

**Colorado State University**

**Department of  
Mechanical Engineering**

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***GUIDELINES  
FOR  
GRADUATE STUDY  
IN  
MECHANICAL ENGINEERING***

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**2010-2011**

*Rev. 03.28.11*

## Introduction

Graduate study in mechanical engineering at Colorado State University (CSU) is intended to bring together faculty members and graduate students in a community of scholars having a common interest in advanced professional study and creative work. The program seeks to cultivate the spirit of intellectual independence and provide the opportunity for extending the boundaries of the mechanical engineering profession. The main areas of emphasis are Advanced Materials; Biomechanics and Biomaterials; Energy Conversion and Thermosciences; and Operations Research and Systems Engineering. More information on these areas can be found at: <http://www.engr.colostate.edu/me/pages/research.html>.

## Advisors

Successful completion of graduate studies requires close cooperation between student and advisor. An initial academic advisor is assigned to every student who enters the graduate program, though students should strive to find a permanent advisor as early as possible. The student and advisor should work together to coordinate the plan of study, i.e. courses, research, committee members etc. If a permanent advisor has not been found prior to the start of the first semester, then the student and temporary advisor should make an initial plan of study.

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The initial advisors are assigned as follows:

<b><u>Advisor</u></b>	<b><u>Area</u></b>
Prof. David Alciatore	Mechatronics
Prof. Thomas Bradley	Complex Transportation and Sustainable Energy Systems
Prof. Prasad Dasi	Fluid Dynamics, Biomedical Engineering
Prof. William Duff	Solar Thermal, Industrial Engineering, Operations Research
Prof. Patrick Fitzhorn	Vehicle Dynamics
Prof. Susan James	Biomedical Engineering – Biomaterials/Biomechanics
Prof. Allan Kirkpatrick	Computational Fluid Dynamics
Prof. Anthony Marchese	Engines – Combustion and Pollutant Formation
Prof. Daniel Olsen	Engines and Energy Conversion
Prof. Ketul Popat	Micro/Nano Technology in Orthopaedic Materials
Prof. Christian Puttlitz	Biomedical Engineering
Prof. Donald Radford	Composite Materials
Prof. Hiroshi Sakurai	Geometric Modeling and Computational Fluid Dynamics
Prof. W.S. Sampath	Photovoltaic Cell Manufacturing
Prof. Steven Schaeffer	Rapid/Flexible Tooling, Casting
Prof. Wade Troxell	Intelligent Control of Networked Distributed Resources
Prof. John Williams	Plasmas and Ion Thrusters
Prof. Bryan Willson	Engines - Optical Combustion Diagnostics
Prof. Azer Yalin	Laser Diagnostics and Atmospheric Plasmas

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## The Graduate Committee

To guide and supervise a student's progress for the M.S. and Ph.D. degrees, a graduate committee should be selected before the end of the student's **second** semester of study. This committee is composed of the faculty advisor (Mechanical Engineering Professor) and other CSU professors. The committee will conduct preliminary (Ph.D.) and final (M.S. and Ph.D.) examinations, make regular evaluations of the student's progress, and conduct the thesis or dissertation defense.

- For **Master of Engineering (M.E. Plan C)\*** an advisor is required, however no thesis or graduate committee is required.
- For **Master of Science (M.S. Plan A)\*** the committee must include an advisor, another mechanical engineering professor and a professor from outside the mechanical engineering department. *\*Note: The Department of Mechanical Engineering does not offer the M.S. Plan B option.*
- For doctoral (**Ph.D.**) students, the committee must include an advisor, two other mechanical engineering professors, and a professor from outside the mechanical engineering department. Committee meetings should be held periodically to review a student's progress. It is the student's responsibility to arrange committee meetings. Rooms may be reserved through the department administrative assistant.

## Program of Study

Due to varying backgrounds and interests, specific courses for a program of study are selected by the student and advisor. Students without an undergraduate degree in mechanical engineering are required to follow prerequisite guidelines for non-BSME students as outlined on the department website at <http://www.engr.colostate.edu/me/pages/documents/Non-BSMERequirementsrevised3-28-11.pdf> Depending on academic background, these students may be admitted as second bachelor's students or admitted directly into the graduate program.

