at 656-5339 (students with last names beginning with A-L) or 656-5341 (students with last names beginning with M-Z).

Students must be enrolled during the semester they plan to graduate. If the student is not a Graduate Assistant (GRA, GLA, GTA, GGA) and is not funded the student may enroll in 1 hour of ME 891 or ME 991. Graduate Assistants on funding must be enrolled full-time (12 hrs).

## THESIS REPORT PREPARATION

Regulations concerning the mechanics of thesis preparation, including forms, number of copies, type sizes, margins, methods of reproduction, and costs appear in the Guide for the Preparation of Thesis and Dissertations, prepared and adopted by the Graduate Council of Clemson University. **Students are responsible for the cost of copying the thesis or report.**

Additional information can be accessed from the Graduate School homepage on the Internet [http://www.grad.clemson.edu/e\\_manuscript.html](http://www.grad.clemson.edu/e_manuscript.html). The Graduate School reviews and accepts theses and dissertations.

## SUBMITTAL OF THESIS

A student should normally complete, with the advisor's approval, a final draft of the thesis at least four weeks before the final examination or presentation. Final copies approved by the research advisor must be submitted to the advisory committee at least two weeks before the final examination. It is within the right of the committee member to refuse to meet without a two week review period. The committee chairperson will arrange for the examination or presentation, which must be administered at least three weeks before the date on which the degree is to be conferred. The Graduate School Announcements ([www.clemson.grad.edu](http://www.clemson.grad.edu)) contains information regarding the required number of copies of the thesis (currently 3 excluding personal and committee copies) and scheduling requirements for the final examination.

## FINAL EXAMINATION

Candidates for Master of Science degrees must pass a final examination at least three weeks prior to the date of the convocation at which the degrees are to be conferred. The final date for this examination is established each semester by the Graduate School. The examination is conducted by the student's advisory committee, and all faculty members are invited to participate.

Students are required to send an abstract title, abstract, date, time, place along with committee members by email to the Assistant Graduate Coordinator two weeks prior to their defense. Notices will be sent to the Graduate School, ME Graduate Students, and ME faculty. Students are required to notify the Graduate School Office of the time and place of the examination at least ten days prior to the scheduled time (this will be done by the Assistant Graduate Coordinator).

The final examination, which normally is oral, demands a broad and penetrating interpretation of the student's research project and/or the student's major and minor areas. Non-thesis M.S. candidates must also pass an examination determined by the student's advisory committee.

## APPLICATION FOR THE DIPLOMA

Form GS-2 must be on file by the graduation preceding the one on which the degree is to be conferred. Form GS-4 is the application for the diploma and it must be filed by the third week of the semester of graduation (see section 2.2.3.) At this time, the student should make arrangements for cap and gown rental if participation in the commencement ceremony is desired. **Please remember that a GS-4 form must be completed for each semester in which you plan to graduate.** i.e., You plan to graduate in May but cannot complete the necessary requirements and you change to August – a new GS-4 form must be completed for August.

### **TIME REQUIRED FOR THE M.S. DEGREES**

The faculty of the Department of Mechanical Engineering considers that, normally, three semesters and a summer are sufficient for full-time graduate students to complete the necessary work and to obtain the Master of Science degrees. Longer tenures are discouraged, and financial support is generally unavailable after three semesters and a summer. Students should check the Graduate School Announcements for time regulations set by the University.

### **MASTER'S STUDENT CHECKLIST**

For the convenience of MS students, Table 2 provides a checklist of milestones in the Master of Science degree program.

## MASTER'S STUDENT CHECKLIST

WHAT	WHEN	HOW
Selection of major advisor	Before fifth week of first semester	Notify Assistant Graduate Coordinator of choice
Preparation of study program	Before seventh week of first semester	In consultation with major advisor or graduate student coordinator
Filing of Study Plan and selection of advisory committee	Before on-line registration for second semester	Form GS-2
Approval of thesis or project	Before end of second semester	Signed thesis or project proposal submitted
Admission to candidacy for degree and application for diploma; cap and gown rental	At the beginning of the semester degree is expected	Form GS-4
Submittal of thesis	First draft <b>at least four weeks</b> before date of final or project report examination; final (approved) copies at least two weeks before final examination	By Student
Final Examination	At least three weeks prior to date on which degree is expected(see Graduate School schedule for last advisor after examination in completed possible date)	Form GS-7 to be filed by major advisor after examination is completed. This form is given to the Graduate program assistant to be forwarded to the Graduate School.
Return Keys and Clear Office Space	When leaving campus	Check-Out Form obtained from the Assistant Graduate Coordinator.

