

Handbook for Students & Faculty

MIT/WHOI Joint Program in Applied Ocean Science and Engineering

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Introduction to the Joint Program

The Massachusetts Institute of Technology (MIT) and the Woods Hole Oceanographic Institution (WHOI) entered into a cooperative agreement in 1968 to offer graduate degrees in oceanography and oceanographic engineering. Since then, the MIT/WHOI Joint Program has become one of the premier marine science programs in the world. Students admitted to the MIT/WHOI Joint Program in Oceanography and Applied Ocean Science and Engineering not only have access to the faculty and staff of both institutions but also to their extensive facilities. Committees made up of faculty from both institutions make all decisions of substance, from admissions to degree granting. The joint degrees awarded are single documents issued by both institutions.

Experts in their fields instruct students using personal research and field studies to support graduate education in ocean sciences and oceanographic engineering. Research interests of the faculties encompass a wide range of theoretical, modeling, observational, and experimental approaches to understanding the oceans.

The Joint Program is organized within five disciplinary areas, each administered by a Joint Committee consisting of MIT and WHOI faculty: Biological Oceanography, Chemical Oceanography, Marine Geology and Geophysics, Physical Oceanography, and Applied Ocean Science and Engineering (AOSE). The Joint Committee associated with each discipline provides guidance as to the course of study for incoming students who have strong interests in that focal area. Many applicants have interests, academic background, and experience that are appropriate for one of these disciplines and they will be admitted to pursue their degree in that area. Some incoming students will have, or develop, interests that span two or more disciplines. While students will be admitted to the discipline that is most appropriate for their preparation and stated interests, the Joint Program leadership works to support and accommodate students with interdisciplinary interests, for example by involving faculty and scientists from different disciplines on the student's thesis committee. This ensures that the student has a well-defined 'home' within the Joint Program, while still being able to pursue interdisciplinary interests. The goal of the MIT/WHOI Joint Program is for each student to achieve their full intellectual potential in their chosen area of study and research, either within the more traditional disciplines of ocean sciences and engineering or within interdisciplinary studies incorporating two or more disciplines.

The Joint Program in Applied Ocean Science and Engineering

The MIT/WHOI Joint Program in Applied Ocean Science and Engineering (JPAOSE) offers graduate students the opportunity to plan an exciting career that combines basic research on a

wide range of oceanic processes with applied research and engineering. Students are given the chance to select individual paths combining skills from mathematics, physics, and engineering disciplines with oceanography.

The educational opportunities in the JPAOSE are unparalleled in breadth and depth. Faculty members from four MIT engineering departments — Aeronautics and Astronautics (AeroAstro), Civil and Environmental Engineering (CEE), Electrical Engineering and Computer Science (EECS), and Mechanical Engineering (ME)— and five WHOI departments – Applied Ocean Physics and Engineering (AOPE), Biology, Marine Chemistry and Geochemistry, Geology and Geophysics, and Physical Oceanography – combine to make up the Joint Program discipline of AOSE. Students entering the JPAOSE are enrolled at MIT through one of the four engineering departments, called the “home” MIT department, which is chosen by the student during the application process. At WHOI, the Department of Applied Ocean Physics and Engineering is the “home” WHOI department. Regardless of which MIT department is the home department, the primary research advisor can be in any one of the five WHOI departments or any one of the four MIT engineering departments.

Unlike the other four disciplines that make up the Joint Program, students in AOSE must satisfy all the degree requirements of their home MIT department, as well some additional Joint Program requirements. Most students enter the JPAOSE with a Ph.D. (or Sc.D., which differ only in name) as their ultimate goal. Depending on the home MIT engineering department, the Master of Engineering, Master of Science, and Engineer degree may also be obtained. In fact, students admitted through the AeroAstro and EECS departments must first complete all the requirements for a master’s degree, including writing a master’s thesis, before being formally admitted to the doctoral program in those departments. The JPAOSE also houses the Navy Master’s program. All Navy students enter through the MIT ME Department.

Though the exact requirements for the doctoral program depend on the “home” MIT department, typically, the doctoral program in AOSE is made up of approximately two years of graduate-level course work, mostly comprised of classes offered at MIT. Most students in AOSE spend their first 3-4 full semesters (not counting summers) based at MIT to complete their course work. The MIT engineering departments require that doctoral students take a general or qualifying examination by the end of their 3rd or 4th full semester, depending on the department. These examinations test their preparation to go forward with thesis research. When passed, the student will then present a proposal of thesis research, normally about six months after their qualifying exam, and typically before the end of their third academic year in the program. From there, the students will then focus on their thesis research, which requires another two to three years. Typically, upon completion of the qualifying examination, AOSE students are based at the institution where their primary research advisor is based.

Advisors and Committees

As students in JPAOSE proceed towards their degree, they will interact principally with their research advisor, their academic advisor, and with two committees, their Thesis Committee and the Joint Committee on Applied Ocean Science and Engineering (JCAOSE).

Research Advisor

Research advisors, also referred to as thesis advisors, are given broad responsibilities concerning the overall academic and research progress of students. The primary responsibilities include guiding the student's academic program, securing financial support for the student, helping to define the student's research, and acting as the student's advocate.

Generally, a student is matched with a research advisor prior to their arrival in the Joint Program. Any MIT faculty¹ member in any of the MIT departments participating in the MIT/WHOI Joint Program or any member of the WHOI faculty² can serve as a primary research advisor for a student in AOSE. Many MIT departments also allow Senior Research Scientists/Engineers/Associates (S/E/A) to advise students³. Faculty from outside of WHOI or MIT can serve as a research advisor only under exceptional circumstances, with permission from JCAOSE and the home MIT department, and with an MIT and/or WHOI co-advisor.

It is essential that students and advisors set up a schedule for regular interaction. Student progress should be reported as requested by the AOSE joint committee and the home MIT department, including annual submission of the student/advisor report on student progress. Results of meetings and examinations where decisions are made affecting the student's graduate career, as well as any documents/forms required by the student's home MIT department, should be documented in writing and sent to JCAOSE, the AOSE Education Coordinator, the MIT Joint Program Office, and the WHOI Academic Program Office.

Upon arrival in the JP, every student and advisor should meet and review the student/advisor expectations and responsibilities guidelines provided on the JP web site (and attached to this handbook in Appendix A). Students are strongly encouraged to interact with research groups at both MIT and WHOI during their graduate careers. All students are expected to attend and participate in lab meetings and research seminars of the research groups to which they belong.

¹ MIT Faculty members, as defined in *Policies and Procedures*, include only Professors, Associate Professors, and Assistant Professors.

² WHOI faculty refers to any member of the WHOI Education Assembly, which includes members of the Scientific Staff and Senior Technical/Engineering Staff.

³ In this handbook, "MIT faculty" is used loosely and as a catch-all term meaning all the MIT faculty as defined in MIT's *Policies and Procedures*, and all other associated personnel allowed to participate in the graduate program by MIT, which may be different in different MIT departments.

Academic Advisor

Every JPAOSE student will be assigned an MIT academic advisor, distinct from their research advisor, in their home MIT department. The academic advisor will sign registration forms each semester and will check that the student is aware of and is meeting milestones such as taking qualifying exams and fulfilling MIT departmental course requirements. In addition, the MIT academic advisor may be a valuable resource for helping a student with course selection. Students may request an academic advisor by writing to the JCAOSE. The MIT academic advisor should be assigned/approved prior to the start of the first full semester at MIT. If the academic advisor changes for any reason, the student is responsible for requesting approval from the JCAOSE in a timely fashion.

The Joint Committee for Applied Ocean Science and Engineering (JCAOSE)

The Joint Committee on Applied Ocean Science and Engineering (JCAOSE) is responsible for overseeing all aspects of the AOSE graduate program, including the following:

- Appointing/approving each student's academic advisors.
- Reviewing the progress of each student in the joint program annually and more frequently if required.
- Approving the student's proposed thesis committee and thesis defense chair.
- Recommending to the deans of the joint program, on the basis of the thesis defense, whether the doctoral degree should be conferred on the student.
- Reviewing petitions and otherwise deciding on the student's continued enrollment and financial support in the joint program based upon the student's demonstrated progress.

The members of JCAOSE are appointed from the MIT and the WHOI faculty. Typically there are at least three MIT faculty members and three WHOI faculty members on the AOSE joint committee, including the AOPE Education Coordinator. Every attempt is made to have at least one faculty member from each of the MIT engineering departments involved in the Joint Program. Appointments are made by the Director of the Joint Program at MIT upon recommendation of the Department Head for faculty of the appropriate MIT department, and by the Vice President for Academic Programs and Dean at WHOI for members of the WHOI Education Assembly, upon the recommendation of the chair of the appropriate WHOI department. The chair of the JCAOSE serves a three year term and the chair position typically alternates between an MIT and WHOI faculty member. The chair of JCAOSE has executive authority on all decisions, requests, and petitions, at his or her discretion, after considering advice from the entire JCAOSE committee.

Thesis Committee

Every AOSE student must form a thesis committee before the end of his or her third year in the Joint Program. Different MIT departments have slightly different rules regarding the makeup of

the thesis committee. However, the following guidelines incorporate both MIT and Joint Program requirements, and should be adhered to by all JCAOSE students:

1. There must be a minimum of three members on a thesis committee, and members of the thesis committee should be selected by the student in consultation with the student's research advisor. The student's research advisor is one of the members of the thesis committee.
2. Many thesis committees have five or six members. However, thesis committees with more than six members can become unwieldy and committee meetings difficult to arrange, and are discouraged.
3. Every thesis committee should have at least one member from the WHOI faculty.
4. Every thesis committee should have at least one member from the home MIT department faculty.
5. In addition:
 - a. MIT AeroAstro requires that two members of every thesis committee be MIT faculty (not necessarily AeroAstro).
 - b. MIT CEE requires that two members of every thesis committee be CEE faculty members, but may wave this requirement on a case-by-case basis for JPAOSE students. Petitions should be sent to JCAOSE and CEE.
 - c. MIT EECS requires that two members of every thesis committee be EECS faculty members.
 - d. MIT ME typically requires that there be three MIT faculty members on every thesis committee, including two ME faculty members. However, ME typically waves this requirement on a case-by-case basis for JPAOSE students. Petitions should be sent to JCAOSE and ME.
6. Chair of the thesis committee:
 - a. MIT AeroAstro: The chair of the thesis committee must be an AeroAstro faculty member. The chair of the thesis committee is often the research advisor (if the research advisor is in AeroAstro), but does not have to be.
 - b. MIT CEE: The chair of the thesis committee must be a CEE faculty member. The chair of the thesis committee must be distinct from the research advisor.
 - c. MIT EECS and ME: The chair of the thesis committee is typically the research advisor, but does not have to be. The chair of the thesis committee can be either a WHOI faculty member or MIT faculty member from the home MIT department.
7. The academic advisor (an MIT faculty member from the home MIT department) can be a member of the thesis committee and can be the chair of the thesis committee, if it does not conflict with the above requirements.
8. In all cases, the proposed thesis committee must be approved by JCAOSE and the home

MIT department. Any subsequent changes in membership of the thesis committee must be approved by JCAOSE and by the home MIT department.

9. In the event that a student needs longer than three years before forming a thesis committee, the student must petition JCAOSE, in a timely fashion, for approval to remain in the Joint Program until a thesis committee is formed. The petition must contain a timeline for forming the thesis committee and must be endorsed by the thesis/research advisor.

In general, the thesis committee works with the student and the advisor(s) to design a thesis project that can be completed within the expected time frame for obtaining a Ph.D. in the Joint Program. The thesis committee helps to keep the student on track to meet this deadline. In addition, the thesis committee administers the thesis proposal defense and the thesis defense. Frequent meetings with the thesis committee are required, as outlined in subsequent sections of the handbook. In general, logistics for committee meetings (room reservation, contacting committee members, drafting an agenda, etc.) are the responsibility of the student.

Faculty from institutions other than WHOI and MIT may also serve as members of thesis committees. The composition of the committee should reflect the best team available to guide the student in their research, but students should be cautioned that faculty from distant locations may only be able to participate on a more limited basis. The JP will reimburse travel for outside committee members only for the Thesis Proposal Defense and final Thesis Defense. Outside members can participate in committee meetings via videoconference if necessary. Approval of the Dean is required for a committee with more than 2 outside members.