The program of study is submitted to the Graduate School with the **GS6 form** by the end of the second semester. The student, advisor, co-advisor (if applicable) and Department Head are required to sign the form. Students will confirm the outside committee member's willingness to participate prior to submitting the program of study. Programs need not be regarded as final in every respect, however, any changes made in the course selection will require advisor approval on the **GS25 form** (application for graduation) that is submitted in the semester before the student plans to graduate. Committee member changes may be made on the **GS9A form** and also must be approved by the advisor and the committee members who are added or removed.

Thesis and dissertation work requires students to become involved in appropriate research activities. Graduate students will typically register for up to three formal courses each term, with four terms typically required to complete the master's degree, and a subsequent six to eight terms typically required to complete the Doctor of Philosophy Degree. Students are required to submit scholarly publications during their research (see "Publication Requirements" section). These articles may be appropriately incorporated as chapters in theses and dissertations.

A full-time course load for graduate students is nine (9) credits per semester; however, there are many instances where a full-time course load is not required due to research activities and remaining number of credit hours required in a degree program. In cases where a graduate student is not registering for classes but is continuing research, registration in the program must be kept current by registering for Continuous Registration (CR) through RamWeb. **Students must register for CR during the semester they plan to graduate, regardless of whether they have completed the degree requirements. Students who fail to register for CR will not be allowed to graduate that semester and will be required to reapply for graduation, apply for readmission, and pay a \$150 fee.**

Courses to be applied towards any mechanical engineering graduate degrees, including transfer credits from other institutions, must have been completed within the ten (10) years immediately preceding the date of completion of the final CSU degree. All transfer requests are submitted to the Graduate School with transcripts and the **GS6 form**. Eligibility requirements apply. The Graduate School will notify the student by email when the GS6 form has been approved, meaning that the recommended committee is satisfactory, the transfer of credits is completed, and the program of study is acceptable. The maximum number of transfer credits for M.E. and M.S. students is 6 and for Ph.D. students is 10.

## **Core Course Requirements** ***for On-Campus Graduate Degrees in Mechanical Engineering***

### **Number of Required Courses**

- M.E. and M.S. students are required to pass two courses from the list of core courses with a grade of B or better.
- Ph.D. students are required to pass three courses from the list of core courses, i.e., one beyond their M.S., with a grade of B or better.

### **Exemptions**

The core course requirements apply to students who enrolled in the mechanical engineering graduate program or transferred from another department or University in Fall 2010 or later. Students enrolled in the graduate program prior to Fall 2010 are not required to take the core courses, i.e., they will be “grandfathered in”, even if they complete their M.S. degree and transfer to the Ph.D. program.

Core courses may be substituted with equivalent graduate courses from other universities (as would often be the case for students who have completed their M.S. degrees elsewhere). All substitutions must be approved in writing by the Associate Department Head for Graduate Studies. To initiate this process, students should email the needed syllabi and transcripts to the graduate coordinator with a request for exemption.

### **Core Course List**

- \*Mathematics for Scientists and Engineers, MATH 530
  - Advanced Fluid Mechanics, MECH 539
  - Advanced Mechanical Systems, MECH 529
  - Advanced Mechanics of Materials, CIVE 560
  - Materials Issues in Mechanical Design, MECH 532
  - Mechanical Engineering Thermodynamics, MECH 538
  - Principles of Dynamics, MECH 524
- \*Must be taken by all Ph.D. students.

### **Core Course Detail**

- **Mathematics for Scientists and Engineers**  
**MATH 530 04(4-0-0)**. Mathematics for Scientists and Engineers. F. Prerequisite: MATH 340 or MATH 345. Proof-oriented linear algebra, ordinary and partial differential equations.
- **Advanced Mechanical Systems**  
**MECH 529 03(3-0-0)**. Prerequisite: MECH 307. Modeling, analysis, and synthesis of practical mechanical devices in which dynamic response is dominant consideration.