TABLE 2 Checklist for Masters Students

# DOCTORAL DEGREE PROGRAM

## Ph.D. QUALIFYING PROCEDURE

### **PURPOSE AND SCOPE**

The purpose of the Ph.D. qualifying examination is to:

- provide students with an opportunity to review the core disciplines in mechanical engineering (approximately 75% at the undergraduate and 25% at the graduate level) and a focus area of central importance to their specialization;
- provide an assessment as to whether students possess attributes of a doctoral candidate by demonstrating understanding of and the ability to apply fundamental principles; and
- evaluate a student's potential for satisfactorily completing the doctoral program.

### **EXAM SELECTION AND SCHEDULING**

With the approval of their advisory committee, students must pre-select 3 exams. At least 2 of the exams must be offered by the Department of Mechanical Engineering. One of the three exams may be administered by another department in the College of Engineering and Science when the subject area is especially pertinent to the student's area of specialization and if such an exam is available.

The following exams will be offered by the Department of Mechanical Engineering. The faculty group that has primary responsibility for each exam is specified in parentheses. Each exam will be constructed and graded by a designated examining committee comprised of two or more faculty members.

Heat Transfer (TFS)  
Thermodynamics (TFS)  
Fluid Mechanics (TFS)  
Engineering Materials (MMS)  
Engineering Design (MMS)  
Manufacturing Processes (MMS)  
Dynamics and Vibrations (MMS)  
Systems and Controls (MMS)  
Solid Mechanics (EM)  
Engineering Mathematics (EM)

Exams must be taken only after admission into the Mechanical Engineering graduate program, and if already enrolled, no later than the second semester of enrollment excluding summer sessions. Students not having an MS degree approved by the Graduate Research Committee must take the exams no later than the third semester of enrollment in the PhD program excluding summer sessions. In the event of extenuating circumstances, advisors may request from the Graduate and Research Committee that a particular student be permitted to take the exams during the third semester of enrollment. Examples of such circumstances include backgrounds in fields other than mechanical engineering and medical or personal problems.

Each exam will be written and last two hours. The exams will be scheduled in the morning and in the afternoon on Monday and Tuesday of the first week of the Fall and Spring semesters, before classes begin.

### **GRADING – PHD QUALIFYING EXAM**

All problems on all exams will be graded by all members of an examining committee. Grades of Pass (P), Marginal (M) or Fail (F) will be assigned for each written exam based on the consensus of each examining committee. Grading of the written exams will be completed and the results will be available by Noon on Monday of the second week of the semester.

### **PROCEDURES AFTER EXAM IS GRADED**

- Students receiving a P grade on all exams may continue in the Ph.D. program.
- Students receiving an F grade on all three exams on the first attempt will not be permitted to continue in the PhD program.
- Students who have received F grades on one or two exams must either re-take exams for which a F grade was received, or take different exam(s) during the next semester when exams are offered. Switching to a different exam still constitutes a second attempt.

Students receiving an M (marginal) grade on any exam will be given a short (nominally 30-minute) oral exam by the respective examining committee. Oral exams will be scheduled in an expedient manner and results will nominally be made available by the end of the second week of the semester. The sole purpose of the oral exam is for the examining committee to obtain additional information in order to determine the final outcome of the student's written exam. Hence, the scope of questions during the oral exam should be limited to the subject matter covered on the written exam. Upon completion of the oral exam, the examining committee will assign one of the following grades:

- Pass (P) – student has passed the exam;
- Conditional Pass (CP) -student has passed the exam subject to conditions, e.g. taking a graduate-level course selected by the examining committee and passing it with a grade of A;
- Fail (F) – student has failed the exam.

*Students who received an F grade on a second attempt will not be permitted to continue in the Ph.D. program.*

### **APPEAL PROCEDURE**

The qualifying exam process provides for re-examination mechanisms for students who fail one or two exams on their first attempt. Students who receive one or more M grades are given oral exams. Failure of three exams on first attempts or one or more exams on second attempts dictates that students may not continue in the Ph.D. program. It is the consensus of the faculty of the Department of Mechanical Engineering that outcomes of the qualifying exam process will not be the subject of appeal, except where it is the consensus view of a student's advisory committee that procedures set forth were not followed.

