

The PhD Student Handbook

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1. REQUIREMENTS FOR THE PH.D. DEGREE IN AEROSPACE AND MECHANICAL ENGINEERING PROGRAMS

1.1. General Requirements for the Doctor of Philosophy

All Ph.D. students are subject to both the Viterbi School of Engineering rules and requirements described in the Ph.D. Student Handbook as well as the University of Southern California's catalogue (<https://catalogue.usc.edu/>). This information supplements and sometimes repeats information contained in the University Catalogue. In case of conflict between documents the University Catalogue always takes precedence. It is expected that all Ph.D. students familiarize themselves with these rules and policies and abide by them.

This degree is granted under the jurisdiction of the USC Graduate School. Students should also refer to the **Requirements for Graduation** section and the **Graduate School** section of the University Catalogue for general regulations. All courses applied toward the degree must be courses accepted by the Graduate School.

1.2. Course Requirements

Satisfactory completion of at least 60 units of approved graduate-level coursework beyond baccalaureate, with a cumulative grade point average of at least 3.0 is required of all Ph.D. students per university requirements. The 60-unit minimum includes research courses (590, 690, 790) and four units of 794ab Doctoral Dissertation. Ph.D. students in the AME department typically take at least 45 lecture units, i.e. regular, non-research courses. Students with a completed graduate degree from an accredited institution, e.g. an M.S. degree, can be admitted to a Ph.D. Program with Advanced Standing. For such students, a minimum of 36 units of coursework beyond that graduate degree, exclusive of 794 Doctoral Dissertation, will be required for the degree. The number of units taken at USC can be reduced by transferring graduate credits from another institution. Transfer units are subject to approval by the Degree Progress Department and by International Admission (for course-work taken at institutions outside the U.S.) and must be approved for subject credit by the faculty advisor.

In preparation for the screening exam, AME 525 and 526 are required. Every semester throughout the PhD curriculum, students must confer with their advisors and must obtain written consent for each course that they register for. Students work with their faculty advisor to take courses for their major and minor for the screening exam. Faculty advisors may request students take specific elective courses.

1.3. Enrollment Status

All Ph.D. students are required to be enrolled in coursework counting towards their degree every Fall and Spring term, from the beginning through the end of the Ph.D. Summer enrollment is not required with the exception of students admitted in the summer semester.

Ph.D. students are required to be enrolled full-time, which is six (6) units of degree applicable coursework during each Fall and Spring semester. The 794 series Doctoral Dissertation and GRSC 800 Studies for the Qualifying Exam fulfill this full-time requirement. Upon passing the qualifying exam, the student must enroll in the 794 series continuously until the dissertation has been successfully uploaded. Failure to remain in continuous enrollment may result in the delay of the degree. International PhD students may have additional requirements to satisfy the conditions of their visa. To ensure that they are in compliance with the F1/J1 visa rules, international students should consult the Office of International Services (OIS).

Courses must be taken for a letter grade with the exception of the directed research courses, ENGR 596 and the 794 series which may be taken for credit/no credit.

1.4. Course Load

Ph.D. students typically enroll in 6-12 units per semester. 6 units is considered full-time for Ph.D. students. After passing the qualifying exam, students must enroll in AME 794; this course fulfills the full-time requirement.

Work with your faculty advisor to identify appropriate courses each semester. If you and your faculty advisor wish for you to exceed 12 units, a justification statement from the faculty advisor must be submitted to the academic advisor for AME Ph.D. programs.

1.5. Faculty Advisor and Guidance Committee

Ph.D. students must have a faculty member as their research advisor. The faculty advisor oversees and approves the selection of the research topic, appropriate course-work, monitors progress toward meeting degree requirements and approves when a student is ready for his or her qualifying exam and defense. Students are encouraged to select their primary advisor who will chair the guidance committee as early as possible within the first semester. Having a Ph.D. advisor is critical for the student's success. The advisor assists in the selection of the research topic, appropriate course-work, and monitors progress toward meeting degree requirements.