- **Advanced Fluid Mechanics**  
**MECH 539 03(3-0-0)** Objectives: To introduce mechanical engineering graduate students to advanced fluid dynamics concepts. Emphasis will be on deep flow physics understanding and application to complex problems typically seen in mechanical and aerospace applications (stability, boundary layers, bluff body flows, compressible flow, shock waves).
- **Advanced Mechanics of Materials**  
**CIVE 560 03(3-0-0)**. Prerequisite: CIVE 360. Analysis of stress and strain failure theory; selected topics in solid mechanics, plate analysis; introduction to elastic stability.
- **Materials Issues in Mechanical Design**  
**MECH 532 03(3-0-0)**. F. Prerequisite: MECH 331. Failure mechanisms from materials viewpoint with emphasis on use in design. Fracture, creep, fatigue, and corrosion.
- **Mechanical Engineering Thermodynamics**  
**MECH 538 03(3-0-0)**. Prerequisite: MECH 337. First and second laws of thermodynamics applied to engineering devices and systems. Introduction to availability, exergy, and lost work analysis.
- **Principles of Dynamics**  
**MECH 524 03(3-0-0)**. F. Prerequisite: MECH 324. Kinematics and dynamics of rigid body motion; Lagrangian and Hamiltonian formulations of mechanics; applications to engineering problems.

## Publication Requirements

Graduates from the M.S. and Ph.D. programs are required to publish in the archival literature of their research fields. The requirement is as follows:

- Graduation with the M.S. degree requires 1 publication in submission to a journal or conference by the time of the thesis defense\*.
- Graduation with the Ph.D. degree requires 1 accepted journal publication and 1 submitted journal publication (or a 2<sup>nd</sup> paper) by the time of the thesis defense\*.

\*Exceptions may be made by submitting a written petition to the Director of Graduate Studies, e.g. in the case of restricting research contracts or intellectual property concerns, the requirement may be changed to a fully prepared paper for subsequent submission.

Notes:

1. This requirement applies to students starting in the Spring 2011 semester or later.
2. The publication numbers given above are minimum requirements; having a larger number is encouraged. For students completing an M.S. followed by a Ph.D., the requirements must be separately met for both degrees.
3. Journal publications should be in peer reviewed journals.
4. The publication requirement will be checked at the time of submitting the GS25 form (application for graduation) to the graduate coordinator. At that time, the graduate coordinator will provide a form in which the publication information is entered.
5. Students should be aware of potential copyright issues and should discuss them with their advisor. Additional information on copyrights is available at:  
<http://www.graduateschool.colostate.edu/documents/eTD-Thesis-and-Dissertation-Manual.pdf>

# Requirements for the Master of Engineering Degree

## Plan C - Regular Coursework (no thesis)

- 30 credits of regular coursework (no thesis, independent study or supervised teaching credits )
- Minimum of 24 credits of courses taken at CSU that are 500-level and above
- Minimum of 15 credits of mechanical engineering courses (must have prefix MECH)
- Advisor required
- No thesis or graduate committee required

*Please note: Mechanical Engineering is a specialization of the College of Engineering Plan C Master of Engineering degree and is therefore only printed on the transcript and not on the final diploma.*

# Requirements for the Master of Science Degree

## Plan A - Thesis

- Minimum of 30 semester credits of graduate work in approved course of study
- Minimum of 24 semester credits earned at CSU
- Minimum of 18 semester credits of 500 level (and above) regular courses (does not include thesis, independent study or supervised teaching credits)
- Thesis credits (a minimum of 6 and a maximum of 12 credits)
- Final thesis defense

**Thesis:** An electronic draft of the thesis and a defense announcement with abstract must be submitted to the student's committee and the department at least two weeks prior to the final examination. The final examination should be conducted at least two weeks prior to the Graduate School thesis deadline.

Graduate School deadlines for forms, submission, and department clearances for graduation are listed at <http://graduateschool.colostate.edu/current-students/student-resources>. Students are required to bring with them to their defenses, the completed Thesis/Dissertation Submission Form for committee and department head signature. The final edited version of the thesis that is being submitted to the Graduate School must also be submitted to the graduate program coordinator for archiving before the student will be cleared for graduation.

**Final Thesis Defense/Exam:** The defense (also known as the final examination) is presented by the student at the end of the master's degree program. The student and committee determine the presentation format. It is most often an oral presentation that is similar to the Ph.D. preliminary examination, but is reduced in scope and invites questions that are application-oriented. The defense is open to all members of the mechanical engineering faculty and the student population. It is the student's responsibility to contact the department administrative assistant to schedule a room for the defense, obtain a template for the announcement, and to submit the announcement with abstract to be shared with mechanical engineering faculty and graduate students.

The graduate program coordinator will provide the advisor with the student file and the **GS24 form** to take to the final examination. The student must provide the Thesis/Dissertation Submission Form. If the student passes the defense, the committee members will sign the forms at the end of the examination.

