



**MECHANICAL ENGINEERING**  
**COLORADO STATE UNIVERSITY**

# Graduate Student Handbook

For

Graduate Degrees  
in Mechanical Engineering

# 2020-2021

**WALTER SCOTT, JR. COLLEGE OF ENGINEERING**  
**COLORADO STATE UNIVERSITY**

[www.engr.colostate.edu/me](http://www.engr.colostate.edu/me)

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## Introduction

Graduate study in mechanical engineering at Colorado State University (CSU) is intended to bring together faculty members and graduate students in a diverse community of scholars having a common interest in advanced professional study and creative work. The program seeks to extend the boundaries of the mechanical engineering profession by developing advanced technologies to provide creative solutions to global problems in energy, environment and human health. The major research areas in the Department of Mechanical Engineering at CSU include energy conversion, alternative energy, emissions and pollution control; biomechanics, biomaterials and nanobiotechnology; hybrid vehicles; building and transportation systems; laser diagnostics, atmospheric plasmas, and computational fluid dynamics.

## Graduate Advisors

Successful completion of graduate studies requires close cooperation between student and advisor. A permanent advisor is usually assigned to every student upon admission based on the research area of the professor. The Associate Head for Graduate Studies serves as advisor to students who pursue the coursework-only Master of Engineering degree. The student and advisor work together to coordinate the plan of study, i.e. courses, research, committee members, etc. If a permanent advisor has not been determined by the start of the first semester, then the student may make an initial plan of study with the Associate Head for Graduate Studies.

### Graduate academic advisors based on research areas are as follows:

<u>Advisor</u>	<u>Research Area</u>
Dr. Todd Bandhauer .....	Thermal Energy Systems; Phase Change Processing; Interdisciplinary Research
Dr. David Bark.....	Biomedical Engineering—Biofluids and Thrombosis
Dr. Xinfeng Gao.....	Computational Fluid Dynamics, Numerical Methods, Data Assimilation and Machine Learning, Aerospace
Dr. Stephen Guzik.....	Computational Fluid Dynamics, Shock-Capturing Methods, Turbulence and Combustion Modeling, Computational Geometry, High Performance Computing
Dr. Soham Ghosh.....	Biomedical Engineering – Mechanobiology, Biomechanics, Epigenetics
Dr. Susan James .....	Biomedical Engineering – Biomaterials/Biomechanics
Dr. Shantanu Jathar.....	Energy Systems, Air Pollution, Climate, Environmental Policy
Dr. Kaka Ma.....	Nanostructured Materials, Nanoscale Mechanics, and Sustainable Materials Engineering
Dr. Kirk McGilvray.....	Biomedical Engineering with emphasis on trauma and degeneration
Dr. Anthony Marchese.....	Combustion, Engines, Alternative Fuels, Algae Biofuels
Dr. Daniel Olsen .....	Engines and Energy Conversion
Dr. Ketul Popat .....	Micro/Nano Technology in Orthopaedic Materials
Dr. Jason Quinn.....	Microalgae Biofuels, Sustainability Assessment: LCA and TEA
Dr. Christian Puttlitz .....	Biomedical Engineering with emphasis on biomechanics
Dr. Donald Radford.....	Composite Materials
Dr. W.S. Sampath .....	Photovoltaic Solar Cell Manufacturing

\*Dr. Steven Schaeffer.....Rapid/Flexible Tooling, Casting  
 Dr. Wade Troxell .....Intelligent Control of Networked Distributed Resources  
 Dr. John Volckens.....Sensors, Air Pollution, and Health  
 Dr. Zhijie Wang.....Cardiovascular Engineering, Biomechanics, and Mechanobiology  
 Dr. Christopher Weinberger.....Computational Solid Mechanics and Material Science  
 Dr. John Williams .....Plasmas and Ion Thrusters  
 Dr. Bryan Willson.....Engines – Optical Combustion Diagnostics  
 Dr. Bret Windom.....Combustion, flames, fuel characterization, diagnostics  
 Dr. Azer Yalin.....Combustion, Plasma, Laser Sensors, Environmental  
 Monitoring  
 Dr. Mostafa Yourdkhani.....Composite materials; multifunctional polymers  
 Dr. Jianguo Zhao .....Robotics and Controls

\*Faculty member eligible to serve as co-advisor

## Colorado Residency

Domestic students are strongly encouraged to declare Colorado residency by the end of their first academic year. This is done by completing a variety of tasks. First and foremost, students must be able to show proof of residence in Colorado for the 12 months prior to the beginning of the second year in the program (e.g. if the semester starts on August 22, 2016, you must be able to show you lived in Colorado on August 22, 2015). You must also establish ties to Colorado (Driver’s License/State ID card, voter registration, car registration – if the vehicle is in your name).