Students identify 1-3 prospective faculty advisors through the admission process. During the first semester, students should identify their primary advisor. Students can petition to change their advisor after the first semester in the Ph.D. by mutual agreement of the student and new faculty advisor.

The Ph.D. student's program of study is additionally supervised by the guidance committee, consisting of five tenured or tenure-track USC faculty, three of whom must be from the major department, at least one of whom must be tenured, and an outside member from a different Ph.D. granting department at USC. It may be reduced to a three-member committee, also as described below, subsequent to the student passing their qualifying exam. This committee as constituted following the student passing their qualifying exam will serve to supervise the dissertation defense.

1.6. Screening Procedure

The initial admission decision admitting a student to the Ph.D. program is based on the student's previous academic records, Graduate Record Examination scores, and other evidence of scholastic abilities indicating promise for completing graduate studies. It is also a prerequisite that all Ph.D. students successfully complete the screening procedures designated by the department and described separately below. Students who fail the screening procedure will be advised that they are not recommended to continue in the Ph.D. program and that any additional work may not be counted toward the degree. The screening examination memo with additional details can be found below.

1.7. Qualifying Examination

To be eligible to take the qualifying examination, the student must have completed at least 24 units toward a degree in residence at USC with a cumulative GPA of 3.0. The Request to take the Qualifying Examination must be filed in the semester prior to taking the examination and *at least 30 days before beginning the examination*. The examination, administered by the guidance committee, is intended to determine the extent of the student's knowledge in basic science and engineering areas as well as the ability to do original and scholarly research. The committee examines the candidate's overall scholarly ability as well as the ability to complete the proposed research together with its originality and potential for archival publication. The examination may be scheduled at any time during the semester provided that all members of the committee are available to administer them. All portions of the examination must be completed within 60 days. *The format of the qualifying exam in the Department of Aerospace and Mechanical Engineering is described separately below.*

After passing the qualifying examinations the Ph.D. student is admitted to candidacy by the Dean of Graduate Studies and the guidance committee become the dissertation

committee. The dissertation committee may be reduced to three members, with at least one member being a tenured faculty member in the student's home department, and one must be an outside member from a different Ph.D. granting department at USC. After this step, students will normally engage in at least one year of full-time graduate study and research on campus. *Following the admission to candidacy continuous enrollment in AME 794 (a, b, c, d, z) is required in subsequent semesters. AME 794 a and b are required minimum.*

1.8. Doctoral Dissertation

An acceptable dissertation based on original investigation and supervised directly by the dissertation committee is required. The dissertation must show mastery of a special field, capacity for independent research, and a scholarly result. Candidates are expected to keep all members of the dissertation committee informed of their progress at all stages of the dissertation. The department offers opportunities for research experience in a variety of areas, representing state-of-the-art activity in the frontiers of science and engineering.

1.9. Defense of the Dissertation

After satisfactorily meeting all other requirements and after the research and writing of the dissertation are substantially complete, the Ph.D. candidate must pass a general final oral examination devoted to the major field and to the topic of the dissertation. The examination will be conducted in such a manner as to determine to the satisfaction of the dissertation committee that the candidate has attained the stage of scholarly advancement and power of investigation demanded by the University for final recommendation to the doctorate. In Aerospace and Mechanical Engineering, the dissertation defense has a form of a technical seminar open to the general university community, followed by a closed examination. Only members of the dissertation committee have the authority to recommend the acceptance of the dissertation. The recommendation must be unanimous and all members of the committee must be present during the oral defense.

If the defense is satisfactory, the committee will approve the defense through the Thesis Center; if additional work is required, the committee may postpone this approval until the additional work is completed to the satisfaction of the committee. *Ph.D. students must also adhere to the upload instructions, deadlines, and guidelines set forth by the USC Graduate School through the Thesis Center.*

2. THE Ph.D. SCREENING EXAMINATION REQUIREMENTS FOR STUDENTS WHO ENTERED PRIOR TO SUMMER 2021

Students who started the program prior to summer 2021 must complete the exam in the format outlined below January 2022.