## **Ph.D. COMPREHENSIVE EXAMINATION**

General requirements and a description of the Ph.D. Comprehensive Examination are given in the Graduate School Announcements ([www.grad.clemson.edu](http://www.grad.clemson.edu)). In the Department of Mechanical Engineering the comprehensive examination may only be taken after an advisory committee has been selected, a graduate degree curriculum has been approved using Form GS-2, and the Qualifying Examinations have been successfully completed.

- The exam must be passed by the end of the fifth semester in which student status is full-time and a GS5 Form must be filed with the Assistant Graduate Coordinator:
  - In extenuating circumstances, the advisor may require a delay from the student's advisory committee in order for the student to take the exam during the sixth semester.
  - A student's advisory committee may request the comprehensive exam be taken earlier.
  - Time begins when a student enrolls in the PhD program. Students become PhD candidates after they pass the Comprehensive exam and their GS5 Form has been processed.
- Grading of the first taking of the exam will be "Pass", "Fail", or "Marginal". A student who receives a grade of Fail will be dismissed from the program. A student who receives a Marginal has one more chance to take and pass the exam.

Additionally, comprehensive examinations are given only at the recommendation of the student's advisory committee and after completion of most of the required course work. Advisory committees often direct that a student take the comprehensive examination after preparing, or in conjunction with presenting, the research proposal. The precise format is determined by the advisory committee and may be oral and/or written. The comprehensive examination typically focuses on the student's research area, but also may cover additional material in order to obtain objective evidence of an adequate intellectual mastery of major and minor specializations.

## **Ph.D. RESEARCH PROPOSAL**

Prior to admission to candidacy for the Ph.D. degree, all Ph.D. students are required to electronically submit a proposal describing the work of their dissertation research to their advisory committee. The proposed research program should be based upon the student's own preparations and also earlier interactions with the advisor and advisory committee. A record of approval should be provided to the Graduate Program Coordinator.

The following format for the proposal is suggested:

- (1) Title
- (2) Research Objective
- (3) Pertinent Background Material
- (4) Methods
- (5) Major Resource Needs
  - a. Currently available
  - b. Required

## **ADMISSION TO CANDIDACY FOR THE Ph.D. DEGREE**

In addition to the requirements set forth in the Graduate School Announcements ([www.grad.clemson.edu](http://www.grad.clemson.edu)), the Department of Mechanical Engineering requires the following:

The request for admission to candidacy must contain a list of each course yet to be taken and must also indicate the title of the student's proposed research. The request should be signed by the chairperson of the student's advisory committee and the Chair of the Department of Mechanical Engineering.

## **PHD ADMISSION WITHOUT AN MS DEGREE AT CLEMSON UNIVERSITY**

Students with a BS degree only entering the PhD Program:

Students having a BS degree in a field approved by the Graduate Research Committee, but not having an MS degree, may apply directly to the PhD program. These students must satisfy the MS core course requirements in their subject area before degree completion, and may receive a one semester delay in all deadlines associated with the PhD qualifying examinations. If the student fails the PhD Qualifying exam, the student is permitted to continue as a Masters student but is ineligible to re-apply to the PhD program in ME. Students enrolled in the MS program will be accepted directly into the PhD program prior to the completion of an MS degree with the written consent of their advisor.

***A student must be admitted to candidacy for the doctoral degree at least six months before the date on which the degree is to be conferred.***

## **Ph.D. FINAL ORAL EXAMINATION**

Information relating to final oral examination scheduling and requirements is contained in the Graduate School Announcements ([www.grad.clemson.edu](http://www.grad.clemson.edu)). Additional information can be obtained from the Graduate Program Coordinator.

## **RESIDENCY REQUIREMENTS**

Residency requirements are established by the Graduate School and are published in the Graduate School Announcements ([www.grad.clemson.edu](http://www.grad.clemson.edu)).

## **SUBMITTAL OF THE DISSERTATION TO THE COMMITTEE CHAIRPERSON**

With the approval of the research advisor, a student should normally complete a draft of the dissertation at least five weeks before the date of the final oral examination. Final copies approved by the advisor must be presented to advisory committee members *no less than two weeks* before the final oral examination. It is within the right of the committee member to refuse to meet without a two week review period. The committee chairperson will schedule the final examination, which must be given no later than three weeks before the date on which the degree is to be conferred. The last date for the final examination is published in the Graduate School Announcements ([www.grad.clemson.edu](http://www.grad.clemson.edu)).