Available Resources

Education Coordinators

The AOSE Education Coordinator is a member of the Department of Applied Ocean Physics and Engineering (AOPE) at WHOI. The role of the education coordinator is to strengthen the quality of the education program within AOPE by serving as a source of information and advice to both students and advisors. The education coordinator is available to talk with students and advisors about any aspect of the education program or the graduate school experience. Students should consider the education coordinator as an informational resource but not a substitute advisor. Specific duties of the education coordinator include providing information on curriculum matters, WHOI and MIT policies and regulations and research funding sources. The education coordinator also acts in cooperation with advisors, the JCAOSE and the APO to help resolve academic or personal problems. Students are encouraged to ask the education coordinator to attend committee meetings throughout their time in the Joint Program.

Academic Programs Office (APO) at WHOI

The Academic Programs Office (APO) at WHOI is responsible for administrative details concerning student registration, stipend support, housing and WHOI-MIT interactions. The APO should be kept informed through copies of all student progress reports, examination notices and results, advisor assignments, and any other documents pertaining to the student's progress in the program. Copies of dissertation proposals should be sent to the APO. The student's official record is kept in the WHOI APO and the MIT department office. The WHOI APO will copy materials and forward them to the appropriate MIT department when necessary. The APO can be reached by phone at (508) 289-2219 or through e-mail at education@whoi.edu.

Joint Program Office at MIT

The MIT Joint Program Office performs functions similar to those performed by to the APO except in the case of stipend support, which for MIT-based students is handled by the appropriate MIT department. The MIT Joint Program Administrator can best direct the student to the appropriate MIT office for any administrative matters (i.e., registration, on-campus or off-campus housing) pertaining to the student's stay on campus. The Joint Program Office can be reached via e-mail at mit-whoi-www@mit.edu.

Individual MIT Engineering Departments Offices

The engineering departments at MIT include Aeronautics and Astronautics, Civil and Environmental Engineering, Electrical Engineering and Computer Sciences, and Mechanical Engineering. MIT department chairs or administrators are available to help students become familiar with departmental requirements or answer questions about the department and its expectations.

Ombuds Office

The Ombuds person acts as a neutral, confidential and informal complaint handler. At WHOI, there is a hotline phone number to call to discuss these issues. The number is 508-566-6736. The MIT Ombuds Office can be reached at 617-253-5921. All discussions are kept in confidence.

Fellow Joint Program Students

Remember that fellow students are going through the same challenges, rigorous course loads and examinations. People who share the same experiences are generally the best ones to turn to for answers or advice. In addition to being a sympathetic ear or a ready source of advice, a fellow student may even bring a new perspective to the subject matter or research methods.

Employee and Student Assistance Program

The Employee and Student Assistance Program, available through the Gosnold Counseling Center, helps students cope with work-related or personal stress. The program is confidential and available at no charge to students. This program is also available to family members of students. Contact phone numbers for appointments or questions are 508-548-7119 or 1-800-649-8115

Consultation

Students are encouraged to talk to people about any difficulties they experience while progressing toward the doctoral degree. The above resources are available for consultation. Individuals initiating an inquiry or complaint will not be reprimanded or discriminated against.

The Doctoral Degree in the Joint Program in Applied Ocean Science and Engineering

Doctoral Degree Requirements

The doctoral program offered through the MIT/WHOI Joint Program in Applied Ocean Science and Engineering requires that the student:

1. Satisfy the requirements imposed by the home MIT department.
2. Complete one summer, fall or spring term of research at Woods Hole within the first five years in the program. Students should obtain course credit through the appropriate course number for the home MIT department. All incoming AOSE students are strongly encouraged to spend their first summer at WHOI, prior to the official start of the first academic year. This first summer at WHOI will serve to fulfill the research semester at WHOI requirement.
3. Complete course 2.688 *Principles of Oceanographic Instrumentation*. This course requirement must be completed by the end of the fourth academic year. This requirement may, under some circumstances, be substituted by an equivalent experience or course by petitioning the JCAOSE for approval. This petition must be received by JCAOSE by the beginning of the fourth academic year.
4. Complete course 12.808 *Introduction to Observational Physical Oceanography*. This requirement must be completed by the end of the fourth academic year. Other classes in Course 12 or Course 7 may be substituted for 12.808 by petitioning the JCAOSE for approval. This petition must be received by JCAOSE by the beginning of the fourth academic year.
5. Participate annually in the AOSE student seminar and annual review process, typically held in mid-summer at WHOI. The exact date is announced in late spring, but is typically the first Wednesday in August.
6. Complete and defend in public a doctoral dissertation with direct application to the ocean or marine environment.
7. Present a seminar at either WHOI or MIT during the same semester as the thesis defense, at the institution where the thesis defense will not be held. Ideally, this seminar will take place about 1-3 weeks in advance of the thesis defense, as it is an importance mechanism for practicing the thesis defense.

Financial Support

The Joint Program is committed to ensuring that each student is funded for their first five years in the program as long as the student maintains good academic standing as determined by the JCAOSE and student's department at MIT. Funding for students is not guaranteed after the end of their fifth year in the program except in extraordinary circumstances. Students are able to receive funding from other sources including external fellowships and appointments such as Research and Teaching Assistants after the end of their fifth year in the program as long as they remain in good academic standing. Guidelines for student obligations and benefits supported by research and teaching assistantships can be found from the MIT Graduate Student's Office at <http://web.mit.edu/gso/>.

If a student was an MIT only graduate student prior to entering the Joint Program, JCAOSE will determine how much, if any, of that student's time as an MIT only graduate student will be counted as time in the Joint Program.

Timeline and Reporting Requirements

JPAOSE students must adhere to timelines established by their home MIT department. In addition, a student must adhere to the following JCAOSE timeline and reporting requirements:

1. Students must submit an annual report and brief presentation of their research for the annual AOSE student seminar and annual review process, typically held in mid-summer (first Wednesday in August) at WHOI. The exact date and location are announced in late spring every year. Advisors must submit an annual evaluation of the student for this review.
2. Students must form a thesis committee and successfully defend a PhD thesis proposal before the end of the third year in the Joint Program. The thesis proposal shall contain a timeline for completion of the student's PhD program and must be submitted to JCAOSE for final approval. In the event that a student needs longer than three years before forming a thesis committee or defending a thesis proposal, the student must petition JCAOSE, in a timely fashion, for approval to remain in the Joint Program until a thesis committee is formed and the thesis proposal is completed and accepted. The petition must contain a timeline for forming the thesis committee and completing the thesis proposal and must be endorsed by the research/thesis advisor.
3. Starting with the summer closest to the end of a student's fourth year in the Joint Program and continuing for each summer after that, the student must submit to the JCAOSE a detailed timeline for the remainder of his or her time in the Joint Program. The timeline shall include major research or thesis milestones and expected dates of completion of all remaining degree requirements and shall be signed by the student's

thesis advisor and all members of the thesis committee. The timeline will be reviewed by the JCAOSE as part of the annual review of student progress and determination of each student's academic standing. JCAOSE shall be notified promptly of any major changes to the timeline.

4. Students are strongly encouraged to complete a doctoral degree in five years overall (including a master's degree). This five year "clock" begins when the student initially enters graduate school at either MIT or the MIT/WHOI joint program. For students applying to the doctoral program from the master's program, the process associated with the doctoral program begins once the student has been approved to take the exam. For these students, the time spent pursuing a master's degree counts in the five year time limit, without exception. The Joint Program does not guarantee funding past five years.
5. If a student expects to require more than six years in the AOSE Joint Program to complete the Ph.D. degree requirements, then four months prior to the end of the student's sixth year in the program, and no later than the last week of Spring term (exam week) in the student's fifth year, he or she must submit to the JCAOSE a request for permission to stay in the program past six years. The request shall be signed by the research advisor and all members of the thesis committee. It shall include a detailed schedule for completing the remaining items necessary for the PhD and a listing of the source(s) of funding for the student. A similar request must be submitted at the end of each subsequent term (summer, fall, and spring) for the remainder of the student's time in the Joint Program.
6. A student will be allowed to continue past the end of his or her seventh year in the Joint Program only in exceptional circumstances. For this to happen, the student must submit to JCAOSE, at least six months before the end of the seventh year in the program, a written request for this approval. The request shall include items listed in (5) as well as an explanation of the reason for the need for the continuation. The request must have the explicit endorsement of each member of the student's thesis committee and thesis advisor. If the request is approved, then JCAOSE will establish additional timeline and reporting requirements to be adhered to by the student and the student's thesis advisor and committee.
7. If at any time the JCAOSE determines that a student is no longer in good academic standing, he or she may be required to leave the Joint Program.

The MIT online Graduate Writing Ability Requirement

All incoming JPAOSE graduate students must demonstrate satisfactory English writing ability, or successfully complete appropriate training in writing. All incoming graduate students, native as well as foreign, must take the MIT online Graduate Writing Ability test (<http://cmsw.mit.edu/graduate-writing-exam/>). Depending on the results, a student will either (a) pass the writing ability requirement, (b) be required to take a relatively short, but intensive, seminar-workshop in expository writing during the first Independent Activities Period (IAP) in January (21W.794 Technical Writing Workshop), or (c) be required to take a course in writing. Several courses suitable for engineers and scientists are offered at MIT, and special courses are available for those for whom English is a second language. Some MIT departments may waive this requirement in lieu of an approved technical writing class.

The MIT English Evaluation Test

All graduate students for whom English has not been the language of instruction in both elementary and secondary school are also required by MIT to take an English Evaluation Test. This test is separate from the graduate writing ability test. All incoming graduate students who were required to submit TOEFL and/or IELTS test scores for admission are required by Institute rules to take the Department of Humanities English Evaluation Test (EET) offered at the end of January and August. Results of the exam are given directly to the student by the EET staff and a copy forwarded to their home MIT department. This test is a proficiency examination designed to indicate areas where deficiencies may still exist and recommend specific language subjects available at MIT.

The Aeronautics and Astronautics Program of Study (AeroAstro - Course 16)

AOSE Joint Program students admitted through the MIT Department of Aeronautics and Astronautics (AeroAstro) pursue a doctoral degree and will be awarded either the Doctor of Philosophy (Ph.D.) or the Doctor of Science (Sc.D.) degree. There is no substantive difference between the two degrees, and the choice of degree name is that of the individual recipient. Doctoral students in the AOSE Joint Program through AeroAstro must complete the requirements of the master's degree program, including the subject requirements and writing a master's thesis, prior to starting their doctoral degree program. For more information refer to the MIT AeroAstro doctoral student guide.

AOSE-AeroAstro Doctoral Degree Requirements and Timeline

The specific requirements for completing a doctoral degree in AOSE-AeroAstro (including the steps specifically required by the Joint Program – highlighted in bold) are:

1. Begin planning the Doctoral Program with the academic and research advisor [Fall Academic Year 1 (AY1)]. **The Joint Program in AOSE strongly encourages new admissions to enroll for the summer term at WHOI prior to starting their first academic year in the Fall.**
2. MIT English Evaluation Test for non-native speakers if not previously satisfied [AY1].
3. MIT Graduate Writing Exam if not previously satisfied [AY1].
4. Complete Field Exam and Research Oral Qualifying Exams within 3 full semester of enrolling in the graduate program [January IAP, AY2].
5. Complete Major Program of study consisting of 5 graduate-level subjects, as approved by the student's thesis committee.
6. Complete Minor Program of study consisting of 3 graduate-level subjects, as approved by the student's thesis committee.
7. 24 math units required.
8. Minimum cumulative 4.4 grade point average.
9. Term-by-term thesis (16THG) registration and progress evaluation.
10. Form Thesis Committee and schedule first meeting within two semesters of being accepted into the doctoral program.
11. Meet with Thesis Committee at least twice a year, ideally once a semester, and update the *Doctoral Program Record* after each meeting.
12. Complete Doctoral Thesis Proposal and Proposal Defense within three regular terms of admission to the doctoral program [by end of AY3].