The screening exam is one component of the overall screening procedure that involves each student's complete academic/research record. The faculty of the Aerospace and Mechanical Engineering Department have approved the following format of the AME PhD Screening Exam:

- 2.1. **Structure of the examination:** The examination will be organized as follows:
 - a. All students will take the written part of the examination.
 - b. After examining the results of the written part of the examination, the faculty will determine whether an oral examination needs to be administered to each student.
- 2.2. **Frequency of the examination:** The examination will be offered once a year in January. If an oral examination is required, it will be administered no later than two weeks after the results of the written part were discussed by the faculty.
- 2.3. **Written part of the examination**
 - a. *Format*

The examination will consist of the following categories

 - i. Applied Mathematics - Two (2) problems
 - ii. Major area - Three (3) problems
 - iii. Minor area - Two (2) problems
 - iv. The examination will be closed book.
 - v. Calculators are allowed, but other electronic devices are not permitted
 - b. *Structure:*
 - i. *Applied Mathematics:* There will be two (2) problems and both of them must be solved. The student must be prepared to answer problems in each of these three topics: Linear Algebra, Complex Analysis and Partial Differential Equations.
 - ii. *Major and Minor Areas:* In each of these parts there will be three problems covering the various topics of the area.

c. Length of the examination: The examination will be divided into two parts given in the morning and afternoon of the same day. One part will consist of Applied Mathematics and will last one and a half (1.5) hours. The second part will include the Major and Minor areas and will last three and a half (3.5) hours.

d. Grading and evaluation of results: Evaluation of the results will be performed in three stages.

- i. The problems will be graded by the corresponding faculty.
- ii. Faculty will meet and decide whether the student passed or failed an area.
- iii. The faculty will then determine whether the student needs to take an oral examination.

2.4. Oral part of the examination

a. Composition of the committee: A committee will be formed for each student and will include three faculty in the student's major area of research.

b. Evaluation of results: The oral examination committee will write its recommendations and a decision will be made at a faculty meeting whether the student passed the screening examination. A Pass/Fail decision will be made for each student at the AME faculty meeting. The general policy is that the screening exam can be taken only once. Individual exceptions to this policy may be approved by the faculty on the basis of other significant indicators, such as, for example, research potential.

2.5. At the time of registration. A Sample copy of a past exam will be posted on the AME web page. At the time of registration, a student must:

- a.** Be admitted to the AME PhD Program, with all conditions cleared in case of a conditional admission;
- b.** Have completed at least 9 units of graduate work (taken for a letter grade) in AME;
- c.** Have completed no more than 36 units of graduate work in AME including research courses, as per AME graduate student handbook;
- d.** Have a cumulative GPA of 3.25 or greater in the AME Graduate Program;
- e.** Declare his/her major and minor in which he/she wishes to be examined;
- f.** Provide evidence that an AME faculty member has agreed to serve as his/her Ph.D. advisor.

2.6. Applied Mathematics, major and minor areas. To facilitate preparation, the material covered in the screening exam, for some research areas, is identified below by a relevant

AME course number and a typical textbook and/or names of the AME faculty members, who may be contacted for further information.

1. **Applied Mathematics** (Profs. *Newton*, Kanso, Newton, Pahlevan, Sadhal, Udwadia)
 - i. Complex Variables
AME 525, Text: “Complex Variables and Applications” by Churchill and Brown.
 - ii. Linear Algebra
AME 525, Text: “Linear Algebra” by Shilov.
 - iii. Differential Equations
AME 526

2. **Combustion** (Profs. *Egolfopoulos*, Pantano-Rubino, Ronney)
AME 513a/b, Texts: “Combustion” by I. Glassman; “An Introduction to Combustion” by S. Turns.

3. **Control Theory** (Profs. *Flashner*, Perez-Arancibia)
AME 451, Text: “Modern Control Systems” by R. C. Dorf and R. H. Bishop.
AME 541, Text: “Linear Systems and Theory” by C.-T. Chen. (*or EE 585 if taken fall 2021*)
AME 552, Text: “Nonlinear Systems” by H. Khalil.