**The student is required to provide the graduate program coordinator with the signed forms to obtain Department Head signature and must submit the signed originals to the Graduate School in person within 2 days following the examination.**

## Requirements for the Doctor of Philosophy Degree

- Minimum of 72 semester credits of graduate work in approved course of study (42 credits beyond the master's degree)
- Minimum of 32 semester credits in the graduate program after admission to CSU
- 10 credits earned after the master's degree may be accepted for transfer credit with approval from the advisor, the department, and the Graduate School
- 21 credits beyond the master's degree must be earned in courses numbered 500 and above. 12 credits must be in regular courses (**in addition to** courses applied to the master's degree and **not including** dissertation, independent study or teaching credits). For students enrolled in a continuous master's/Ph.D. program, all courses taken during the master's program may be applied to the doctoral degree even if the total master's degree credits exceed 30. For students who do not submit a master's degree in partial fulfillment of the requirements for the Ph.D., at least 62 credits must be earned at CSU and at least 37 credits beyond the bachelor's degree must be earned in courses numbered 500 or above.
- Written Diagnostic Examination
- Ph.D. Preliminary Examination
- Ph.D. Dissertation Defense (Final Examination)
- Dissertation credits (30 credits maximum)
- Dissertation

The above coursework outlines minimum requirements. Additional coursework may be required by a particular program and/or a student's committee. The dissertation is a major effort in which the doctoral candidate undertakes a program of work which will result in a significant contribution to the major field of one's own interest. In general, such a program will involve consideration of a challenging problem utilizing analytical, experimental, and/or design techniques. The objective, on the one hand, may be to determine and explain the behavior of a simple system, or on the other, to bring into logical order the techniques of a field which has suffered random growth. The results of the dissertation will be new analytical knowledge, design knowledge, experimental knowledge, or a combination of these. Whatever its nature, the dissertation topic must provide an opportunity for the candidate to make an original contribution to the field.

### Ph.D. Written Diagnostic Exam

**Purpose:** To test the candidate's understanding of undergraduate foundational topics in mechanical engineering and to determine the candidate's "breadth" of knowledge. The candidate must pass in two topical areas as listed below. Based on the results of the exam, students may be required to take additional courses to strengthen their knowledge of mechanical engineering fundamentals..

**Scheduling:** The exam must be attempted during the student's first two semesters in the program. Students entering the Ph.D. program directly from a bachelor's degree will be allowed to take the exam during their third semester. Students may attempt the diagnostic exam twice. In the event the diagnostic exam is failed, at the discretion of the department, it may be attempted again the next time the exam is offered. Students must submit the "Intent to Take Written Diagnostic Exam" form by mid-September to take the exam in the fall, and by mid-February to take the exam in the spring. Two topical areas shall be specified on the form. Please see the "Resources" section at the following link for procedures, intent form, and study guides: [http://www.engr.colostate.edu/me/pages/grad\\_about.html](http://www.engr.colostate.edu/me/pages/grad_about.html).

Students are required to demonstrate competency in two of the following topical areas:

- 1) Energy & Thermal Sciences
- 2) Mathematics
- 3) Mechanics of Solid Bodies & Materials
- 4) Moving Systems

## Ph.D. Preliminary Examination

**Purpose:** The purpose of the preliminary examination is to determine the candidate's background knowledge in the proposed dissertation area and to determine the adequacy of the current research plan. Upon successful completion of the exam, the committee and student have an outline of the research plan and expectations for the student's dissertation.

**Scheduling:** Students are expected to conduct the preliminary exam after an extensive literature review in the area and collection of preliminary data. At the time of the exam, the student must have already selected an advisor from the department and a graduate committee, and must have been working with the major professor on the definition of the research leading to the dissertation. The student has a maximum of two opportunities to pass the exam. The preliminary exam must be completed **at least two semesters prior to the final dissertation defense.** The summer term counts as a semester. Students are advised to complete the preliminary exam within a year after passing the diagnostic exam.

**Procedure:** The student is required to provide a written research proposal to each member of the committee **at least two weeks prior to the exam date.** The research proposal must include a detailed survey of the supporting literature, preliminary data and a summarized research plan. Any mechanical engineering faculty member may request a copy of the proposal before the examination. The research proposal must also be submitted to the department administrative assistant along with an announcement with abstract **at least two weeks prior to the exam date** to make the documents available to faculty and to facilitate the announcement of date, time and location of the exam

The exam will consist of the student's presentation of the research proposal and questions by the committee to further assess the preparedness of the student to continue the degree, followed by analysis of the proposal by the student's committee with recommendations for changes in the plan. The student and advisor will prepare a rough outline of the changes to the research plan suggested by the committee in the preliminary exam. The student's advisor will be responsible for bringing the student's folder to the exam.