## **SUBMITTAL OF THE DISSERTATION TO THE GRADUATE OFFICE**

The degree candidate is required to bring the completed dissertation final draft with all necessary signatures to the Graduate School prior to reproducing the necessary copies. Dissertations must be constructed in accordance with format instructions of the

Graduate School. Because the Graduate School must carefully check that all degree requirements have been met, strict deadlines for processing of dissertations must be observed. A nominal binding fee must be paid to the Bursar, and the Bursar's receipt must be submitted to the Graduate School along with the dissertation. The student is responsible for placing the dissertation in proper final form.

Four copies, excluding the personal and committee copies, are to be submitted to the Dean of the Graduate School. An additional copy of the approval page, title page, and an abstract must also be submitted, with the abstract not exceeding word count restrictions. A doctoral student must pay a fee to the Bursar for publication of the abstract. **Students are responsible for the cost of copying the dissertation.**

## **APPLICATION FOR THE DIPLOMA**

The formal application procedure for the diploma is governed by the Graduate School and published in the Graduate School Announcements ([www.grad.clemson.edu](http://www.grad.clemson.edu)). A nominal diploma fee must be paid at the time of application if mailing is required, and arrangements should be made for cap and gown rental. The GS 4 is required for each semester the student plans to graduate. If the graduation date is changed a new GS4 Form is required each time.

## **TIME REQUIRED FOR THE DOCTORAL DEGREE**

Although excessive tenures are discouraged, the department does not recognize any minimum or maximum time for obtaining the Ph.D. degree. The Graduate School does place restrictions on the maximum time allowed to obtain a graduate degree, however, as specified in the Graduate School Announcements ([www.grad.clemson.edu](http://www.grad.clemson.edu)). Although no minimum course work requirements exist, committees are encouraged to require courses other than those that directly support the dissertation defense. A minimum of 18 semester hours of doctoral research credit are required. Work in the minor field or fields, if required, normally comprises from 12 to 24 hours in courses carrying graduate credit. In general, the degree will be awarded when the academic and research advisor(s) are satisfied that the research program is complete and that all other formal requirements have been met. Typically, doctoral degrees are completed in a three-four year period.

## **Ph.D. CHECKLIST**

For the convenience of the Ph.D. student, Table 3 provides a checklist of milestones for the Ph.D. program.

## DOCTORAL STUDENT CHECKLIST

What	When	How
Selection of advisor	Before start of seventh week of first semester of residence	Department form
Selection of advisory committee	During first semester of residence committee	Academic advisor will approve
Filing of preliminary study plan (GS2 Form)	Before registration for third semester	In consultation with advisor and committee; use Form GS-2
Qualifying Examinations	During second semester of doctoral study (During third semester for PhD students not having an MS degree)	In consultation with advisor and Department
Comprehensive examination	After completing most of doctoral course work	Major advisor will arrange
Admission to candidacy (GS5 Form)	After successful completion of comprehensive exam(s); <b>minimum of six months</b> before date on which degree is expected	GS 5 Form
Research proposal	After successful completion of qualifying examinations	Written proposal and written record to the Graduate Coordinator of results
Submittal of dissertation to committee	First draft must be in hands of major advisor at least five weeks before date of final oral exam; final corrected copies must be in hands of all committee members at least two weeks before date of final oral exam	
Application for diploma; rental of cap and gown	Apply to Registrar within four weeks following start of final semester	Form GS-4
Final oral examination	At least three weeks prior to convocation at which degree is to be conferred; last date listed in <u>Graduate School Announcements</u>	Form GS-7
Submittal of dissertation to Graduate School Office	At least one week prior to date on which degree is to be conferred	See Graduate School web page for definite dates
Departmental check out	At least 2 days before leaving	Check-out Form

## **INSTRUCTIONS FOR FINAL ORAL EXAMINATIONS FOR ALL GRADUATE PROJECT OR THESIS DEGREES**

Student oral presentations are open to the general public: however, attendance and participation in the examination following the presentation are limited to members of the student's advisory committee.

Students should observe the following suggestions in preparing for an oral examination.

(1) Each member of a student's advisory committee should have a copy of the engineering project report at least one week prior to the final examination. Each committee member should receive a copy of the M.S. thesis two weeks prior to the final examination or a copy of the Ph.D. dissertation two weeks prior to the final examination. These documents should be in final form.