4. **Design** (Prof. Jin)
AME 410
AME 503
AME 505 (*or AME 508 if taken fall 2022*)

5. **Dynamics and Vibrations** (Profs. *Udwadia*, Yang)
AME 420
AME 521 (*or CE 541 if taken fall 2021*)
AME 524

6. **Elasticity and Solid Mechanics** (Profs. *Safadi*, Oberai, Plucinsky)
AME 403
AME 506
AME 509

7. **Fluid Dynamics** (Profs. *Luhar*, Bermejo-Moreno, Domaradzki, Newton, Pantano-Rubino, Uranga)
AME 530a
AME 511
AME 535a

8. **Heat Transfer** (Dr. *Sadhal*)
AME 515 Advanced Heat and Mass Diffusion

AME 516 Convection Processes
AME 517 Radiation Heat Transfer

9. **Materials** (Profs. *Hodge*, Balakrishna, Kassner)

MASC 551
AME 560
AME 562

10. **Medical Engineering** (Profs. *Newton*, Oberai, Pahlevan, Sadhal)

AME 536
AME 516
AME 508
AME 416

11. **Advanced Manufacturing** (Prof. Gupta)

AME 547 Manufacturing Automation
AME 554 Additive Manufacturing Technologies
ISE 511L (*or AME 546 if taken spring 2022*)

3. THE Ph.D. SCREENING EXAMINATION REQUIREMENTS FOR STUDENTS WHO ENTERED SUMMER 2021 and LATER

3.1 PhD Screening Procedure

The PhD screening procedure will comprise an *oral exam* in the student's chosen *major* area as well as an evaluation of the student's academic performance and research record. Students admitted to the AME PhD program will typically undergo the screening process at the end of their first full academic year. Academic and research performance will be used to determine whether the student is eligible to sit the oral exam. The outcome of the oral screening exam will then be used to determine whether a student remains in the AME PhD program. If a student does not meet the eligibility requirements or fails the oral exam, they may request to be transferred to the MS program. A standing *Screening Exam Committee* comprising 3 full-time AME faculty members will be responsible for administering this process.

The following sections describe the eligibility requirements, oral exam structure and decision-making process. A listing of potential major and minor areas is provided at the end.

3.2 Eligibility Requirements

To be eligible for the oral exam, the student must:

- a. Be admitted to the AME PhD Program, with all conditions cleared in case of a conditional admission;

- b. Declare their major and minor areas;
- c. Have an AME faculty member who has agreed to serve as PhD advisor;
- d. Have completed at least 18 units of graduate coursework taken for a letter grade in AME at USC, comprising the following courses:
 - i. **Two *applied mathematics* courses, AME 525 and AME 526,**
 - ii. **Two courses in the chosen *major area*,**
 - iii. **One course in the chosen *minor area*;**
- e. Have completed no more than 3 semesters in the AME PhD program, and for a retake no more than 4 semesters;
- f. Have a GPA of 3.50 or greater in the AME graduate program AND a grade of A- or better in the *applied mathematics* courses.

Students with a GPA of less than 3.25 in the AME graduate program OR grades *B* or lower in the *applied mathematics* coursework will NOT be eligible to take the oral screening exam. Such students may request to be transferred to the MS program.

3.3 Special Cases

For students with GPA between 3.25 and 3.50 OR grades of *B+* in the *applied mathematics* coursework, eligibility decisions will be made on a case-by-case basis. These decisions will be based on a holistic evaluation of research and coursework performance, considering any special circumstances. The *Screening Exam Committee* will make eligibility decisions in such cases.

3.4 Substituting AME 525 and/or AME 526

Students who are granted a waiver for AME 525 or AME 526 must take a written test in the waived applied mathematics course(s) and obtain A- or better to be eligible for the screening exam. The written test will coincide with the final exam of the waived course. Only equivalent graduate-level courses can be considered for requests to waive AME 525/526 for the purposes of satisfying the screening exam eligibility requirements.

Approval from the PhD advisor and the Screening Exam Committee is required.