**Results:** By completing and signing the **GS16 form**, the committee shall:

1. **Pass:** recommend the student advance to Ph.D. candidacy and accept the research plan as agreed to by the committee during the exam
2. **Fail:** Recommend that the student take the preliminary examination again, if the student's research plan or background knowledge is unacceptable but the committee feels that the potential exists for satisfactory performance
3. **Terminate:** Recommend the student be terminated from the Ph.D. program

***Within 2 days following the examination, the student is required to submit the Report of Preliminary Examination (GS16 form) to the Graduate School.***

## Ph.D. Dissertation Defense

**Purpose:** The purpose of the dissertation defense (also known as the final exam) is to allow faculty members and the public to critically examine and comment on the dissertation work and its significance and contribution to the research area and literature.

**Scheduling:** Upon completion of the research, the candidate must furnish to each committee member a preliminary copy of the dissertation **at least three weeks prior to the proposed defense date.** After careful study and possible conferences with the candidate and other committee members, each member will make a recommendation as to the scheduling of the final defense. Upon majority approval of the committee, the candidate may schedule the dissertation defense. The dissertation should be submitted to the department administrative assistant, along with an announcement with abstract, **at least two weeks prior to**

**the exam date** to make the documents available to faculty and to facilitate the announcement of date, time and location of the exam. Common courtesy to both the candidate and committee dictates that the committee be given two weeks to reach a decision on the acceptability of a student's dissertation. In the event that the candidate does not receive approval to schedule the public defense, the committee must make further suggestions to the candidate.

**Procedure:** Final examinations are open to the public and are conducted in a formal and professional manner. The student's faculty advisor is responsible for bringing the student's file with necessary forms to the defense. To begin the presentation, the candidate is introduced by the advisor. The candidate then presents the findings of the doctoral research to the committee and to the public. After the presentation, questions are invited from all present.

**Results:** Upon completion of the public question and answer period, the committee members and other members of the mechanical engineering faculty who are present at the defense will go into closed session. The committee members will decide whether to accept or reject the dissertation. If the dissertation is accepted, the committee members will sign the **GS24 form**. If the dissertation is rejected, the committee members will make appropriate recommendations to the student, who must complete the required revisions. Another dissertation defense may or may not be scheduled, based on the decision of the committee. When the dissertation is approved, the student must have the committee members and department head sign the Thesis/Dissertation Submission Form, found on the graduate school website at <http://graduateschool.colostate.edu/documents/Thesis-Dissertation-Submission-Form.pdf>

## Quality of Work

Any student not making satisfactory progress as determined by his or her graduate committee, or whose cumulative grade point average is less than B (3.0), shall be automatically placed on academic probation. New students will not be placed on probation until after completion of 12 credits or two semesters, whichever comes first.

A student's individual graduate committee or the department graduate committee may recommend immediate dismissal upon finding that the student is making unsatisfactory progress toward the degree and that satisfactory progress cannot reasonably be anticipated. Such a recommendation must be documented in writing with substantive justification for this action in lieu of probation. It must be referred to the department head for approval and to the dean of the Graduate School for final action. The student may appeal such an immediate dismissal through the existing Graduate School grievance procedure. Otherwise, the student must improve his or her cumulative grade point average to at least 3.0 in the semester following probation or face immediate dismissal and/or make satisfactory progress as determined by the student's graduate committee.

In special studies, departmental seminars, and research, students must earn an S, or average B or better. Averages in the category of formal course work and in the category of research, special studies and seminars are determined independently. Additionally, the Department of Mechanical Engineering may choose to place the student on probation for falling below a 3.0 average, in either area, in any single semester.

To be eligible for graduation, a student must maintain at least a B average (3.0 GPA) in formal course work and satisfactory grades in research, special studies and seminars included in the program of study. Supervised teaching credits do not count towards the number of credits needed for graduation. Work graded D, F, and U will not be accepted toward degree requirements. Grades of I (incomplete) must be replaced with appropriate letter grades within twelve months or the credits involved will be converted to an F grade and will not be accepted toward degree requirements.