(2) The computer, transparencies, 35-mm slides, and other visual aids should be used in making presentations of research results.

(3) Presentations should be well planned and should be completed in approximately 30 minutes or as directed by the primary advisor. Professional demeanor during presentations is expected.

(4) Questions from the audience should be handled without prompting by members of the advisory committee.

# GENERAL INFORMATION

## INFORMATION

Students should not hesitate to ask questions concerning departmental policies or procedures. The Graduate Program Coordinator and the Assistant Graduate Coordinator's task is to assist students with such questions.

## E-MAIL

Many events of importance are announced via e-mail. It is very important that you check your e-mail several times a day. **This is the primary way of communicating information to you.** If you are requested to respond, please do so in a timely manner.

## NOTICES

Notices of interest to graduate students will be placed on the departmental bulletin board and, on occasion, directly mailed to students. To ensure receipt of departmental mailings, each student should have a current address and phone number on file with the Assistant Graduate Coordinator and the University. The department maintains a mail slot for receipt of graduate student mail.

## ASME MEMBERSHIP

Application forms for membership in ASME may be obtained from the ASME advisor. Graduate students are encouraged to associate with the national society, as well as the Greenville section.

## BUILDING SECURITY

Building security is everyone's responsibility. You should make sure to lock your office and laboratory doors when you leave (even for a few minutes). In the evenings and on weekends building doors should not be propped open at any time. Do not bring personal items of value into the building. **Do not allow people in the building if they do not have card access, especially during sporting events.** Thefts can occur. Do not be careless about building security. You may be the next theft victim.

## OFFICE SUPPLIES

The department does not furnish office supplies to graduate students. Entrance to the supply room is by key only and students must be accompanied by a staff or faculty member.

## COPY MACHINES

Copy machines are located in room 104 and room 217 and are available for graduate student use. A 7-digit code is required for access which must be approved by student's advisor. This code can be obtained from the departmental secretary in room 207.

## EQUIPMENT CHECK-OUT

Equipment needed for research and teaching activities, such as digital cameras, laptops, projectors, etc., can be signed out with the departmental secretary in room 207. Graduate students are personally responsible for equipment signed out to them. Lending or borrowing of equipment between graduate students is prohibited.

## **ORDERING EQUIPMENT OR SUPPLIES**

Graduate students will be held responsible for the purchase of any equipment they order without proper authorization. It is requested that all purchases be made through the purchasing office in our department. Guidelines for proper authorization are available from the departmental office.

## **COMPUTER CENTER ACCOUNT NUMBER**

Each graduate student will be automatically assigned a unique computer usage identifier providing access to the centralized computer facilities. This computer ID is given to students in the Riggs building, room 10.

## **KEYS AND KEYCARDS**

Key and keycard requests should be initiated through the department secretary, and the request must be approved by your academic adviser and department chair, or his designee. The key(s) issued to you are for your use only, they must never be loaned to anyone else, even another graduate student. Failure to observe this rule will result in your key privilege being withdrawn. Keys must be returned before the student leaves. There is a fee for each not returned to the department.

## **LABORATORY MAINTENANCE**

Students assigned to laboratory spaces are expected to maintain the professional appearance of the laboratories. Janitors will sweep floors and empty wastepaper baskets only. It is strongly encouraged that no food or drink be taken into the laboratories.

## **DEPARTMENTAL FILES**

Departmental files should not be accessed without proper authorization. Students should contact the Assistant Graduate Coordinator for information on obtaining necessary authorization.

## **DEPARTMENTAL TELEPHONES**

Graduate students making research-related calls at the request of an advisor should use the telephones in the departmental office. No student will be authorized to place long distance telephone calls without the permission of the appropriate advisor. Student use of departmental telephones must be limited to business and University calls.

## **PRIOR THESES/DISSERTATIONS**

Prior theses/dissertations are available and can be checked out by seeing the Assistant Graduate Coordinator.

## **FACULTY OFFICES**

Faculty members carry out numerous duties, of which research and graduate education are but two. Please observe faculty office hours when posted and arrange appointments in advance. Do not enter a faculty office without knocking on the door and wait to be invited in before opening the door.