- 13. The Joint Program in AOSE: Complete items 2-4 of the AOSE requirements listed on page 12 [by end of AY4].**
14. Meet with the Thesis Committee about 8 weeks before the desired thesis defense date to present the content of the thesis and request permission to proceed with scheduling the defense.
- 15. The Joint Program in AOSE: Present a seminar at either WHOI or MIT during the semester of the thesis defense. This seminar should take place at the institution where the thesis defense is not held.**
16. Doctoral Degree earned with satisfactory defense of the Ph.D. thesis and submission of written thesis by due date [AY 5 or 6]. Joint Program students are strongly encouraged to complete their doctoral degree in five years. MIT AeroAstro requires that the thesis defense be completed within four regular semesters of successfully completing the Thesis Proposal Defense.

Administration of the Doctoral Program: AeroAstro Graduate Committee (GradComm)

The AeroAstro Doctoral Program is administered by the AeroAstro Department Graduate Committee (GradComm), in coordination with JCAOSE. All questions regarding application of policy and procedures of the Department's Doctoral Program must be resolved and approved by the GradComm. This includes the scheduling of examinations and of thesis presentations, and the certification that requirements have been satisfactorily completed, in coordination with the JCAOSE. Students are advised to keep the Chair of the GradComm informed of their plans and progress through the Graduate Program administrator, as well as the JCAOSE, the AOSE Education Coordinator, the MIT Joint Program Office and the WHOI APO.

Admission to the Doctoral Program

Admission to the Doctoral Program in AeroAstro is a five step process:

1. Admission to the AeroAstro department's graduate program
2. Passing performance on the Field Exam (FE)
3. Passing performance on the Research Evaluation (RE)
4. Completion of a master's degree, including course work and thesis
5. A faculty review consisting of an examination of the student's achievements including an assessment of the quality of the past research work and evaluation of the student's academic record in light of the performance on the FE and RE.

Field Exam and Research Evaluation

To enter the doctoral program, students must successfully complete the Field Exam (FE) and Research Evaluation (RE) within three regular terms of enrolling in the Graduate Program. The

FE/RE is offered during IAP, each January. For more information see the AeroAstro Doctoral Program Guide. Any student planning on taking the FE/RE must have an endorsement of a person that meets the requirements of a doctoral thesis advisor. In order to be admitted to the FE/RE, the student must attain a minimum cumulative grade point average of 4.4 in technical subjects as a graduate student at MIT.

The FE is solely an oral examination. Each student selects a single field from a list of 11 fields for the FE based upon his/her research interests. Prior to the oral examination, students will be given questions in a written form and allowed to prepare for 60 minutes. Following the preparation period, the oral examination will then be conducted for a period of 45 minutes.

The RE consists of a 20 minute presentation by the student on research they have performed followed by 25 minutes of questions. While a clear and concise presentation is important, the major factor in the RE assessment is the student's ability to respond to questions from the examiners.

AeroAstro Master of Science (SM) Requirements

- English Evaluation Test (for non-native English speakers).
- Technical writing requirement (MIT's online Graduate Writing Skills Exam).
- 12 math units required
- 66 subject units, not including thesis units, in graduate subjects in the candidate's area of technical interest. Classes taken on a pass/fail basis do not count towards degree requirements.
- Within the 66 subject units, a minimum of 21 units from AeroAstro subjects.
- Minimum cumulative grade point average of 4.0.
- Term-by-term thesis (16THG) registration and progress evaluation.
- Acceptable thesis.

Research and 16.THG Requirement

Given the integral role of research in graduate studies and importance of feedback to the student, the department requires that:

- All graduate students must register for 16.THG every semester. The number of credit hours of 16.THG should be appropriate to the student's situation and should be agreed upon by the student and advisor upon registration each semester.
- For the Fall and Spring semesters, a formal research progress evaluation will be conducted between the student and advisor in the process of assigning a grade for 16.THG. Additional information on the 16.THG requirement including advice on determining an appropriate number of credit hours is given in documentation on the department's website.

Graduate Mathematics Requirement

The purpose of the Graduate Mathematics Requirement is to give students exposure to advanced mathematical concepts at the graduate level. A detailed description of this requirement is available on the AeroAstro department's website.

Thesis Committee

In AeroAstro, the student, in consultation with the research advisor, should form a Thesis Committee and schedule a first meeting within 2 full semesters of admission to the doctoral program. The composition of the thesis committee is described on page 8. Students must arrange a meeting of the thesis committee **at least once each term**.

Thesis Committee Meeting Record

The formal log of Thesis Committee meetings is the *Doctoral Program Record Form*. The form includes the names of the members of the Thesis Committee, a list of major and minor subjects, which the student must complete, and a record of important dates and milestones in the candidate's progress toward the degree. It is the responsibility of the candidate to ensure that all important decisions and recommendations of the Thesis Committee, dates of completion of each requirement of the doctoral program and of requirements made by the thesis committee or the department GradComm, be recorded in the *Doctoral Program Record Form* and returned to the MIT Academic Programs Office, with a copy forwarded to the WHOI Academic Programs Office.

Major Program of Study

The student should propose to the thesis committee for its approval a specific set of subjects that will constitute the major program of study for the degree. At a minimum, this program will include at least five graduate subjects in the major field. Subjects taken in the SM program can be counted toward this requirement. Doctoral candidates are normally expected to take their major subjects at MIT.

Minor Program of Study

The Minor Program must consist of a coherent set of related graduate subjects adding up to at least 30 units (typically three courses) in a field of study related to Aeronautics and Astronautics, which is not in the candidate's primary field of study. The aim of the Minor requirement is to broaden the candidate's knowledge and perspective of fields that support the candidate's capabilities as an aerospace engineer. In consultation with his/her Thesis Committee and a Minor Field Advisor, the student proposes a minor field and set of subjects. Only G or H-level courses are acceptable for this requirement and there must be agreement by the Thesis Committee that the minor field is sufficiently different from the major field. The proposed minor field and set of subjects must then be approved by the department's Graduate

Committee. Graduate subjects at MIT are classified as one of two types: G-level and H-level. A G-level subject indicates a subject approved for graduate credit. An H-level subject is a higher-level graduate subject that is an approved subject for a graduate degree.

If distinct from their primary field of study, Joint Program students may incorporate within their minor the two courses listed in the “AOSE Requirements”: 2.688 Principles of Oceanographic Instrument Systems – Sensors and Measurements, and 12.808 Introduction to Observational Physical Oceanography. Refer to this “minor” as a minor in Applied Ocean Science and Engineering. Alternatively, these two courses may be incorporated within the Major Program of Study, if appropriate, and with the approval of the thesis committee.

Minor Field Advisor

The advisor for the Minor field (so-called “minor advisor”) can be any MIT faculty member. The purpose of the minor advisor is to ensure that the minor courses form a coherent whole. The Minor Advisor will typically not be a member of the Thesis Committee unless he/she can also advise in the Major field of study.

Minor Proposal Form

The student submits the *Minor Proposal Form* to the department’s Graduate Committee via the department’s Academic Program staff. This form must be signed by the Minor Advisor signifying that the subjects proposed by the student form a coherent set in the Minor Field. The form must also be signed by the Thesis Committee Chair signifying that the Minor Field is related to aerospace engineering and is outside of the student’s Major Field. The student’s minor proposal will then be approved by the department’s Graduate Committee. Next, the student is responsible for forwarding a copy of the minor proposal form to the WHOI Academic Programs Office and JCAOSE for approval.

Satisfactory Performance in the Minor Field

Satisfactory completion of the Minor program of study is certified by the Minor Advisor. The Minor Advisor has the responsibility of determining what constitutes satisfactory performance in the Minor program.

Thesis Proposal and Thesis Proposal Defense

The thesis proposal and proposal defense must be completed within three terms of entering the doctoral program. The purpose of the thesis proposal and proposal defense is to ensure that the student has (a) performed an adequate literature search, (b) a deep understanding of their research field, (c) identified a problem that could produce a doctoral-quality contribution(s), and (d) a reasonable plan for how to proceed. The student prepares a thesis proposal document that is then distributed to an evaluation committee, which includes the student’s Thesis Committee. In addition, the student is responsible for submitting a copy of

their thesis proposal document to the Academic Programs Office at MIT, the WHOI Academic Programs Office, and JCAOSE. The student then defends this proposal to the evaluation committee. Based on the proposal and the proposal defense, the evaluation committee may recommend actions to improve the student's proposal and his/her understanding of their research field.

Doctoral Thesis and Thesis Defense

In AeroAstro, the doctoral thesis must be completed and defended within four terms of completion of the thesis proposal defense.

Additional Information

For more information see:

- a. *AeroAstro Doctoral Program Guide* – http://web.mit.edu/aeroastro/academics/grad/forms/New_Doctoral_Booklet.pdf
- b. *Thesis Specifications Booklet* - <http://libraries.mit.edu/archives/thesis-specs/>.
- c. *Graduate Student Education Manual* – <http://web.mit.edu/gso/gpp/index.html>.

The Civil and Environmental Engineering Program of Study (CEE - Course 1)

AOSE Joint Program students admitted through the MIT Department of Civil and Environmental Engineering (CEE) pursue a doctoral degree and will be awarded either Doctor of Philosophy (Ph.D.) or the Doctor of Science (Sc.D.) degree. There is no substantive difference between the two degrees, and the choice of degree name is that of the individual recipient. Doctoral students in the AOSE Joint Program through CEE are not required to write a master's thesis prior to starting their doctoral degree program, although some may be encouraged to do so, on a case-by-case basis. For more information refer to the MIT CEE doctoral student guide.

AOSE-CEE Doctoral Degree Requirements and Timeline

The specific requirements for completing a doctoral degree in CEE (including the steps specifically required by the Joint Program – highlighted in bold) are:

1. Begin planning the Doctoral Program with academic and research advisor [Fall Academic Year 1 (AY1)]. **The Joint Program in AOSE strongly encourages new admissions to enroll for the summer term at WHOI prior to starting their first academic year in the Fall.**
2. MIT English Evaluation Test for non-native speakers if not previously satisfied [AY1].
3. MIT Graduate Writing Exam if not previously satisfied [AY1].
4. Approval of Doctoral Program and admission to General Exam through Student Interview [Fall AY2].
5. Selection of Exam Committee and Scheduling of General Exam Part 2 for April or May AY2 [scheduling done in January AY2].
6. Complete General Exam Part 1 and Part 2 [by end of AY2].
7. Complete Responsible Conduct of Research course [by end of AY2].
8. Form Doctoral Thesis Committee following completion of General Exam.
9. Approval of Doctoral Research Proposal [by Dec. 31, AY3].
10. **The Joint Program in AOSE: Complete items 2-4 of the AOSE requirements listed on page 11 [by end of AY4].**
11. Meet regularly [minimum of twice per year], ideally once per semester, with Doctoral Thesis Committee.
12. Meet with the Thesis Committee about 8 weeks before the desired thesis defense date to present the content of the thesis and request permission to proceed with scheduling the defense.
13. **The Joint Program in AOSE: Present a seminar at either WHOI or MIT during the semester of the thesis defense. This seminar should take place at the institution where the thesis defense is not held.**

14. Doctoral Degree earned with satisfactory defense of the Ph.D. thesis [AY 5 or 6]. Joint Program students are strongly encouraged to complete their doctoral degree in five years.

Course Requirements

A Doctoral Program consists of 120 units of graduate level coursework, including a 3-subject Core and one breadth subject. The student must consult with their faculty, or academic, advisor and research advisor when preparing their Doctoral Program. The 3-subject Core reflects the core knowledge in the student's chosen field within CEE, which is tested in Part 1 of the General Exam (see below). The three subjects are selected from an approved list of 4 to 5 subjects within a specific sub-group of CEE. The breadth subject must be drawn from a discipline that is distinct from any discipline included in the Core Program. For example, students should consider subjects in writing, foreign language, political science, business, law, and/or other branches of science and engineering.

The remainder of the doctoral program is made up of graduate subjects that complement the Core. The Doctoral Program may incorporate subjects completed during a CEE Master's degree. Finally, up to 24 units of graduate credit taken outside MIT or taken in a non-CEE MIT SM degree may be transferred to the CEE Doctoral Program. All transfer credits must be related to the proposed doctoral research area, with the one exception of a single breadth course. The Academic Programs Office must approve transfer credits from outside of MIT.