If you are a domestic, out of state student, be sure to review the Residency Office’s website for more information about obtaining residency (<http://sfs.colostate.edu/residency/>). Also, plan on attending a Residency Orientation provided by the Office of Financial Aid: <https://financialaid.colostate.edu/residency-orientations/>

*\*International students are not eligible to declare Colorado residency unless they are immigrating to the United States.*

## 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 in the non-BSME guidelines, available from the Graduate Program Specialist. 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 should confirm the outside committee member’s willingness to participate prior to submitting the program of study. Programs of study 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 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 semesters typically required to complete the master’s

degree, and a subsequent six to eight semesters 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.

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. Transfer requests are submitted to the Graduate School with the GS6 Program of Study during the second semester and must include a course syllabus and a transcript showing that the course(s) was not used for another degree. 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. degrees is 6 and for Ph.D. degrees is 10.

A full-time course load for graduate students is 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 who are registered for CR may not be on contract for a research or teaching assistantship but may work as student hourly employees. **See Graduate School website for more information on CR:** <https://graduateschool.colostate.edu/policies-and-procedures/continuous-registration-graduate-enrollment-policies/>

## Graduate Committee

To guide and supervise a student's progress for the M.S. and Ph.D. degrees, a graduate committee should be selected by the student and advisor before the end of the student's second semester of study. This committee is composed of the faculty advisor, an “outside committee member” from a department other than Mechanical Engineering, and additional co-advisors or committee members with appropriate faculty designations. The graduate committee makes regular evaluations of the student's progress and conducts/evaluates defenses for the preliminary and final exams.

## Advisor and Graduate Committee Make-up

\*Refer to Departmental Code for details of faculty assignments.

### **Master of Engineering (M.E. Plan C)**

1. Advisor from the student's department (typically the Associate Department Head for Graduate Studies)
2. No graduate committee or outside member required

### **Master of Science (M.S. Plan A)**

For M.S. candidates, the graduate committee must consist of at least three members:

1. Advisor from the student's department (can be tenured/tenure-track faculty or associate research professor—**co-advisor must be tenure or tenured track if advisor is associate research professor**)
2. A co-advisor or committee member from the student's department (can be tenured/tenure-track faculty, associate research professor, or teaching faculty)
3. An outside committee member from another department (tenured or tenure-track faculty)
4. A co-advisor or additional committee members from any department may be added to the

student's committee, if appropriate, as long as items 1-3 above are met

### **Doctor of Philosophy (Ph.D.)**

For Ph.D. candidates, the graduate committee must consist of at least four members:

1. Advisor from the student's department (can be tenured/tenure-track faculty or associate research professor—**co-advisor must be tenure or tenured track if advisor is associate research professor**)
2. Two members from the student's department serving as co-advisor or committee member (faculty or staff member with tenured/tenure-track faculty or special faculty appointment)
3. An outside committee member from another department (tenured or tenure-track faculty)
4. A co-advisor or additional committee members from any department may be added to the student's committee, if appropriate, as long as items 1-3 above are met

For detailed information on Advisor and Graduate Committee Makeup and committee member requirements, please refer to <https://graduateschool.colostate.edu/policies-and-procedures/advisor-committee/>

## **Core Course Requirements**

### **Number of Required Courses**

- M.S. students are required to complete **2** courses from the list of core courses with a grade of B or better
- Ph.D. students are required to complete **3** courses from the list of core courses with a grade of B or better

### **Core Course List**

- \*Mathematics for Scientists and Engineers, MATH 530
- \*Computational Methods for Mechanical Engineers MECH 568
- \*Mathematical Modeling for Chemical and Biological Engineering CBE 521
- Advanced Mechanics of Materials, CIVE 560
- Advanced Mechanical Systems, MECH 529
- Materials Issues in Mechanical Design, MECH 532
- Mechanical Engineering Thermodynamics, MECH 538
- Advanced Fluid Mechanics, MECH 539
- Advanced Heat Transfer, MECH 544