## **GRADUATE STUDENT OFFICES**

Graduate student offices will be assigned after the start of the semester. Priority is given to graduate laboratory assistants (GLA) then to graduate research assistants (GRA) then to graders (GGA) then to other non-supported graduate students. Office space is limited, and not all students will have desks. If a student is assigned a desk, it is this student's responsibility to maintain the area clean and organized. Janitors will sweep floors and empty wastepaper baskets only. **No cooking is allowed in student offices;** the graduate lounge is equipped with a microwave and a sink for such a purpose.

## **VACATIONS/LEAVE TIME**

Graduate students are expected to work over the entire semester period as defined by the University Calendar. The student work time frame should NOT be perceived to be the same as the semester class schedule. Generally, graduate "teaching" assistants work on the same calendar as faculty with 12-month appointments unless different work expectations are distinctly articulated in the letter of appointment. Graduate Research Assistants should not be paid if they are not present on-campus and do not report to work with the exception of University holidays.

A graduate assistant may request up to four weeks leave without pay per semester and one week of leave without pay per summer session from his or her immediate supervisor for illness of close family member, death in the immediate family, and personal illness or hardship.

## **MILITARY LEAVE**

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

## **FINAL CHECK OUT**

Graduate students leaving the University for any reason should:

- (1) Turn in all keys to departmental staff members in the Machine Shop;
- (2) Return all equipment and supplies to appropriate locations;
- (3) Clean assigned laboratory space, and or office space
- (4) Inform the Department Chair of the departure; and
- (5) Return all borrowed material (books, proceedings, CDs, etc.)
- (6) Complete the departmental Graduate Student Final Check-Out Form (Form 12)
  - i. Copies of this form may be obtained from the Assistant Graduate Coordinator.

## **GRADUATE ASSISTANTS**

The Graduate School defines a graduate assistant as a student with a baccalaureate degree from an approved institution who contracts to devote a minimum of ten working hours per week to the University for at least one semester. Graduate assistants pay tuition charges at the rates listed in the current Graduate School Announcements ([www.grad.clemson.edu](http://www.grad.clemson.edu)). To receive a tuition reduction for a particular semester, students must be on assistantships at the beginning of the semester.

# Ph.D. Qualification Form

## DEPARTMENT OF MECHANICAL ENGINEERING PH.D. QUALIFICATION FORM

\_\_\_\_\_ has been evaluated for entry  
into the Ph.D. program in Mechanical Engineering.

The method of evaluation was (check appropriate boxes):

\_\_\_\_\_ written examination

\_\_\_\_\_ oral examination

The results of the examination have been judged to be:

Certification by the PhD Qualifying Examination Committee Coordinator, the Graduate and Research Committee Chair, and the Mechanical Engineering Department Chair is required.

Name \_\_\_\_\_ Signature \_\_\_\_\_ Date \_\_\_\_\_  
(Qualifying Exam Coordinator)

Name \_\_\_\_\_ Signature \_\_\_\_\_ Date \_\_\_\_\_  
(Graduate & Research  
Committee Chair)

Name \_\_\_\_\_ Signature \_\_\_\_\_ Date \_\_\_\_\_  
(ME Department Chair)

## PROCUREMENT PROCEDURES

**The guidelines below must be followed when making any type of purchase that will be charged to a departmental or research account. Purchases made without following these procedures will be considered personal, and become the responsibility of the person initiating the purchase.**

- Please see the Departmental Secretary to initiate charges being made to the Bookstore, Communications Center, and Printing Services. The Secretary is located in 102 Fluor Daniel and may be reached by phone at 656-3473. These purchases require completion of "Section A" only on a Purchase Authorization Form provided by the Secretary.
- Motor Pool/Trip Requests require a completed draft copy of the official request form provided by the Departmental Secretary. This form must have an account number or project name, and your advisor's signature.
- Please see the Department Accountant to initiate charges being made by Direct Voucher and Interdepartmental Order. The office is located in 106D Fluor Daniel and may be reached by phone at 656-5638. These purchases require completion of a Purchase Authorization Form provided by the Accountant.
- Direct Vouchers have a purchasing limit of \$1,500. This limit includes the unit price of the item(s) being purchased and all additional charges, except sales tax. Ms. Liles will provide you with a requisition number for use in placing the order, once the authorization is processed.
- Interdepartmental Orders are for purchases made from other on-campus departments.
- Purchase Requisitions are issued for purchases over \$1,500. These purchases are processed in 120 Kinard and must be handled through the University Purchasing Department. Most items over \$1,500 will have to be opened to competitive bidding and purchase.