Students are expected to have a GPA \geq 4.5 to be considered for the General Exam.

Student Interview

During the Fall term of the second academic year (AY2), students must indicate if they are interested in participating in one of two available Student Interviews. Students select which of the two interviews to attend and contact the appropriate Doctoral Program Officer:

- Prof. Dennis McLaughlin – Environmental Science and Engineering (dennism@mit.edu)
- Prof. Oral Buyukozturk - Mechanics of Materials, Structures, Geomechanics, Systems, CSE (obuyuk@mit.edu)

A minimum of one week before the Student Interview, the following should be submitted to the corresponding office listed above:

1. A one-page summary of proposed doctoral research written for a general scientific audience.
2. The Doctoral Program form with advisor signature.
3. A one-paragraph letter from the student's research advisor stating the student's strengths and weaknesses and including a statement of support for the student to be admitted for the General Exam. This letter (or email) is sent directly to the Doctoral

Program Officer, with a copy sent to the Graduate Academic Administrator, Kiley Clapper and to JCAOSE.

Approval of the Doctoral Program and admittance to the General Exam are based on a review of academic and research performance. Students are expected to have a GPA ≥ 4.5 to be considered for the General Exam. The Student Interview is held with a group of faculty and research staff, organized by research area. At the interview, the student briefly describes the research they plan to pursue, explaining how the proposed set of subjects supports their research and career plans. The student will also identify their breadth class. Faculty may give advice on classes to add or take away from the proposed Doctoral Program. After the student leaves the room, there is a 5 to 10 minute discussion, beginning with a reading of the faculty advisor letter. At the end of the discussion, a formal recommendation is made to admit or decline the student for the General Exam, and the recommendation may include formal requirements to alter the Doctoral Program.

Students are subsequently informed of their acceptance to the General Exam and of any changes required in their program. If the advisor is not present, then the Doctoral Program Officer will inform the student. Once the Doctoral Program form has been submitted, students may not change their selection of Core subjects. The remaining subjects in the Doctoral Program may be altered, with approval from the doctoral thesis committee.

Research and 1.THG Requirement

Research effort is tracked academically through enrollment in 1.THG. Every AOSE JP graduate students enrolled through CEE (Course 1) must register for 1.THG every semester. The number of credit hours is determined in consultation the advisor. Through enrollment in 1.THG, students are formally graded on research performance each semester, in accordance with MIT Faculty Rules and Regulations.

Responsible Conduct of Research

Each PhD student is required to complete MIT's online course on the Responsible Conduct of Research within the first two years, i.e. by the end of Spring term AY2. For more information see the CEE graduate handbook/website.

General Exam Part 1 [Core Knowledge]

The General Exam (GE) Part 1 tests core knowledge within the students selected field of study, as represented by the **3-Subject Core** designated in the Doctoral Program. To pass the General Exam Part 1, the student must receive a grade of A (including A-) in each of the subjects selected for the Core. If the student receives a grade less than A, they have the option of re-taking that subject to improve the grade, or taking and passing a separate written exam. The subject instructor prepares the separate written exam. It consists of an open-book question,

which the student will have eight (8) hours to complete, e.g. 9 am to 5 pm. During the written exam, the student may not request information from any person other than the instructor and may not use information from the internet. All texts used by the student must be cited. If the option of a written exam is selected, the written exam should be completed during May of AY2. If the core program includes a subject from outside the department, the student must submit a completed Outside Examiner's Letter with appropriate signatures. Only one subject may be examined by a faculty/staff from outside CEE. If the instructor is not a member of CEE and declines to provide a question, a designated CEE faculty or Senior research staff within the appropriate area will write the exam.

The student performance on GE Part 1 is evaluated by a committee of CEE faculty and staff. The advisor of each student being reviewed is expected to attend this evaluation, or to send a statement in advance to the General Exam Officer. The outcome of the examination may be pass, fail with recommendation to retake, or fail with no option to retake. Students are allowed only two attempts at passing the general examination. If allowed, a retake of the exam must occur the next time the exam is offered. Changes in the core program are not permitted.

General Exam Part 2 [Research Aptitude]

The General Exam Part 2 must be completed by the end of the fourth academic term (generally April or May AY2) and tests the following skills: 1) Can the student formulate a research question, set out a plan of research, and interpret the results. 2) Can the student clearly present and defend this research. 3) Does the student have sufficient understanding of the field to answer a broad range of questions and to comment on relevant literature.

The exam has three components:

1. A written document describing research completed. Details of this document can be found in the attached CEE Doctoral Program Guide. The student distributes the research report to their committee a minimum of one week before the presentation. It is the student's responsibility to deliver the document in the preferred format for the committee.
2. A review of a relevant publication chosen by the advisor. The paper will be assigned one week before the presentation meeting. Questioning will involve informally discussing the paper (no slides), focusing on a set of 3 to 5 questions that will be provided by the committee when the paper is assigned.
3. A 30-minute oral presentation of research with significant questioning from committee. The research presented by the student can be drawn from their SM or MEng thesis, their RA at MIT, or research conducted as part of a previous position. The research must be in the same field as the subgroup core listed in the Doctoral Program.

The student should schedule the committee meeting for 2 hours. The student will begin by informally presenting their response to the question(s) posed by the committee beforehand regarding the published paper (item 2). Committee members may ask questions for clarification or to go into further depth. After twenty to thirty minutes, the committee chair will end this discussion and instruct the student to begin their research presentation. The student should plan a 30-minute presentation, but the actual presentation will take longer as faculty will interject with questions. The committee members are expected to have read the report and come prepared with questions.

The evaluation committee is comprised of a student's thesis advisor and a minimum of two faculty or senior research staff in CEE. In many cases, this group will become the Doctoral Thesis Committee. The chair of the evaluation committee must be within CEE and a faculty member or Senior Research Staff and cannot be the thesis advisor. After the form is submitted, one additional CEE faculty member from outside the core area will be assigned to the committee. Students should consult their research advisors when choosing the members of the evaluation committee. Students *must* submit the Part 2 Schedule Form before the beginning of the term in which the exam will be held (generally in January AY2).

Doctoral Thesis Committee and Approval of Doctoral Research Proposal

After passing Part 1 and Part 2 of the General Exam (typically by the end of AY2), the student forms a Doctoral Thesis Committee and within one academic term schedules a defense of Doctoral Research Proposal (typically by the end of Fall Term AY3). The composition of the thesis committee is described on page 8.

Once the thesis committee is formed, the student prepares a research proposal and schedules a date to present the proposal to the doctoral thesis committee. The oral presentation is 45 minutes, followed by 45 minutes of questions. The proposed research must be in the field defined by the student's core area. At least 10 days prior to the proposal defense, the student delivers copies of the written proposal to the committee members with a final schedule of when and where the presentation will take place. Possible outcomes of the proposal defense include 1) Accept as written, 2) Accept with modification, 3) Fail with encouragement to retake within 6 months, and 4) Fail.

After the approval of the thesis proposal, the student schedules regular meetings with the doctoral thesis committee to demonstrate progress and receive feedback. Two meetings per year are strongly recommended, with a minimum requirement of one per year. In addition, the committee chair may require additionally meetings in response to student progress.

Doctoral Defense

A final committee meeting should be convened approximately 8 weeks before the desired date for the doctoral defense. During this meeting, the student will outline the full thesis,

highlighting results from each chapter, indicating papers published, in review or in prep, and including a detailed timeline for completion. Based on the results of this meeting, the thesis committee will approve the thesis content and timeline, and approve the scheduling of the thesis defense. Approval must be noted on the *Record of Thesis Committee Meeting* form.

MIT has three degree-granting cycles per year: February, June and September. The date of the thesis defense must at least one week prior to the department's thesis submission deadline. CEE requires that the first draft of the thesis must be sent to the thesis committee at least two weeks before the defense date. The date, time and location of the defense must be communicated to the graduate academic administrator and JCAOSE at least 10 days prior to the defense date. Likewise, the abstract template must be completed and submitted, and an electronic copy of the thesis draft must be shared with the CEE and AOSE faculty. The formal thesis defense has two components, the public presentation, which anyone can attend, and a 30-90 minute closed session with only the thesis committee. The public presentation should be 40 minutes long, followed by 10 minutes for questions. The student is responsible for publicizing the thesis defense. For more information see the CEE graduate handbook/website.

The Electrical Engineering and Computer Science Program of Study (EECS - Course 6)

AOSE Joint Program students admitted through the MIT Department of Electrical Engineering and Computer Science pursue a doctoral degree and will be awarded either the Doctor of Philosophy (Ph.D.) or the Doctor of Science (Sc.D.) degree. There is no substantive difference between the two degrees, and the choice of degree name is that of the individual recipient. Doctoral students in the AOSE Joint Program through EECS must complete the requirements of the Master's degree program, including the subject requirements and writing a master's thesis, prior to starting their doctoral degree program. A student who enters with a master's degree may have satisfied these requirements, but may need to complete some additional research requirements to ensure that he or she has the research experience necessary for doctoral level research. For more information refer to the MIT EECS doctoral student guide.

AOSE-EECS Doctoral Degree Requirements and Timeline

The specific requirements for completing a doctoral degree in EECS (including the steps specifically required by the Joint Program – highlighted in bold) are:

1. Meet with academic and research advisors to plan curriculum [early Fall Academic Year 1 (AY1)]. **The Joint Program in AOSE strongly encourages new admissions to enroll for the summer term at WHOI prior to starting their first academic year in the Fall. An academic advisor (also called the graduate counselor in EECS) in the home MIT department is assigned to each student upon arrival.**
2. MIT English Evaluation Test for non-native speakers if not previously satisfied [AY1].
3. MIT Graduate Writing Exam if not previously satisfied [AY1].
4. Complete Technical Qualifying Exam [by end of Spring AY 1 – 2nd regular term]
5. Complete Master's thesis and course requirements [by beginning of Fall AY3 – 5th regular term].
6. Form Thesis Committee [by end of Fall AY3 – 5th regular term].
7. Complete Research Qualifying exam [end of Spring AY3 – 6th regular term].
8. Prepare and defend Doctoral Thesis Proposal [end of Spring AY3 – 6th regular term].
9. **The Joint Program in AOSE: Complete items 2-4 of the AOSE requirements listed on page 11 [by end of AY4].**
10. All requirements, including courses, teaching, and minor, must be completed [by beginning of AY5 – 9th regular term].
11. Meet regularly [minimum of twice per year] with Doctoral Thesis Committee.
12. Meet with the Doctoral Thesis Committee 6-8 weeks before the desired thesis defense date to request permission to proceed with scheduling the defense.

13. **The Joint Program in AOSE: Present a seminar at either WHOI or MIT during the semester in which you defend your thesis. This seminar should take place at the institution where the thesis defense is not held.**
14. Doctoral Degree earned with satisfactory defense of the Ph.D. thesis and submission of thesis by due date [AY 5 or 6]. Joint Program students are strongly encouraged to complete their doctoral degree in five years.

EECS Doctoral Degree Requirements

1. Successful completion of the General Examination, including the Technical Qualifying Examination (TQE) and the Research Qualifying Examination (RQE).
2. Complete the requirements for the Master's degree, including subject requirements and the thesis requirement.
3. Complete a minor program consisting of two subjects approved by the student's doctoral committee. The intent of the minor is to broaden the student's experience at an advanced level.
4. Complete additional subjects related to the doctoral research as specified by the doctoral committee (normally no more than two beyond those required for the Master's degree and to satisfy the TQE). Most doctoral students have taken more than eight graduate-H subjects.
5. Carry out a teaching assignment as approved by the doctoral committee. This will usually consist of one or more terms as a teaching assistant but other arrangements are possible.
6. Write and present a thesis proposal to the doctoral committee.

Doctoral Degree General Examination

The General Examination for the Doctorate will consist of two parts: The Technical Qualifying Examination (TQE) and the Research Qualifying Examination (RQE).