*\*MATH 530, MECH 568, or CBE 521 must be taken by all Ph.D. students*

### **Core Course Detail**

- **Mathematics for Scientists and Engineers - MATH 530, 4 credits.** Proof-oriented linear algebra, ordinary and partial differential equations.
- **Mathematical Modeling for Chemical Engineers – CBE 521, 3 credits.** Application of mathematical models to analysis and design of chemical reactors and separation processes.
- **Computational Methods for Mechanical Eng. – MECH 568, 3 credits.** Fundamental principles which provide the foundation for the software and algorithms used in Mechanical Engineering.

- **Advanced Mechanics of Materials - CIVE 560, 3 credits.** Analysis of stress and strain failure theory; selected topics in solid mechanics, plate analysis; introduction to elastic stability.
- **Advanced Mechanical Systems - MECH 529, 3 credits.** Modeling, analysis, and synthesis of practical mechanical devices in which dynamic response is dominant consideration.
- **Materials Issues in Mechanical Design - MECH 532, 3 credits.** Failure mechanisms from materials viewpoint with emphasis on use in design. Fracture, creep, fatigue, and corrosion
- **Mechanical Engineering Thermodynamics - MECH 538, 3 credits.** First and second laws of thermodynamics applied to engineering devices and systems. Introduction to availability, exergy, and lost work analysis.
- **Advanced Fluid Mechanics - MECH 539, 3 credits.** Introduces mechanical engineering graduate students to advanced fluid dynamics concepts. Emphasis 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, and shock waves).
- **Advanced Heat Transfer - MECH 544, 3 credits.** Fundamentals and engineering applications of heat transfer including conduction, convection, and radiation.

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) or transferred from the MS degree to the PhD degree within CSU. Substitutions must be approved in writing by the Associate Department Head for Graduate Studies while transfer of requirements from the MS to PhD will be approved by the Graduate Program Specialist. To initiate course substitution process, students should email a syllabus for each course in question to the Graduate Program Specialist with a request for an exemption from the equivalent course on the core course list. Please note that such exemptions replace required courses but do not change the credit hour requirements for the degree. For core course transfer from the CSU MSME program, a simple email request to the Graduate Program Specialist is necessary indicating the core course requirements to transfer. The core course transfer does not alter the additional credit requirements of the degree.

## 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 2nd paper) by the time of the dissertation defense\*.

\*Exceptions may be made by submitting a written petition to the Associate Head for 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. 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 each degree.
2. Journal publications should be in peer reviewed journals.
3. The publication requirement will be checked at the time of submitting the GS25 form (application for graduation) to the Graduate Program Specialist.

Students should be aware of potential copyright issues and should discuss them with their advisor.

Additional information on copyright is available at: <http://lib.colostate.edu/etd>

## **Seminar Series**

Graduate students in Mechanical Engineering are required to attend seminars and presentations. Master of Engineering students are strongly encouraged to attend. Master of Science students must complete 8 seminars prior to scheduling their final thesis defense, and Doctor of Philosophy students must complete 16 seminars prior to scheduling their final dissertation defense. Seminars include department seminars (invited speakers), thesis and dissertation defenses, webinars, and conferences (conferences count as one seminar attendance). Seminar attendance must be verified by the faculty advisor in an email to the Graduate Program Specialist.

## **Quality of Work**

Per Graduate School policy, students whose cumulative grade point average (GPA) is less than B (3.0), at the end of a semester will be automatically placed on academic probation. New students will not be placed on probation until they have completed 12 credits or two semesters, whichever comes first. Students are permitted one semester to bring the GPA back up to the required 3.0 to return to good standing. If this requirement is not met the student will be automatically dismissed from the Graduate School unless the student's faculty advisor and the Department Head agree to submit a petition to the Graduate School for a one-semester extension to return to good standing. If this requirement is not met, the dismissal will go through.

Credits earned for research (thesis and dissertation credits) and supervised teaching are graded as Satisfactory (S) or Unsatisfactory (U) by the faculty advisor. The student must maintain "S" grades to remain in good standing. Independent Study credits may be graded with a letter grade or with an S/U grade. The student must maintain a grade of "S" or "B" or better to remain in good standing. If the student does not maintain grades of "S" and "B" or better in these credits, the student will be placed on probation. These grades will also be considered in committee decisions about student progress, probation and/or dismissal.