- i. Follow the procedure to transfer a graduate-level course to USC as outlined by the USC registrar.
- ii. Request the support of your faculty advisor, who will confirm support by emailing the Ph.D. staff advisor.
- iii. Submit the course transcript and brief statement outlining your rationale to the Ph.D. staff advisor.
- iv. Students with an AME 525 or 526 exemption *do not qualify for a unit reduction* prior to taking the screening exam (i.e. students must complete at least 18 units of graduate coursework taken for a letter grade in AME at USC, see eligibility requirements above).

3.5 Oral Exam - Timing and Administration

The oral exam will take place in the summer immediately after the student's 1st year in the AME PhD program. Any potential retakes will occur early in the following fall semester. The standing 3-member *Screening Exam Committee* will be responsible for administering the oral exam. This includes evaluating student eligibility, appointing the *Student Committee*, and communicating these decisions to AME faculty.

The *Student Committee* will comprise the student's potential PhD advisor and two additional full-time faculty members in the AME department. The *Screening Exam Committee* may seek input from the potential PhD advisor on the composition of this committee.

3.6 Oral Exam - Format

The oral exam will focus on the student's chosen *Major* area. The exam will be directed by the 3-member *Student Committee*. The specific format of the exam is at the discretion of the *Student Committee*. Sample exam tasks may include but are not limited to:

- Analytical problems similar to homework, quiz, or exam questions in the major area coursework,
- Major-related coding tasks or design challenges, or
- Presentations reviewing relevant literature.

The *Student Committee* will ensure that the student has sufficient time to prepare for and complete the assigned task. For example, the student may be allowed 30 minutes to prepare for analytical problems or 1-3 days for coding tasks, design challenges, or paper reviews. The student will be notified of these expectations at least one week before the scheduled oral exam. At the time of the oral exam, the student will be allowed 30 minutes to present their work with an additional 30 minutes for Q&A, though these are guidelines rather than strict limits.

3.7 Decisions

The *Student Committee* will make a pass/fail/retake recommendation based on the student's performance in the oral exam. The recommendation from the *Student Committee* will be considered advisory to the *Screening Exam Committee*. The *Screening Exam Committee* will be responsible for making pass/fail/retake decisions and communicating these decisions to the AME faculty at a dedicated faculty meeting.

Students who pass the oral exam will be allowed to continue in the PhD program. Students who fail the oral screening exam may request to be transferred to the MS program. Students who are offered the opportunity to retake the oral screening exam must do so in the following fall semester at a time determined by the *Student Committee*. No more than one retake will be permitted.

Students who are determined to have failed the screening exam by the *Screening Exam Committee* may request reevaluation by the full AME faculty, if such a request is supported by a potential PhD advisor. Decisions made by the AME faculty will be final.

3.8 Major and Minor Areas

1. **Combustion** (Profs. *Egolfopoulos*, *Pantano-Rubino*, *Ronney*)
AME 513a/b, Texts: “Combustion” by I. Glassman; “An Introduction to Combustion” by S. Turns.
2. **Control Theory** (Profs. *Flashner*, *Perez-Arancibia*)
AME 451, Text: “Modern Control Systems” by R. C. Dorf and R. H. Bishop.
AME 541, Text: “Linear Systems and Theory” by C.-T. Chen. (*or EE 585 if taken fall 2021*)
AME 552, Text: “Nonlinear Systems” by H. Khalil.
3. **Design** (Prof. *Jim*)
AME 410
AME 503
AME 505 (*or AME 508 if taken fall 2022*)
3. **Dynamics and Vibrations** (Profs. *Udwadia*, *Yang*)
AME 420
AME 521 (*or CE 541 if taken fall 2021*)
AME 524
5. **Elasticity and Solid Mechanics** (Profs. *Safadi*, *Oberai*, *Plucinsky*)
AME 403
AME 506
AME 509
6. **Fluid Dynamics** (Profs. *Luhar*, *Bermejo-Moreno*, *Domaradzki*, *Newton*, *Pantano-Rubino*, *Uranga*)
AME 530a
AME 511
AME 535a
7. **Heat Transfer** (Dr. *Sadhal*)
AME 515 Advanced Heat and Mass Diffusion
AME 516 Thermal and Biological Transport Phenomena
AME 517 Radiation Heat Transfer
8. **Materials** (Profs. *Hodge*, *Balakrishna*, *Kassner*)
MASC 551