A student completes the TQE by demonstrating competence in four technical topic areas associated with specific subjects offered by the department. In all topic areas, competence may be demonstrated by performance on a written examination to be given at the end of the spring term. In some topic areas, competence may be demonstrated by receiving the grade of "A" in a specified graduate subject. A student who has not demonstrated competence in four topic areas by the end of the first year must take an oral presentation in the following fall term in order to continue in the doctoral program.

Students who have successfully completed the TQE apply to take the RQE when they have nearly completed their Master's thesis research (or the equivalent for those who enter with a Master's degree). The RQE is an oral examination conducted by a committee of three faculty members. The student prepares a paper describing the research and submits this to the

committee before the examination. Successful completion of this examination completes the General Examination for the Doctorate.

Master of Science Course Requirements

Graduate subjects at MIT are classified as one of two types: G-level and H-level. A G-level subject indicates a subject approved for graduate credit. An H-level subject is a higher-level graduate subject that is an approved subject for a graduate degree.

MIT's EECS requirements for the Master's degree are 66 units of coursework plus an acceptable thesis. The 66 units of coursework must include a minimum of 42 units of graduate H-level subjects. EECS requires that the 66 units consist of at least four subjects, and that the 42 H-level units consist of at least four subjects. The remaining requirement of 24 units may be graduate H-level subjects, other subjects (G-level subjects), or intermediate or advanced undergraduate subjects, as approved by the Graduate Counselor and the EECS Department. In general, subjects which ordinarily may be taken by first or second year undergraduate students will not be accepted for non-H credit in a Master's program.

Minor Requirement

Each student must complete a minor program to be approved by the relevant Area Chair and consisting of two MIT subjects, at least one of which is a graduate subject. The intent of the minor is to provide a broadening experience and the subject matter may fall well outside of EECS subjects.

Additional Subjects

The doctoral committee reviews the student's preparation and proposed research at the time of the RQE and periodically thereafter. The doctoral committee may require that the student take additional graduate subjects in order to be well prepared in the research field. The doctoral committee will inform the graduate office of any subjects that are required.

Teaching Experience

Each doctoral student is expected to take part in the department's teaching program. In order to satisfy this requirement, the student must complete a one-term teaching assignment, usually as a teaching assistant, with approval from the doctoral thesis committee. The assignment may involve direct teaching or course development. If a student applies twice for a teaching assignment and no suitable position is available, then the requirement is waived. The doctoral committee will inform the graduate office when this requirement is completed.

Thesis/Research Advisor

The thesis/research advisor for an AOSE JP student enrolled through EECS can be an MIT EECS Faculty member or Senior Research Scientist/Engineer or a member of the WHOI Faculty, or the

student can be co-advised by a EECS and other MIT faculty member. A thesis advisor is responsible for certifying and signing the thesis. In the case of co-advisor, both must certify and sign the thesis.

Generally, a student is matched with a research advisor prior to their arrival in the Joint Program. Upon arrival, all students in the Joint Program should meet with their thesis advisor, or research advisor, and review the student and advisor expectations and responsibilities. These are included in an appendix at the back of this handbook and can also be found on the joint program web site.

Doctoral Thesis Committee

The doctoral thesis committee is charged with establishing the post-qualification requirements and with monitoring the student's progress. The doctoral committee meets with the student at least once per term and reports in writing to the Graduate Office and JCAOSE annually. The doctoral committee consists of at least three members, at least two of whom are EECS faculty members and at least one of whom is from WHOI, with optional members as deemed appropriate.

Thesis Proposal

An acceptable doctoral thesis proposal is normally required by the end of the sixth term. The thesis proposal must be approved by the thesis advisor and two additional faculty members of MIT EECS before submission to the graduate office. There may be additional readers and/or a co-advisor, but at least two EECS faculty members must be included. Once approved by the thesis advisor and readers, the proposal must be forwarded to JCAOSE for approval and then to the WHOI APO and the MIT Joint Program Office.

For more information see the EECS graduate handbook/website.

NOTE: The MIT Mechanical Engineering Handbook and Requirements are in the process of being changed. These changes are not reflected in this version (14 March 2016) of the JP handbook.

The Mechanical Engineering Program of Study (ME - Course 2)

AOSE Joint Program students admitted through the MIT Department of Mechanical Engineering (ME) pursue a doctoral degree, unless the students have specifically applied for the Navy Master's Program (described in more detail later). Doctoral candidates will be awarded either Doctor of Philosophy (Ph.D.) or the Doctor of Science (Sc.D.) degree. There is no substantive difference between the two degrees, and the choice of degree name is that of the individual recipient. Doctoral students in the AOSE Joint Program through ME are not required to write a master's thesis prior to starting their Ph.D. degree program, although some may be encouraged to do so, on a case-by-case basis. For more information refer to the MIT ME doctoral student guide.

AOSE-ME Doctoral Degree Requirements and Timeline

The specific requirements for completing a doctoral degree in ME (including the steps specifically required by the Joint Program – highlighted in bold) are:

1. Meet with academic and research advisors to plan curriculum [early Fall Academic Year 1 (AY1)]. **The Joint Program in AOSE strongly encourages new admissions to enroll for the summer term at WHOI prior to starting their first academic year in the fall. An academic advisor in the home MIT department is assigned to each student upon arrival.**
2. MIT English Evaluation Test for non-native speakers if not previously satisfied [AY1].
3. MIT Graduate Writing Exam if not previously satisfied [AY1].
4. Take Qualifying Exams within three full semesters of enrolling in the doctoral program [January/May AY2]. Minimum cumulative 4.5 grade point average to be eligible to take Qualifying Exams.
5. Form Doctoral Thesis Committee [by Fall AY3].
6. Prepare and defend Doctoral Thesis Proposal [by end of Fall AY3].
7. Complete major program of advanced study.
8. Complete minor program of study in a field different from that of the major.
9. **The Joint Program in AOSE: Complete items 2-4 of the AOSE requirements listed on page 11 [by end of AY4].**
10. Meet regularly (minimum of twice per year), ideally once per semester, with Doctoral Thesis Committee.
11. Meet with the Doctoral Thesis Committee 8 weeks before the desired thesis defense date to request permission to proceed with scheduling the defense.
12. **The Joint Program in AOSE: Present a seminar at either WHOI or MIT during the semester in which you defend your thesis. This seminar should take place at the institution where the thesis defense is not held.**

13. Doctoral Degree earned with satisfactory defense of the Ph.D. thesis and submission of thesis by due date [AY 5 or 6]. Joint Program students are strongly encouraged to complete their doctoral degree in five years.

Thesis/Research Advisor

The research/thesis advisor for an AOSE JP student enrolled through ME can be an MIT ME faculty member or Senior Research Scientist/Engineer or a WHOI faculty member, or the student can be co-advised by a ME and other MIT faculty member. A thesis advisor is responsible for certifying and signing the thesis. In the case of co-advisors, both must certify and sign the thesis.

Generally, a student is matched with a research advisor prior to their arrival in the Joint Program. Upon arrival, all students in the Joint Program should meet with their thesis advisor, or research advisor, and review the student and advisor expectations and responsibilities. These are included in an appendix at the back of this handbook and can also be found on the joint program web site.

The Qualifying Exam

The purpose of the qualifying examinations is to determine whether the applicant possesses the attributes of a doctoral candidate: mastery of the mechanical/ocean engineering disciplines and ingenuity and skill in identifying and solving unfamiliar problems.

The qualifying examinations are offered twice yearly (January and May) during a two-week period. All JP doctoral students *must take the qualifying exam (for the first time) before the end of three regular terms* (fall and spring) after admission to the doctoral program, typically in January of their second year (assuming matriculation in September). There will be no exceptions, except by prior petitioning to the both the MIT ME Graduate Officer and the JCAOSE.

To be eligible to take the qualifying exams, JP doctoral student must have:

1. Completed at least 72 credit units of coursework, not including credit received for thesis work. Of these, at least 48 must be H-level graduate subjects. The remaining 24 units may be for G-level subjects.
2. Completed at least three H-level graduate subjects (36 units) in the MIT Department of Mechanical Engineering (Course 2).
3. Taken at least one graduate mathematics subject (12 units) offered by the MIT Mathematics Department (Course 18). No waivers are allowed.
4. A minimum GPA of 4.5.

The qualifying examinations consist of two parts:

1. Three subject area examinations chosen from the approved list (the subject or subjects most suitable for preparation for these exams are indicated in parentheses):

- Dynamics (2.032) **or** Acoustics (2.066)
- Mechanics of Solid Materials (2.002, 2.071), **or** Structural Mechanics (2.080J)
- Fluid Mechanics (2.25), **or** Hydrodynamics (2.20), **or** Geophysical Fluid Mechanics (12.800)
- Thermodynamics (2.42)
- Heat and Mass Transfer (2.52 or 2.55)
- System Dynamics and Control (2.140 and 2.151) **or** Signal Processing (6.003) **or** Probability and Random Processes (6.431 and 2.22)
- Biological Engineering (2.795J and 2.798J)
- Optics (2.710)
- Manufacturing (2.810)
- Design

2. A thesis (research) area examination: The student takes a research oral exam, which consists of a 25-minute presentation by the student, followed by questioning (45-minutes total), on the master's thesis or equivalent original research such as initial work toward the doctoral thesis.

Some of the subject exams have a written component, an oral component, or both. Both the list of subjects and the format of each subject exam undergo some metamorphosis. New subjects may be made available with one term's advance notice; existing subjects may be discontinued, but only upon at least two years' notice. The Mechanical Engineering Faculty and JCAOSE as a whole review each student's performance in the qualifying examinations and make decisions regarding passing, being allowed to repeat the exams, or failing. Candidates who are permitted to repeat the exams must do so the next time they are offered. ***In no case is a candidate allowed to repeat more than once.***

Major Program of Advanced Study

The major is a program of advanced study which gives the candidate both depth and breadth in a field of engineering or science approved by the departmental Graduate Committee. Examples are: (i) Mechanics; (ii) Product Realization; (iii) Controls, Robotics and Instrumentation; (iv) Energy Science and Engineering; (v) Ocean Science and Engineering; (vi) Biomechanics and Engineering; (vii) Micro/Nanomechanics and Engineering. The Graduate Officer may approve appropriate alternatives.

The set of major subjects should bring candidates to the state of the art in their chosen field, insofar as that is possible via coursework. These subjects are typically H-level. Candidates must

satisfy their Doctoral Committee and the Graduate Officer that their proposed program meets this intent. The major represents the principal component of the candidate's coursework.

The program of study comprised of the major, minor, and additional supporting subjects will typically consist of **at least 144 credit units** (12 subjects). Advanced subjects taken toward a Master's degree may be used to satisfy the requirements of the doctorate. Advanced subjects taken at another graduate school may also be counted toward the MIT doctorate, if approved by both the Graduate Officer and the candidate's thesis committee. The limit is 72 credit units if the subjects were taken outside MIT.

Minor Program of Study

A minor program of study in a field different from that of the major is required for all students entering the Joint Program in AOSE through the MIT ME department. This is a ME requirement. Three subjects (not less than 24 units) must be taken in a coherent field different from the major. These subjects may be taken inside or outside the ME department. JP students may use the three AOSE requirements -- one summer of research at WHOI with a WHOI faculty member (*2.689J Special Projects in Oceanographic Engineering*), *2.688 Principles of Oceanographic Instrument Systems: Sensors and Measurements*, and *12.808 Introduction to Observational Physical Oceanography* -- to obtain a minor in Applied Ocean Science and Engineering.

Thesis Committee and Doctoral Research Proposal

In the semester after passing the qualifying exam (typically by the end of Fall Term AY3), the student forms a Doctoral Thesis Committee, converges on a proposed program of study for the major and minor, prepares a Doctoral Thesis Proposal, and schedules a defense of the Doctoral Thesis Proposal.

A student's doctoral thesis committee acts as an advisory body during the course of the student's dissertation research, monitors the student's research for satisfactory progress and examines the student on that research at the time of the thesis defense. It is the responsibility of the thesis committee to guide the student, and this should include regular meetings with the student to assess progress and make recommendations. It is the student's responsibility to set up frequent meetings with the thesis committee, including meeting as an entire group at least twice per year.