Students will be reviewed annually by their advisor and/or committee to determine if they are making satisfactory progress towards the completion of their degree. 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.

To be eligible for graduation, a student must maintain at least a B average (3.0 GPA) in formal course work as well as satisfactory grades in research and other non-graded credits courses included in the program of study. Work graded C will be accepted toward degree requirements only if the GPA is still above 3.0. Repeated courses are added to the transcript but may not be removed. Grades of 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 will be converted to an F grade. Students may not graduate with an "I" on their transcript.

## **Annual Ph.D. Student Evaluations**

The annual student evaluation process assists students and advisors in planning for timely completion of program requirements, provides consistent feedback to students as they proceed through the program, alerts students and advisors to problems, and provides students and advisors the opportunity to develop effective approaches for addressing those problems. Evaluation forms are available on the ME graduate

website.

The first step of the process, the completion of Section A, requires students to provide a report of their academic and professional accomplishments over the past year. This allows students to assess their progress, keep their curriculum vitas/resumes up to date, and provide advisors with the information needed to evaluate student performance. The second step, the completion of Section B, requires advisors to review student progress to ensure that students are making satisfactory progress towards degree completion. After meeting to discuss the evaluation, both parties are required to sign and submit the evaluation to the Graduate Program Specialist for approval. If it is determined that the student has not made satisfactory progress towards degree requirements, the student's graduate committee will follow section E.1.3 of the Graduate and Professional Bulletin:

### **E.1.3 Scholastic Standards**

When a student's graduate advisory committee or an appropriate departmental graduate committee finds that a student is making unsatisfactory progress toward the degree and that satisfactory progress cannot be anticipated, a plan should be created, and the following steps should be taken:

1. Inform the student of the concerns, create a progress plan with the student, develop a timeline and inform the student of potential consequences (dismissal) if the progress is not satisfactory.
2. The committee should keep in contact with the student to give feedback during the progress plan timeline and document such contacts and their outcomes.
3. At the end of the timeline, if progress is not adequate, the committee may recommend dismissal from the program. The recommendation goes to the Department Head and the dean of the Graduate School and should include documentation on the steps taken with justification for this action.

The recommendation must be referred to the Department Head for approval and the Dean of the Graduate School for final action. The student may appeal such an immediate dismissal through the existing Graduate School appeals procedure. Departments which invoke this process must have published guidelines explaining the performance indicators which lead to immediate dismissal.

## **Financial Aid**

Generally, Master of Engineering (coursework-only) students are not funded through Graduate Research or Teaching Assistantships. Master of Engineering students may be eligible for student hourly positions.

Graduate Research Assistantships (GRA) are negotiated between student and the supervising faculty member. GRA assignments involve significant assistance with research in the faculty laboratory, which may or may not be directly related to the student's thesis/dissertation topic. Graduate Teaching Assistantships support the undergraduate program, and as such, involve the Associate Head for Undergraduate Studies and the Associate Head for Graduate Studies in the selection process. Priority for Graduate Teaching Assistantships is given to students seeking the PhD, with consideration to the advising faculty member's previous use of graduate teaching assistantships as a funding mechanism. Assignments to undergraduate courses are made with regard to student background and preparedness to assist undergraduate students in a given subject.

## **Requirements for the Master of Engineering Degree (30 hours)**

### **Plan C - Regular Coursework (no thesis)**

- Minimum 30 credits of regular coursework (no thesis, independent study, or supervised teaching)

- Minimum 24 credits taken at CSU that are 500-level and above
- Minimum 21 credits taken after program admission
- Minimum 15 credits of mechanical engineering courses (must have prefix MECH)
- Advisor required but no Graduate Committee required

Please note: Mechanical Engineering and Engineering Management are specializations in the College of Engineering, Plan C, Master of Engineering degree; therefore, the Mechanical Engineering and Engineering Management title only appear on the student's transcript and not on the final diploma.