AME 560

AME 562

9. **Medical Engineering** (Profs. *Newton*, Oberai, Pahlevan, Sadhal)

AME 536

AME 516

AME 508

AME 416

10. **Advanced Manufacturing** (Prof. Gupta)

AME 547 Foundations for Manufacturing Automation

AME 554 Additive Manufacturing Technologies

AME 504L Mechatronic Systems Engineering

4. THE PH.D. QUALIFYING EXAMINATION

It is expected that the Qualifying Exam will be taken no later than one semester following completion of graduate courses or after the completion of 60 units of graduate work, whichever comes first. All portions of the examination must be completed within 60 days.

The written portion of the examination consists of a research proposal and literature search on a topic chosen by the graduate student with the agreement of the potential Ph.D. advisor. The subject of the proposal may or may not be the same as the topic of the Ph.D. dissertation. It is suggested that the student aim at producing a report consisting of 30–50 pages of standard-sized typing, including figures. The typed document should include:

- a. a statement of the problem under consideration;
- b. a critical survey of the literature;
- c. the research goals of the project;
- d. research plan;
- e. discussion of preliminary results (if applicable).

The student is expected to write the report independently with the minimal input from the advisor. The typed document will be given to the members of the guidance committee at least one week before the scheduled date of the oral examination.

The oral portion of the Ph.D. Qualifying Examination consists of a formal defense of the written report in the presence of the guidance committee. The candidate first makes an oral presentation with appropriate visual aids (slides, viewgraphs, etc.). It is recommended that the candidate plan for a 30–40 minute presentation emphasizing a clear definition of the problem, pertinent related contributions from the literature, proposed problem area to be researched, and proposed approaches to be used in the research. The candidate should give careful attention to the formulation of the research problem and to the scientific bases which motivate various choices underlying the research plan. The presentation is followed by a discussion and question period on the topic of the proposal conducted by the members of the guidance committee. The discussion is aimed at assessing the ability of the candidate to do original research work and to think critically about the implication of results. It is not a defense of a significant fraction of the dissertation research. In the course of the discussion, members of the guidance committee may also choose to test the student’s knowledge in his/her major area of research interest. The guidance committee may choose, in individual cases and based on perceived weaknesses in the student’s performance, to conduct an oral examination testing mainly the student’s knowledge of fundamentals.

5. PROGRESS REVIEW

Each academic department in the Viterbi School of Engineering will conduct a review of each PhD student twice per year: once in the spring semester and another time in the fall. Students are asked to submit detailed information through the PhD progress system as specified by the department. Students are expected to meet with their faculty advisor(s) to discuss their progress as well as go over their future research and academic plans. Students are expected to continue to meet the deliverables as outlined through the PhD program progress each semester. Failure to do so can lead to dismissal. Students who do not complete the progress review by the deadline will have a registration hold placed on their account, preventing course registration in the upcoming term.

6. ACADEMIC WARNING AND DISMISSAL

Faculty advisers and departments take factors other than satisfactory grades and adequate GPAs into consideration in determining a student's qualifications for an advanced degree. A student's overall academic performance, research progress, specific skills and aptitudes, and faculty evaluations will be considered in departmental or program decisions regarding a student's

continuation in a doctoral degree program. Students must not exceed 1 semester without a faculty advisor.

Students who fail to meet these criteria will be informed by their department chair, program director, committee chair or school dean. After being informed, the student will have 1 semester to rectify their deficiencies. After this probationary period, the faculty has the right to recommend that a student be dismissed from the AME Ph.D. program or be denied readmission to the program.

Additionally, the AME Department can recommend dismissal if a student does not meet satisfactory departmental milestones including passing the screening examination or qualifying examination.