The doctoral thesis committee must consist of 3-6 members (including the advisor), including at least two MIT faculty members, at least one from the MIT ME department and one from the WHOI faculty. If appropriate, the student may invite members from outside MIT/WHOI. The student invites one committee member to be the chair of the doctoral thesis committee. The committee chair must be a member of MIT ME or WHOI faculty, and is often the student's advisor. The student must submit the names of the doctoral thesis committee members to the

MIT ME Graduate Office and JCAOSE for approval. Changes in the membership of the thesis committee, if deemed necessary by the thesis advisor in consultation with the student, must be submitted in writing to JCAOSE for approval.

Program Record Card

The program of study for the major and minor should be entered on the student's Program Record Card (history card). Students must get signed approval on their Program Record Card (history card) for their major and minor list of subjects from the doctoral committee at its first meeting, and then submit it for approval to the MIT Graduate Officer and JCAOSE. The student must bring the Program Record Card to all thesis committee meetings. History cards are kept on file in the departmental Graduate Office.

For more information see the ME graduate handbook/website.

NOT UP
TO DATE

The AOSE Navy Master of Science Program in Mechanical Engineering (ME - Course 2)

The Joint Program offers a Master's degree program for U.S. Naval Officers, and more than 80 officers have received this degree dating back to the first award in 1970. The Joint Program recently accepted a U.S. Coast Guard Officer into a Master's degree program, and this option may continue in the future. The U.S. Navy manages the initial application process for Naval Officers prior to consideration by the Joint Program.

All Navy students in the Joint Program are accepted through the MIT Mechanical Engineering Department. Two Joint Committees now consider Naval Officers for admission to the master's degree program: the Joint Committee for Applied Ocean Science and Engineering (JCAOSE) and the Joint Committee for Physical Oceanography (JCPO). The Master's degree program is suitable for motivated students with undergraduate degrees in geoscience, physics, chemistry, mathematics, or engineering. The program is designed to be completed in 27 months (two years and a summer), and there is typically very little flexibility in the timing, as this is dictated by the U.S. Navy. The first year is spent taking courses and beginning research with an advisor. In the second year, the student conducts research, culminating in a Master's thesis.

Thesis/Research Advisor

Any MIT faculty member in any of MIT engineering departments participating in the MIT/WHOI Joint Program or any member of the WHOI Scientific Staff can serve as a primary research advisor for a Navy Master student in AOSE. Many incoming JP Navy Master students have already been matched with a research advisor prior to their arrival in the Joint Program. However, some students may spend part of the first summer in the program (the summer before the start of first full academic year) identifying a research advisor. All JP Navy Master students must notify the Chair of JCAOSE and the MIT ME Graduate Office of their thesis advisor within six week of arrival.

Unlike JP Doctoral students, JP Navy Master students do not form a thesis committee, do not take the MIT ME qualifying examinations, and do not publicly defend a thesis. The Master's thesis is signed off by the research advisor and the chair of JCAOSE chair (or the chair of JCPO chair if the Navy student enters through the JP PO). In addition, if neither the thesis advisor or chair of JCAOSE is a member of the Mechanical Engineering Department, a reader who belongs to the Mechanical Engineering faculty must also endorse the thesis.

Academic Advisor

Navy students must identify an Academic Advisor in the MIT Mechanical Engineering Department prior to the start of the first full semester. JCAOSE must approve the choice of

Academic Advisor. As with the incoming JP Doctoral students, the academic advisor will sign registration forms each semester and will check that the student is aware of and is meeting milestones and fulfilling MIT departmental course requirements. In addition, the MIT academic advisor may be a valuable resource for helping a student with course selection. All JP Navy Master students must notify the Chair of JCAOSE and the MIT ME Graduate Office of their MIT academic advisor within six week of arrival.

Navy Master of Science Degree Requirements

The Navy Master of Science Degree program offered through the MIT/WHOI Joint Program in Applied Ocean Science and Engineering requires that the student:

1. Satisfy the requirements imposed by the MIT Mechanical Engineering Department.
2. Complete course 2.688 *Principles of Oceanographic Instrumentation*. This requirement may, under some circumstances, be substituted by an equivalent experience or course by petitioning the Joint Committee of Applied Ocean Science & Engineering (JCAOSE) for approval. This petition must be received by JCAOSE by the beginning of the second academic year.
3. All incoming JP Navy students are **strongly** encouraged to spend their first summer at WHOI, prior to the official start of the first academic year. A math refresher class is offered to get Navy officers, who may have been out of school for a number of years, back up to speed and help prepare them for the upcoming semester taking classes at MIT.

Navy Master of Science Course Requirements

Graduate subjects at MIT are classified as one of two types: G-level and H-level. A G-level subject indicates a subject approved for graduate credit. An H-level subject is a higher-level graduate subject that is an approved subject for a graduate degree. The Master's course requirements are as follows:

- Students must successfully complete at least **72 credit units** of coursework, corresponding to six 12-unit subjects, not including credit received for thesis work. Of the 72 units of required coursework, at least **48 must be H-level graduate** subjects. The remaining 24 units may be for G-level subjects, or for certain advanced undergraduate subjects that are not requirements in MIT's undergraduate Mechanical Engineering curriculum.
- The program is expected **to include at least three H-level graduate Course 2 subjects (36 units)**.
- Students must take at least **one graduate mathematics subject (12 units)** offered by the Mathematics Department at MIT. No waivers are allowed.
- A minimum grade point average of 3.5 (A=5, B=4, C=3, D=2, F=0) must be maintained in graduate school.

- Students are allowed to transfer credit toward their Master's degree from graduate subjects taken previously at MIT or another accredited institution, and *not used as part of the credits required for an undergraduate or graduate degree*. **The limit is 24 credit units** if the subjects were taken outside MIT. Transferred subjects must have a grade of B or higher. No thesis units may be transferred.

Navy Master of Science Thesis Requirements

In the Mechanical Engineering Department at MIT, the Master's thesis is considered to be the centerpiece of a student's graduate experience. The student must complete an acceptable thesis under the supervision of an MIT ME faculty member or a member of the WHOI Scientific Staff. The thesis is an original work of research, design, or development. The thesis/research advisor and the Chair of JCAOSE (or JCPO for Navy students entering through JCPO) sign and accept the thesis upon completion. If the thesis advisor is not a member of the Mechanical Engineering Department, a reader who belongs to the MIT Mechanical Engineering faculty must also endorse the thesis.

Doctoral Thesis Preparation and Defense

The scheduling and deadlines indicated in this section apply to all AOSE students, regardless of the home MIT department. Additional MIT department-specific deadlines may also apply. It is the responsibility of the student to comply with all the requirements imposed by the home MIT department. In the event that the AOSE Joint Program deadlines are different to the MIT department deadlines, the earlier of the two deadlines should be satisfied.

Thesis Content

In general, a thesis consists of five parts:

1. Abstract
2. Introduction including a historical review and background of the problem
3. Chapters that develop the original contribution toward the solution of the problem
4. Final summary
5. Bibliography

The student is encouraged to incorporate, as part of Item 3, published manuscripts or manuscripts that have been prepared or submitted for publication, provided that they are partly or entirely the student's original contribution. If the paper has been published and copyrighted, a waiver of the copyright must be submitted with the thesis. If multiple-authored papers are included in a thesis, the student must obtain statements from all co-authors detailing their specific contributions to the papers in question and submit them to JCAOSE. No doctoral thesis containing such multiple-authored papers will be accepted for final approval without these statements or without the explicit written permission of JCAOSE.

Detailed information about requirements for preparation and submission of the thesis to both MIT and WHOI are online at <http://mit.who.edu/thesis> and <http://libraries.mit.edu/archives/thesis-specs/>

Thesis Defense Scheduling Approval

Students should meet with the thesis committee 6-8 weeks prior to the desired thesis defense date to take the preliminary examination and obtain final approval for the content and scheduling the thesis defense. A draft of the thesis should be submitted to all members of the thesis committee 1 week prior to this meeting. The student's thesis committee must approve the final thesis prior to the student submitting the defendable draft to both MIT and WHOI.

Chair of the Thesis Defense

Students must submit the name of the thesis defense chair to JCAOSE for approval at least 4 weeks prior to the defense. The thesis defense chair must be either an MIT faculty member, from the student's home MIT Engineering Department, or a WHOI faculty member. The thesis defense chair should be related to the student's discipline of intent, but cannot be a member of the thesis committee.

Announcing the Thesis Defense

It is the responsibility of the student to arrange for announcements of the thesis defense to be printed and posted at least 3 weeks prior to the defense.

Defendable Draft

At least 2 weeks in advance of the thesis defense, the student must submit copies of the defendable draft of the thesis to the WHOI Academic Programs Office (one copy) and the student's MIT Engineering Department (two copies). When submitting the defendable draft, a Dissertation Defense Notice must accompany the defendable draft copy that is distributed to the institution to where the student will be defending. A copy of the form can be found at <http://mit.who.edu/thesis>. This form must be signed by the student and advisor.

Public Seminar at Institution where the Thesis Defense will not be held

All doctoral students must present a seminar at either WHOI or MIT during the same semester as the thesis defense, at the institution where the thesis defense will not be held. Ideally, this seminar will take place shortly before the thesis defense, approximately 2 weeks in advance of the thesis defense, as it is an importance mechanism for practicing the thesis defense. It is the student's responsibility to advertise the seminar appropriately.

Thesis Defense Deadlines

MIT has three degree-granting cycles per year: February, June and September. The precise due dates for the final thesis for JP students vary slightly year to year, but follow the official MIT deadlines as posted in the MIT Academic Calendar, and can also found posted at <http://mit.who.edu/thesis>. MIT Engineering Department due dates sometimes differ slightly from the MIT Academic Calendar and it is the responsibility of the student to check the exact due dates with their home MIT department. It is strongly recommended that the thesis defense take place at least two weeks prior to the final thesis due date to allow time for changes to thesis recommended by the thesis committee during the thesis defense.

Thesis Defense

All students in the Joint Program are required to hold a public thesis defense. The student schedules the date and reserves a room for the defense. It is also up to the student to coordinate scheduling with the thesis committee, the MIT department chair, the JCAOSE Chair, and the WHOI Education Coordinator. If any one of these people cannot attend, the student must obtain verbal approval to proceed from the JCAOSE Chair.

The public thesis defense consists of:

1. A public seminar in which the entire thesis research or some significant part is presented. This presentation should be roughly 50 to 60 minutes long.
2. A period of detailed questioning by the audience following the seminar. (The thesis committee members are encouraged to ask questions at the closed session).
3. A closed session of questioning by the thesis committee and voting faculty members may follow. All voting faculty members are encouraged to read the thesis prior to the defense.
4. The student will then be asked to leave so that the thesis committee and voting faculty members may discuss the candidate and vote to decide whether or not it was a successful defense.
5. For some MIT departments, there are minimum requirements for the number of voting faculty members that need to be or say they will be present.
6. A simple majority vote of those present is needed to pass.
7. Thesis committee members who cannot attend the thesis defense must submit a letter detailing their assessment of the thesis to the chair of the thesis defense.

The chair of the thesis defense will:

1. Introduce the candidate.
2. Instruct the candidate and audience to the format and formalities of the defense process.
3. Moderate the public questioning period.
4. Lead private discussions and take a vote.
5. Write a memo to the MIT department head, JCAOSE Chair, and the Associate Dean at WHOI regarding the results of the defense.

After a student's successful doctoral thesis dissertation defense, the final version of a thesis must be submitted to both the student's home department at MIT and WHOI's Academic Programs Office within two weeks.