## Requirements for the Master of Science Degree (30 hours)

### **Plan A (thesis required)**

- Minimum 30 semester credits of graduate work in approved course of study
- Minimum 24 semester credits earned at CSU in courses numbered 500 and above
- Minimum 21 credits taken after program admission
- Maximum 6 transfer credits (with original transcript) not counted towards any other degree
- Minimum 18 credits in regular courses numbered 500 and above (not including dissertation, independent study, or supervised teaching)
- Two core courses with a B or better
- Minimum one publication in submission
- Minimum 8 seminars attended
- Minimum of 6 and maximum of 12 thesis credits may be applied to the degree.
- Final thesis defense
- Final thesis submission

**Program:** Students pursuing the Master of Science (M.S.) degree in mechanical engineering are expected to conduct research under the supervision of a faculty advisor who also is usually the Principal Investigator (P.I.) for a government or industry sponsored project. The student's research, in conjunction with thesis credits and coursework, will culminate in an article for submission to a peer-reviewed journal and a final thesis. The final thesis may incorporate findings from the article.

**Thesis Defense:** The thesis defense (also known as the final examination) is presented at the end of the master's degree program. It is most often an oral presentation describing the research and findings reported in the thesis. The defense is open to all mechanical engineering faculty, staff, and students and includes an open question period for all in attendance as well as a private question period for the committee.

**Scheduling:** The Department has set deadlines two weeks prior to Graduate School deadlines to avoid last minute emergencies that could prevent a student from graduating. It is the student's responsibility to contact the Graduate Program Specialist to schedule a room for the defense, obtain a template for the announcement, to submit the announcement with abstract, and submit an electronic draft of the thesis to be shared with mechanical engineering faculty and graduate students. Students should begin planning for the defense and thesis submission a minimum of three weeks prior to the defense and a minimum of four weeks prior to Graduate School deadlines.

### **Suggested Timeline:**

#### *Three weeks prior to the defense:*

- Confirm a date and time for your defense with your graduate committee

***Two weeks prior to the defense:***

- Contact the Graduate Program Specialist to schedule the room and provide you with a template for your announcement with abstract
- Submit announcement with abstract by email to Graduate Program Specialist for distribution and advertising
- Email a draft of the thesis (.pdf format) to your graduate committee and the Graduate Program Specialist

***Two weeks prior to the Graduate School deadline for Thesis & Dissertation Submission:***

- The final examination/defense should be conducted at least two weeks prior to the Graduate School deadline for Thesis & Dissertation Submission to allow for unexpected delays.

*If circumstances prevent a student from meeting department deadlines, the Graduate Program Specialist should be informed by the student's advisor so that steps may be taken to ensure that the Graduate School deadlines and requirements are met for the intended graduation term.*

**Graduate School Deadlines:** <http://graduateschool.colostate.edu>

**On the day of the defense:** The student's advisor is required to pick up the student file from the mechanical engineering office. Student files are not released to students. The student may choose to bring the completed Thesis/Dissertation Submission Form for committee and department head signature to the defense as a matter of convenience. However, the committee reserves the right to withhold signatures until they have seen the final thesis.

**Results:** At the conclusion of the examination, the committee members will sign the **GS24 form** under the "pass" or "fail" section. The student is required to obtain the department head's signature on the original **GS24 form** and submit a copy to the Graduate Program Specialist. The advisor is required to return the student file to the graduate program coordinator.

***The signed original of the GS24 form must be delivered in person by the student to the Graduate School within 2 days following the examination.***

**Thesis Submission:** The student submits the Thesis/Dissertation Submission Form (**GS30**) to the Graduate School, after which the Graduate School provides directions for electronic submission.

**Clearance to Graduate:** In addition to submission to the Graduate School, the final dissertation also must be emailed (pdf preferred) to the Graduate Program Specialist for archiving before the student will be cleared for graduation (**GS25B form**) by the department. Graduating students also should check their "Graduate Degree Plan" in RAMweb for discrepancies or comments. Any issues found there must be resolved before the student will be cleared for graduation by the Graduate School.