**Please return this form to the Department Accountant, signed by you and your advisor, indicating that you have read and understood these guidelines.**

\_\_\_\_\_  
Student's Name (printed)

\_\_\_\_\_  
Student's Signature                      Date

\_\_\_\_\_  
Advisor's Signature                      Date

# Graduate Student Final Check-out Form

Each student must secure the following certification before leaving the department.

\*\*\*\*\*

1. Student Name: \_\_\_\_\_

2. Forwarding Address: \_\_\_\_\_  
\_\_\_\_\_

3. Phone Number: \_\_\_\_\_ Email: \_\_\_\_\_

4. *To my knowledge, the student is cleared for departure.*

Advisor: \_\_\_\_\_

1. All university keys, shop supplies and tools have been returned.

\_\_\_\_\_  
Department Technician

\_\_\_\_\_  
Date

2. Key Deposit has been returned if paid.

\_\_\_\_\_  
Departmental Secretary

\_\_\_\_\_  
Check No.

\_\_\_\_\_  
Date

3. I have returned all items mentioned in (1) above, and my lab space and office area is clean and devoid of all personal items. A forwarded address has been submitted.

\_\_\_\_\_  
Graduate Student Signature

\_\_\_\_\_  
Date

4. Student is cleared.

\_\_\_\_\_  
Assistant Graduate Coordinator

\_\_\_\_\_  
Date



## Departmental Expectations for Graduate Work

The purpose of this “release form” is to help avoid misunderstandings between advisor and graduate student concerning expectations for degree completion. If the advisor requires this form, Part I should be completed, signed by the advisor and student, and filed with the GS2 form. The advisor must sign Part II before a student can receive a graduate degree in the Department of Mechanical Engineering.

The goal should be to complete most of these topics in a continuous manner, while the research is being conducted, rather than waiting until the end. One important point is that computer programs written, data generated, discoveries made, derivations developed, etc., by a Clemson graduate student are the property of Clemson University, not of the student.

Publications and other methods for disseminating research results are expected activities of graduate students. Doctoral students, and in most cases, MS students in the Department are expected to publish one or more archival journal papers. In many ways, the quality of an MS or Ph.D. program is measured by the publications. This release form puts this and related topics into the proper perspective.

**Print: Student Name:** \_\_\_\_\_ **Advisor:** \_\_\_\_\_

**Part I.** The following should be completed, signed and filed with the GS2 form. Additional requirements and/or additional narrative describing individual requirements should be attached.

- The student will provide an electronic copy of their final thesis  

Required by advisor	Not required by advisor
---------------------	-------------------------
- The student will give their lab book to the advisor  

Required by advisor	Not required by advisor
---------------------	-------------------------
- The student will provide acceptable drafts of all papers that should result from the degree program  

Required by advisor	Not required by advisor
---------------------	-------------------------
- The student will tutor continuing students in the methods and processes of their work  

Required by advisor	Not required by advisor
---------------------	-------------------------
- The student will prepare all data in a final format that is acceptable for publication  

Required by advisor	Not required by advisor
---------------------	-------------------------
- The student will document all work that is of importance to the future of the research group, even though this work might not be included in the thesis or dissertation  

Required by advisor	Not required by advisor
---------------------	-------------------------
- The student will return all books, papers and other documents that are obtained from the advisor while in the degree program.  

Required by advisor	Not required by advisor
---------------------	-------------------------
- The student will clean and vacate their office and lab work areas  

Required by advisor	Not required by advisor
---------------------	-------------------------
- The student will provide their advisor with electronic copies of all work including any computer programs.  

Required by advisor	Not required by advisor
---------------------	-------------------------

**Signing below indicates this form has been reviewed by the student and advisor. Return the form to Assistant Graduate Coordinator for filing. A copy may be retained by the student and advisor if requested.**

Advisor’s Signature: \_\_\_\_\_ Date: \_\_\_\_\_

Student’s Signature: \_\_\_\_\_ Date: \_\_\_\_\_

**Part II.** The advisor agrees that the student has completed all obligations as detailed in Part I.

Advisor’s Signature \_\_\_\_\_ Date: \_\_\_\_\_

**FORM 15**

**Acknowledgment of Contents**  
(Place in student's departmental record)

I have read, understand, and will comply with the policies and procedures contained in the Manual for Graduate Students of the Department of Mechanical Engineering.

Signature: \_\_\_\_\_

Name (Please print): \_\_\_\_\_

Date: \_\_\_\_\_