The timetable below summarizes the timeline for the thesis defense preparations:

Preparation for Thesis Defense	Timeline
Thesis Committee Meeting for approval of thesis defense scheduling and content. (A draft of the entire thesis must be submitted to the thesis committee members at least 1 week ahead of this meeting.)	6-8 weeks before desired thesis defense date
Submit name of thesis defense chair to JCAOSE for approval.	At least 4 weeks prior to thesis defense date
Print and post announcements of the thesis defense	At least 3 weeks prior to thesis defense date
Defendable draft	At least 2 weeks prior to thesis defense date
Dissertation defense notice	This form must be submitted at the same time as the defendable draft
Public seminar at institution where thesis defense is not held	Ideally 2 weeks prior to thesis defense date. Required to be in the same semester as thesis defense
Final signed thesis due	No later than 2 weeks after the thesis defense, and at least 1 day before the final thesis date posted in the MIT Academic Calendar

**Appendix A -
Student/Advisor Expectations and Responsibilities Guidelines**

**Appendix B -
AeroAstro Graduate Student Handbook/Guide
(see also <http://aeroastro.mit.edu/graduate-program/doctoral-degree>)**

**Appendix C -
CEE Graduate Student Handbook/Guide
(see also <http://cee.mit.edu/graduate/forms>)**

**Appendix D -
EECS Graduate Student Handbook/Guide
(see also <http://www.eecs.mit.edu/academics-admissions/graduate-program/graduate-office-materials>)**

**Appendix E -
ME Graduate Student Handbook/Guide
(see also <http://meche.mit.edu/education/graduate#resources>)**

Faculty/Student Responsibilities*

1. Advisors and students should be familiar with appropriate discipline [handbook\(s\)](#) and with the [Joint Program housing policy](#).
2. When a student first arrives, the advisor and student should discuss what courses the student should take, and when. Advice is also available from the education coordinator and the student's academic advisory committee.
3. When a student first arrives, the advisor and student should discuss what research project(s) the student should undertake, including expectations of when and how that research will be carried out (e.g., during first summer, semesters when classes are in session, during IAP, during subsequent summers), and balance between coursework and research. They should also discuss any upcoming fieldwork (timing and duration), and whether it is optional or required.
4. Advisors should make expectations clear to the student, including how frequently the advisor and student should meet. The advisor should make him/herself available to provide advice to the student, and clarify with the student how best to set up meetings – e.g., regular weekly meetings, or meetings as needed with some amount of lead time so that the advisor can set aside time, etc. Likewise the student should feel comfortable communicating with the advisor regarding the frequency of meetings.
5. Full-time Graduate Research and Teaching Assistants (and students on Fellowships and Scholarships as well) are expected to devote at least 50 hours per week on average to academic activities, including time devoted to classes, research activities, and any activities specific to Research or Teaching Assistant duties. If supported as a Graduate Research Assistant, 20 hours per week on average should be devoted to work on the grant/contract. Specifics of how the 20-hour per week obligation is to be satisfied should be agreed upon by the advisor and the student (e.g., less time devoted to grant/contract activities when classes are in session, more time during IAP and summer). It is good to have an understanding between the student and advisor about this balance (the education coordinator is another resource to provide advice about balance). If supported as a Teaching Assistant, the student is expected to devote 20 hours per week to Teaching Assistantship activities (10 hours/wk for half-time TA).
6. Students are entitled to two weeks of vacation per year and should clear vacation schedules in advance with advisor(s). It is useful for students and advisors to discuss expectations given that many oceanography students spend considerable time in the field. Information about terms of appointments is at <http://odg.mit.edu/gpp/assistance/rata/terms-of-appointment/>
7. Advisors and students should discuss authorship protocol (e.g., when is someone an author vs. acknowledged; when is someone first author; etc.), and scientific

conduct. Training in scientific conduct is now required by some funding agencies. Ethics training is available, and advisors should encourage students to take advantage of such training.

8. Advisors should make best efforts to fund students fully, and encourage (and assist as needed) students to submit fellowship applications. If the student has his/her own funding through a fellowship, and wishes to pursue research not covered by existing grants, the student needs to have the advisor's permission and support. The student and the advisor then need to openly discuss possibilities and how other costs (e.g., lab supplies and analyses) will be covered. The burden of funding the student and his/her research costs falls on the advisor, thus the need for the advisor being in agreement that the student should pursue this research.
9. Regular feedback should be provided to the student about progress, and if the student is not fulfilling the advisor's expectations, the advisor should bring that to the student's attention in a timely manner so that the student can address the concern (rather than waiting until the semester's end or as part of the annual review).
10. Advisors and students should discuss progress at annual review time and go over any issues or concerns. On all submitted memos/paperwork, copy Ronni and Lea (who will print the correspondence and place it in the student's file).
11. As the student's research progresses, the advisor(s) should encourage participation in scientific meetings and assist with writing and submitting abstracts, choice of sessions and travel costs, and encourage and assist with networking at meetings. Both MIT and WHOI offer funding to help with student travel to conferences when they are presenting. See <http://mit.who.edu/policies>. Advisors should introduce students to colleagues and program managers from funding agencies at meetings, as well as when colleagues or program managers visit the home institution.
12. Each year students and advisors should discuss career goals (which may evolve). Advisors should offer advice to students on postdoc and job opportunities, and encourage the student to think broadly about his/her career.
13. Advisors should encourage and assist with publication of results including advice on appropriate journals; structure, length and content of articles; appropriate analyses and graphics; and guidance in responding to reviewers.
14. Advisors should provide timely feedback (e.g., within a week or two, with an idea of the timing provided by the advisor) as students write up results for their theses.
15. In addition to the Educational Coordinator, Associate Dean, Dean, MIT Director of the Joint Program, and Joint Committee members, the Department Chair at WHOI and Department Head at MIT are go-to people for graduate students who need advice or assistance on important professional matters such as resolving conflicts or other issues

with their advisors or others in the department. MIT also has an Ombuds Office
<http://web.mit.edu/ombud/>.

*There may be some discipline-specific variations to these general guidelines – see discipline handbooks

July 2015

MIT RESOURCES AND OFFICES

Faculty members and their students are encouraged to resolve conflicts and seek assistance through a variety of MIT resources and offices, compiled in resources.mit.edu. These include:

DEPARTMENT/PROGRAM GRADUATE OFFICERS

odg.mit.edu/gpp/oversight/officers

DEPARTMENT/PROGRAM HEADS

OMBUDS OFFICE

Room 10-213

Phone 617-253-5921

ombud.mit.edu

GRADUATE PERSONAL SUPPORT (GPS)

OFFICE OF THE DEAN FOR GRADUATE EDUCATION (ODGE)

Room 3-138

Phone 617-253-4860

Email odg@mit.edu

odg.mit.edu

CONFLICT MANAGEMENT @ MIT DIVISION OF STUDENT LIFE (DSL)

Room W20-507

Phone 617-253-3276

Email conflictmanagement@mit.edu

studentlife.mit.edu/conflictmanagement

INSTITUTE COMMUNITY & EQUITY OFFICE

Room 4-250

Phone 617-324-7319

Email iceo@mit.edu

diversity.mit.edu

COMMUNITY WELLNESS @ MIT MEDICAL

Room E23-205

Phone 617-253-1316

Email wellness@med.mit.edu

medical.mit.edu/services/community-wellness

MIT MEDICAL

Building E23

Phone 617-253-4481

medical.mit.edu

MENTAL HEALTH & COUNSELING @ MIT MEDICAL

Building E23, 3rd Floor

Phone 617-253-2916 weekdays

617-253-4481 nights/weekends

medical.mit.edu/services/mental-health-counseling

ACTIVE MINDS @ MIT

Email activeminds-exec@mit.edu

activeminds.mit.edu



COMMON VALUES

on the Graduate Student Experience

Graduate students form a large part of the MIT community, and their involvement can have a significant influence on the Institute. Therefore each graduate student bears a responsibility for respect and maturity in their behavior towards all members of the Institute community.

The following enumerated statements are intended as a resource for advisors and students on how to build and maintain a healthy, rewarding and productive relationship. Clearly, such a list cannot be exhaustive; the following guidelines address concerns that arise in the context of a research environment, such as the graduate program at MIT.

For more general concerns and for situations requiring immediate response, MIT offers a variety of resources (*see resources.mit.edu*).

1. Faculty members and their graduate students are strongly encouraged to build their relationship by establishing common expectations on the major elements of their professional interactions, such as:
 - A. Requirements for achieving and maintaining an acceptable academic standing as well as graduation requirements for each academic unit;
 - B. A regular time for meeting;
 - C. Lead times for feedback on work such as thesis and manuscript drafts;
 - D. A shared understanding of what constitutes sufficient notice and reasonable scheduling of events the student is expected to attend following a request from their advisor;
 - E. A shared understanding of academic integrity and responsible conduct of research.
2. Faculty and students are strongly encouraged to attempt to resolve conflicts through direct discussion and other informal procedures.
3. Graduate students are strongly encouraged to keep their advisor apprised of academic progress and seek their advisor's input on the same subject on a regular basis.
4. Graduate students should receive attribution for scholarly assistance to faculty, and vice versa, including contributions to publications and patents.
5. Faculty are expected to be supportive of their students' participation in extra-academic activities and to recognize the value of such activities for their intellectual and professional development. Depending on the discipline, these activities might include training in job interviews, information on academic and non-academic career options, and internships.
6. A number of resources are available for graduate students who wish to terminate their relationship with their advisor and search for a new research laboratory. These include their departmental or program graduate administrator, program head or departmental graduate officer, a dean in the ODGE, or an Institute ombudsperson.
7. Graduate students share with the faculty the responsibility for securing, maintaining, and protecting the integrity of grades, scholarship, and research.
8. Faculty members have the responsibility to inform graduate students of the source and amount of their financial support and of all expectations associated with any funded position. Faculty members should inform graduate students promptly of matters that affect their funding status.
9. Graduate students and faculty have a responsibility to inform each other as soon as they have knowledge of a possible change of their status. Graduate students should provide reasonable notice to their advisor if they intend to leave or change advisors; have a medical or personal issue that interferes with study and research; or are experiencing other academic or life issues that an advisor might reasonably need to know about. When circumstances require leaving a research project, graduate students should provide a summary of their work so that any delay associated with continuation of the project is minimized.
10. Beyond the responsibility to provide an evaluation once per term via a thesis grade, advisors should consider providing additional periodic feedback of academic progress, performance and professional potential, preferably in the form of a written evaluation.
11. Graduate students are protected by a variety of policies and procedures, as summarized in the document *Institute Policy Guiding the Graduate Student Experience*. If a student feels that they have been unfairly treated, or treated in a way that is in violation of MIT policies, and attempts at informal solutions were unsuccessful, the student can appeal by means of confidential Institute Complaint Resolution procedures. The student can be accompanied by a member of the MIT community to a meeting about the complaint. These individuals may not be family members, subordinates, or attorneys. The role of the MIT community member is to provide support and guidance, not to be a substitute for the party, who is the primary participant.