## **Requirements for the Doctor of Philosophy Degree (72 credit hours)**

### **With a Master of Science in Engineering**

- Completion of 72 credit hours of approved graduate coursework required
  - 42 semester credits of Ph.D. graduate work in approved course of study
  - 30 semester credits automatically applied for M.S. in Engineering from an accredited

- university with original transcript
  - Maximum 10 transfer credits for courses numbered 500 and above, earned after the M.S. degree, and not counted towards any other degree (with original transcript)
- Minimum 32 credits earned at CSU
  - Minimum 21 credits in courses numbered 500 and above
  - Minimum 12 credits in regular courses numbered 500 and above (not including dissertation, independent study or supervised teaching)
  - Maximum 30 dissertation credits may be applied to the degree
  - Three courses from core course list (equivalents may be substituted)
- Minimum one journal publication accepted in a peer-reviewed journal
- Minimum one journal publication submitted or second paper completed
- Minimum 24 departmental seminars attended
- Oral Qualifying Examination (by the 4th semester)
- Ph.D. Preliminary Examination
- Ph.D. Dissertation Defense (final examination)
- Ph.D. Dissertation Submission

### **With a Bachelor of Science in Engineering**

- Completion of 72 credit hours of graduate work in approved course of study
  - Maximum 10 transfer credits for credits earned after the bachelor's degree not counted towards any other degree (with original transcript)
- Minimum 62 credits earned at CSU
  - Minimum 42 credits in courses numbered 500 and above
  - Minimum 30 credits in regular courses numbered 500 and above (not including dissertation, independent study or supervised teaching)
  - Maximum 42 thesis/dissertation credits may be applied to the degree
  - Three courses from core list
- Minimum two publications submitted to a peer-reviewed journal (or one publication submitted and second paper completed)
- Minimum one publication accepted in a peer-reviewed journal
- Minimum 16 departmental seminars attended
- Oral Qualifying Examination (by the 4th semester)
- Ph.D. Preliminary Examination
- Ph.D. Dissertation Defense (final examination)
- Ph.D. Dissertation Submission

*These departmental requirements are minimums and may differ from general Graduate School requirements. In some cases, additional coursework may be required by a particular program and/or student's committee. For graduate school requirements, please refer to Section E.4.2 of the Graduate and Professional Bulletin at <https://catalog.colostate.edu/general-catalog/graduate-bulletin/>*

**Program:** Students pursuing the Doctor of Philosophy degree in mechanical engineering will undertake advanced research under the mentorship of a faculty advisor (P.I.), most often on a government or industry funded project as a paid research assistant. The degree plan will involve consideration of a challenging problem utilizing analytical, experimental, and/or design techniques. The objective may

be 1) to determine and explain the behavior of a simple system or 2) to bring into logical order the techniques of a field which has experienced random growth. This research - in addition to coursework, exams, journal articles, and dissertation credits - will culminate in a final dissertation. The dissertation will contain new analytical knowledge, experimental knowledge, design knowledge, or a combination thereof. Whatever its nature, the dissertation must make an original contribution to the field.

## **Ph.D. Oral Qualifying Exam**

### **Purpose:**

The main objective of the exam is to ensure that all PhD graduates are able to demonstrate a mastery of the underlying theory specific to their dissertation research and a thorough understanding of theory in their engineering sub-discipline. The Oral Qualifying Exam is private and only open to the student's Examination Committee and his/her graduate advisor.

### **Examination Committee:**

The examination committee will consist of four (4) examiners, one of whom will act as a chair of the committee as soon as it is formed at the request of the student to be examined. The chair and one additional committee member must be tenure track or tenured faculty in the Department of Mechanical Engineering. The other two committee members can be filled by faculty inside or outside the department. However, if they are not faculty at Colorado State University, they are permitted on the Examination Committee only by approval of the graduate education committee (GEC).

The faculty advisor is not part of the examination committee but can be present during the examination as a courtesy. The faculty advisor has no voice on the committee.

### **Scheduling:**

1. The student must complete at least one year of graduate course work and all of the required Core Courses prior to taking the Qualifying Exam.
2. The student must take the exam by the beginning of their fourth semester in the PhD program. The exam can be taken earlier provided that criterion 1 is satisfied.
3. The student and examination committee must establish a day and time for the exam to be administered and the student must submit the intent to take the oral qualifying exam form at least 60 days prior to exam date.
4. The report of the oral qualifying exam must be submitted by the chair to the Graduate Program Specialist within 1 week of the examination.
5. With permission of the Associate Department Head for Graduate Studies, it is permissible to have one and only one committee member who is not the chair give their portion of the exam up to one week (7 calendar days) early due to scheduling conflicts. In this case, the committee member must provide, in writing, the examination results and comments from their portion of the exam to the committee chair. That examiner then gives up their voice on the outcome of the exam. The early examination of a single subject must occur prior to the rest of the exam. In the case of absence due to illness or other unforeseen circumstances, the exam must be rescheduled within 2 weeks. If this pushes the exam into the student's 4<sup>th</sup> semester, this does not constitute a violation of point #2 above.

### **Format:**

1. The exam will be a 2-hour oral exam administered in four 30-minute segments by the Examination Committee.

2. The exam will consist of 4 topical areas, at least 2 of which will be from the following list of core subject areas. The associated Core Course is listed in parentheses as a general guideline for the topical area. However, the topical content of the oral exam is at the discretion of the examiner.
  - Thermodynamics (MECH 538)
  - Dynamics of Mechanical Systems (MECH 529)
  - Materials (MECH 532)
  - Solid Mechanics (CIVE 560)
  - Fluid Mechanics (MECH 539)
  - Heat Transfer (MECH 544)
  - Mathematics for Scientists and Engineers (MATH 530)
  - Computational Methods for Mechanical Engineers (MECH 568)

The remaining 2 subject areas may be based on the candidate's dissertation research topic subject at the approval by the Advisor and Examination Committee or otherwise should be based on coursework similar to the core subject areas listed above.

3. The Examination Committee can choose to conduct the oral examination on these topics in the context of the candidate's dissertation topic.
4. The Examination will be graded on an integer scale of 0 to 8.0 (scoring in increments of 0.5), with a maximum grade of 2.0 for each of the four topical areas. The final number grade will determine the outcome of the exam as follows:

<b>Integer</b>	<b>Outcome</b>
6.0 to 8.0	Pass
4.5 to 5.5	Pass with Conditions
2.5 to 4.0	Fail with Permission to Retake
0 to 2.0	Fail

Note that any committee member can require that a student complete additional work for any integer grade less than 8.0.

5. The Examination Committee will meet in private (without the presence of the thesis advisor) to determine a final score on the 0 to 8 scale and assign the associated final grade of pass, pass with condition, fail with permission to retake, or fail. Those students who fail with permission to retake will only be allowed to retake the exam once.
6. The Examination Committee will report the results of the qualifying examination to the Associate Department Head of Graduate Studies.

### **Research Advisor's Role:**

1. The student's Research Advisor will work with the student to identify the 4 subject areas of the Qualifying Exam and the appropriate members of the Examination Committee for each subject area.
2. After agreeing on the recommended constitution of the Examination Committee, the student will contact the members of the Examination Committee to request their participation in the Qualifying Exam process and solicit a chair.
3. Having obtained consent from the Examination Committee members and Research Advisor, the student will obtain approval for the proposed topical areas and Examination Committee make-up by

the Associate Department Head for Graduate Studies.

4. The Research Advisor may be present during the Qualifying Exam but will not participate in the examination process.
5. The Research Advisor may not be present for the private Examination Committee deliberation during which the final grade is assigned but will be a part of the post-examination debriefing (after the score has been determined).
6. The committee chair will communicate the results to the student and their advisor.

## 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 to develop a satisfactory dissertation. The exam is based on the candidate's written research proposal that contains a detailed survey of the supporting literature, preliminary data, and a summarized research plan. Upon successful completion of the preliminary exam, the committee and student will agree to a final research plan that includes clear expectations for the content of the dissertation. The Preliminary Examination is generally closed to the student's graduate committee, but an advisor/student may elect to open up the presentation portion of the exam.

**Scheduling:** Prior to planning the preliminary exam, students should be actively conducting research with a faculty advisor, have the graduate committee confirmed, and have the **GS6 form** (Program of Study) on file with the Graduate School. The preliminary exam is conducted after an extensive literature review and collection of preliminary data which leads to a "working title" or definition of the research project and a written research proposal.

Students are advised to complete the preliminary exam within a year after passing the Ph.D. Oral Qualifying Exam. *The preliminary defense is required a minimum of two semesters prior to the final dissertation defense.*

### **Suggested Timeline:**

#### *Three weeks prior to the preliminary exam:*

- Confirm a date and time for your preliminary exam with your graduate committee

#### *Two weeks prior to the preliminary exam:*

- Contact the Graduate Program Specialist to schedule the room and provide you with a template for your announcement with abstract
- Submit announcement with abstract by email to the Graduate Program Specialist for distribution and advertising
- Email the written research proposal to each member of the committee and the Graduate Program Specialist to be shared with mechanical engineering faculty and graduate students.

**Procedure:** On the day of the prelim, the student's advisor is required to pick up the student file from the mechanical engineering office. Student files are not released to students. 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. The student has a maximum of two opportunities to pass the preliminary 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

The student is required to obtain the department head's signature on the original **GS16 form** and submit a copy to the Graduate Program Specialist. The advisor is required to return the student file to the Graduate Program Specialist.

*The signed original of the GS16 form must be delivered in person by the student to the Graduate School within 2 business days following the examination.*

## **Ph.D. Dissertation Defense**

The Ph.D. dissertation is a major effort in which the doctoral candidate undertakes a program of work that will result in a significant contribution to the student's major field of study.

**Purpose:** The purpose of the Ph.D. 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. Final examinations are open to the public and are conducted in a formal and professional manner.

**Scheduling:** The Department has set deadlines two weeks prior to Graduate School deadlines to avoid last minute emergencies that could prevent a student from graduating. It is the student's responsibility to contact the Graduate Program Specialist to schedule a room for the defense, obtain a template for the announcement, to submit the announcement with abstract, and submit an electronic draft of the dissertation to the department to be shared with mechanical engineering faculty and graduate students.

### **Suggested Timeline:**

#### *Four to six weeks prior to the defense:*

- Provide each committee member with a preliminary copy of the dissertation for review. Common courtesy to both the candidate and committee dictates that committee members be given two weeks to reach a decision on the acceptability of a student's dissertation. During this time, they may request meetings with the candidate to discuss the dissertation and suggest revisions. After this review period, with majority approval by the committee, the candidate may schedule the dissertation defense. In the event that the candidate does not receive approval to schedule the public defense, the committee must make further suggestions to the candidate and set up a follow up meeting.

#### *Two weeks prior to the defense:*

- Contact the Graduate Program Specialist to schedule the room and provide you with a template for your announcement with abstract

- Submit announcement with abstract by email to the Graduate Program Specialist for distribution and advertising
- Email a draft of the dissertation (pdf format) to the Graduate Program Specialist

***Two weeks prior to the Graduate School deadline for Thesis & Dissertation Submission***

- The final examination/defense should be conducted at least two weeks prior to the Graduate School thesis/dissertation submission deadline to allow for unexpected delays.

*If circumstances prevent a student from meeting department deadlines, the Graduate Program Specialist should be informed by the student's advisor so that steps may be taken to ensure that the Graduate School deadlines and requirements are met for the intended graduation term.*

**Procedure:** 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. The presentation is concluded with a public question and answer period, which is followed by a closed session where the committee members will decide whether to accept or reject the dissertation.

**On the day of the defense:** The student's advisor is required to pick up the student file from the mechanical engineering office. Student files are not released to students. The student also may choose to bring the completed Thesis/Dissertation Submission Form to the defense as a matter of convenience, however, the committee reserves the right to withhold signatures until they have seen the final dissertation. This form must also be signed by the department head.

**Results:** If the dissertation is accepted the committee members will sign under the "pass" section on the **GS24 form**. If the dissertation is rejected, the committee will sign under the "fail" section, make recommendations that the student must complete in a given length of time, and may or may not schedule a second defense, noting the requirements on the form. Regardless of the results, the student is required to obtain the department head's signature on the original **GS24** form and submit a copy to the Graduate Program Specialist. The advisor is required to return the student file to the Graduate Program Specialist.

***The signed original of the GS24 form must be delivered in person by the student to the Graduate School within 2 days following the examination.***

**Survey of Earned Doctorates:** PhD graduates must complete the Survey of Earned Doctorates (<https://graduateschool.colostate.edu/current-students/steps-to-your-phd-degree/>)

**Thesis Submission:** The student submits the Thesis/Dissertation Submission Form (**GS30**) to the Graduate School, after which the Graduate School provides directions for electronic submission. Directions may also be found at: <https://graduateschool.colostate.edu/current-students/steps-to-your-phd-degree/>

**Clearance to Graduate:** In addition to submission to the Graduate School, the final dissertation also must be emailed (pdf preferred) to the Graduate Program Specialist for archiving before the student will be cleared for graduation (**GS25B form**) by the department. Graduating students also should check their "Graduate Degree Plan" in RAMweb for discrepancies or comments. Any issues found there must be resolved before the student will be cleared for graduation by the Graduate School.

## Contact Information

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