INSTITUTE POLICY

Guiding the Graduate Student Experience

1. MIT does not discriminate against individuals on the basis of race, color, gender, sexual orientation, religion, handicap, age or national or ethnic origin in administration of its education policies, admission policies, scholarship and loan programs and other Institute administered programs and activities.
web.mit.edu/policies/7/7.1.html
2. Graduate students are protected from harassment, including sexual misconduct and retaliation.
web.mit.edu/policies/9/9.5.html
hrweb.mit.edu/policy/3-10
sexualmisconduct.mit.edu/sexual-misconduct-policy
web.mit.edu/policies/9/9.6.html
3. Any graduate student who believes that they have been unfairly treated is encouraged to resolve the concern through the Institute's complaint resolution procedures.
web.mit.edu/policies/9/9.6.html
4. Pending approval by the Dean for Graduate Education, female graduate students anticipating giving birth may take paid child-birth accommodation.
odg.mit.edu/gpp/registration/changes/childbirth-accommodation-maternity-leave
5. As with all members of the MIT community, graduate students are to be treated with evenhanded respect for their dignity, individual qualities, and property.
web.mit.edu/policies/9/9.1.html
6. Graduate students have a right to and responsibility to maintain a safe and clean working environment.
web.mit.edu/policies/9/9.2.html
7. Graduate students have the right to conduct research in an environment free from conflicts of interest and the responsibility to maintain their research free of conflicts of interest.
web.mit.edu/policies/4/4.4.html
8. Graduate students have the right to conduct research in an environment free from academic misconduct and dishonesty and a responsibility to maintain standards of academic integrity and responsible conduct of research.
web.mit.edu/policies/10/10.1.html
9. Graduate students are protected from personal exploitation. In the case of full-time research assistants, supervised activities should be confined to thesis research and professional development.
odg.mit.edu/gpp/roles/roles/student-and-faculty
web.mit.edu/policies/8/8.2.html - sub3
10. Graduate students in a paid assistantship have a right to paid vacation in accordance with Institute policy.
web.mit.edu/policies/8/8.3.html
11. Graduate students must be notified of the work requirements for each subject, including grading criteria and procedures, at the beginning of each term.
web.mit.edu/faculty/teaching/termregs.pdf
12. Each academic unit should ensure that students have ready access to the following information.
 - A. Degree requirements
 - B. Academic deadlines
 - C. Time limits for seeking advanced degrees
 - D. Departmental procedures for general and/or qualifying exams
 - E. Guidelines for resolving concerns or conflicts within the department
 - F. Individuals available for consultation regarding student issues and problems
 - G. Criteria for termination or withdrawal of a graduate student
 - H. Rules governing teaching assistant and research assistant appointments and fellowshipsodg.mit.edu/gpp/roles/roles/department
13. If a department or program is considering terminating a graduate student, that student should be made aware at an early stage of the reasons for such consideration, and should be notified in writing when formal consideration of termination is initiated.
odg.mit.edu/gpp/roles/roles/department

Quick Guide to the Structure of the AeroAstro PhD Program

The Doctoral Qualifying Examination:

- Requires endorsement from a faculty member and minimum of 4.4 GPA
- Must be taken during IAP occurring between 3rd and 4th terms (Fall registration)
- Consists of a field exam and a research evaluation
- Research advisor is not present during the research evaluation
- Qualifier outcome and feedback is communicated by the advisor only

The Doctoral Committee:

- At least one AeroAstro faculty member
- At least 3 members: faculty or recognized experts in the research field
- Formed not more than 2 regular semesters after passing the Qualifying Exam

The Major Field of Study:

- At least 5 subjects in a proposed field of study
- Approved by the doctoral committee

The Minor Program of Study:

- 30 units (typically 3 subjects) in technical subjects related to AeroAstro and sufficiently different from the major field
- Approved by the doctoral committee

The Math Requirement:

- At least 24 units (2 subjects) in graduate level course 18 subjects or subjects in the approved math requirement list

The Thesis Proposal Defense:

- Scheduled no later than 3 regular semesters after passing the Qualifying Exam
- External evaluator: a faculty or recognized expert on the research field
- Department representative could be an AeroAstro member of the committee. A representative external to the committee could be assigned, if requested.
- Structure:
 - o Discussion of written document and agreement (or not) to proceed (student should not be present)
 - o 30 minute presentation followed by ~30 minute Q&A
 - o Committee deliberation and decision (student not present during deliberation)

The Thesis Defense:

- Scheduled no later than 4 regular semesters after passing the proposal defense
- Two thesis readers: faculty or recognized experts on the research field not already on the doctoral committee
- Department representative assigned by the graduate office
- Structure:
 - o 60 minute presentation followed by ~30 minute Q&A
 - o Committee deliberation and decision (student not present during deliberation)

Massachusetts Institute of Technology

The Doctoral Program

in

Aeronautics and Astronautics

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- Change to Minor Proposal Process
- Minor edits and updates

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1. General Description

The Doctoral Program of the Department of Aeronautics and Astronautics offers opportunities for advanced graduate study and research in the disciplines of aeronautics and astronautics. In recognition of creative and independent accomplishment at a high level of excellence, the Department awards either the Doctor of Philosophy (PhD) or the Doctor of Science (ScD) degree. There is no substantive difference between the two degrees, and the choice of degree name is that of the individual recipient.

The two major components of the Doctoral Program are course work and research. Together these are intended to stimulate intellectual growth and develop powers of objective understanding of the physical world. The course work focuses on a program of study in the student's chosen major and minor fields of specialization. Its purpose is to broaden the student's command of basic scientific principles, encourage the imaginative application of science and technology for the productive and economic uses of mankind, and foster the ability to express and communicate ideas in the English language. The research involves an original investigation of an advanced problem, the results of which are summarized in a written thesis and reported in a thesis seminar.

2. Administration of the Doctoral Program

The Doctoral Program is administered by the Department Graduate Committee (GradComm). All questions regarding application of policy and procedures of the Department's Doctoral Program must be resolved and approved by the GradComm. This includes the scheduling of examinations and of thesis presentations, and the certification that requirements have been satisfactorily completed. Students are advised to keep the Chair of the GradComm informed of their plans and progress through the Graduate Program administrator.

3. Doctoral Program Requirements

A checklist of all Doctoral Program requirements is in Appendix A. They are detailed in subsequent sections. Students should also refer to the following documents:

- a. *Thesis Specifications Booklet* - <http://libraries.mit.edu/archives/thesis-specs/>.
- b. *Graduate Student Education Manual* – <http://web.mit.edu/gso/gpp/index.html>.

3.1 English Evaluation Test

All incoming graduate students who were required to submit TOEFL and/or IELTS test scores for admission are required by Institute rules to take the Department of Humanities English Evaluation Test (EET) offered at the end of January and August. Results of the exam are given directly to the student by the EET staff and a copy forwarded to the AeroAstro Graduate Administrator. This test is a proficiency examination designed to indicate areas where deficiencies may still exist and recommend specific language subjects available at MIT.

3.2 Graduate Writing Exam

The department requires that all entering graduate students demonstrate satisfactory English writing ability by taking the Graduate Writing Exam offered online each July by the Program in Writing and Humanistic Studies. Students admitted in February must take the examination with those admitted in September. Students admitted into an interdisciplinary program through AeroAstro will also be

required to take the Writing exam. The Writing exam will be waived for students in interdisciplinary programs that require a technical writing class approved by the AeroAstro GradComm.

Students can only take the exam once and must score 80 or above to fulfill the requirement. Examinees whose score 75 and below are required to take a writing workshop during their first January Independent Activities Period (IAP), for a letter grade. This must be done during the first IAP period.

3.3 Admission to the Doctoral Program (Qualifying)

Admission to the Doctoral Program in this department is a five step process:

1. Admission to the department's Graduate Program
2. Passing performance on the Field Exam (FE)
3. Passing performance on the Research Evaluation (RE)
4. Completion of an SM degree
5. Granting of admission to the Doctoral Program through a faculty review consisting of an examination of the student's achievements including an assessment of the quality of the past research work and evaluation of the student's academic record in light of the performance on the FE and RE. Note: Often, a student will take the FE and RE prior to completing his/her SM. In this case, admission to the Doctoral Program will be conditionally granted pending successful completion of an SM.

The FE and RE formats are discussed in detail in Section 4.

3.4 Research and 16.THG Requirement

Given the integral role of research in graduate studies and importance of feedback to the student, the department requires that:

- All graduate students must register for 16.THG every semester. The number of credit hours of 16.THG should be appropriate to the student's situation and should be agreed upon by the student and advisor upon registration each semester.
- For the Fall and Spring semesters, a formal research progress evaluation will be conducted between the student and advisor in the process of assigning a grade for 16.THG. This progress evaluation is administered through a web-based system maintained by the department's academic programs office.

Additional information on the 16.THG requirement including advice on determining an appropriate number of credit hours is given in documentation on the department's website.

3.5 The Thesis Committee

The candidate forms the Thesis Committee by visiting members of the faculty and research staff whose research interests are similar to the candidate's own interests, discussing plans and objectives with them and verifying their willingness to serve. This action, including a first meeting with the

Thesis Committee, should be taken within one year of admission to the Doctoral Program (see Section 3.3).

3.5.1 Roles of the Thesis Committee

1. Advising and supervising the candidate's research work
2. Approving a major program of study
3. Development of a minor program of study
4. Conducting the thesis proposal defense
5. Monitoring the quality of the candidate's academic performance in all subjects, and ensuring at all stages of the program that the candidate is making satisfactory progress towards the degree.
6. Monitoring and suggesting modifications to drafts of the candidate's thesis prior to formation of the ad hoc Thesis Defense Committee.
7. Participating in the ad hoc Thesis Defense Committee.

The Thesis Committee does not assume responsibility for the quality of the research performed by the candidate--its role in the process is to evaluate critically the progress reported by the candidate, and offer suggestions and advice which might help the candidate in the pursuit of the research goals. The quality of the research is the sole responsibility of the candidate, and is the essential measure by which the faculty judges performance in the doctoral program.

3.5.2 Membership of the Thesis Committee

Thesis Committee Chair

The Thesis Committee Chair plays a role as department academic representative on the committee. The role is a management function in addition to an intellectual one. The Thesis Committee Chair *must* be a faculty member¹, emeritus faculty member, Professor of the Practice², or Senior Research Scientist/Engineer/Associate³ in the department. Note: The Thesis Committee Chair will frequently also be the Thesis Advisor. These two roles are not exclusive.

Thesis Advisor

The Thesis Advisor is the main intellectual advisor for the thesis research. Faculty members, emeriti faculty, Professors of the Practice, and Senior Research Scientist/Engineer/Associates are eligible to be Thesis Advisors. Principal Research Scientist/Engineer/Associates are also eligible *providing they have the written permission of the Department Head*⁴.

The policies and procedures governing the make-up of the Thesis Committee are in effect for *all* students who enter the doctoral program in February 2005 or later.

¹ Faculty members, as defined in *Policies and Procedures*, include only Professors, Associate Professors, and Assistant Professors

² *Policies and Procedures* emphasizes the connection of Professors of the Practice with education in the statement that they "demonstrate a deep commitment to teaching and research".

³ Senior S/E/A are academic staff, a different category from other research appointments. Specifically, as stated in *Policies and Procedures*, "Senior Research Scientist, Senior Research Engineer, and Senior Research Associate are the senior positions in the campus research staff structure and for that reason have been designated academic staff positions with special status and prerogatives."

⁴ A Deputy, Associate, or Assistant Head would also be able to sign off for this.

Current Principal Researchers who are Thesis Advisors of students at the time this policy is put into effect (February 2005) are grandfathered for those specific students only. For any additional doctoral students the written permission must be in place.

Thesis Committee Member

The Thesis Committee must have at least three members. *Two of these must be MIT faculty members, including emeriti faculty, or Professors of the Practice in the major field, i.e., two faculty who are familiar with the field and are expected to contribute to the research.* The other committee members may be MIT faculty, MIT research staff, or individuals who are familiar with the field from industry, government, or another university. The advisor for the minor field (the so-called "minor advisor" as formerly denoted) does not count as one of the two faculty members needed for the committee unless the "Minor advisor" is also able to advise on the major field of study.

3.5.3 Thesis Committee Meeting Record and Frequency

The formal log of Thesis Committee meetings is the *Doctoral Program Record Form*. The form includes the names of the members of the Thesis Committee, a list of major and minor subjects, which the student must complete, and a record of important dates and milestones in the candidate's progress toward the degree. All important decisions and recommendations of the Thesis Committee, dates of completion of each requirement of the doctoral program and of requirements made by the thesis committee or the department GradComm must be recorded in the *Doctoral Program Record Form* in the Academic Programs Office. It is the responsibility of the candidate to ensure that recommendations for future action are recorded in the *Doctoral Program Record Form* by the Thesis Committee Chair, and to return the form to the Academic Programs Office, Room 33-202.

It is also the responsibility of the candidate to undertake any course of action recommended by the Thesis Committee. Finally, the candidate must keep the Thesis Committee informed of plans and progress by calling a meeting of the Thesis Committee **at least once each term**.

3.5.4 The Doctoral Stipend Rate

Students admitted to the Doctoral Program (as described in Section 3.3) become eligible for the doctoral stipend rate. Note: Students conditionally admitted to the Doctoral Program prior to completion of an SM must complete the SM to become eligible for the doctoral stipend rate.

3.6 The Major Program of Study

The student should propose to the Thesis Committee for its approval a specific set of subjects that will constitute the major program of study for the degree. At a minimum, this program will include at least five graduate subjects in the major field. Subjects taken in the SM program can be counted toward this requirement.

Doctoral candidates are normally expected to take their major subjects at the Institute.

3.7 The Minor Program of Study

The Minor Program must consist of a coherent set of related graduate subjects adding up to at least 30 units (typically three courses) in a field of study related to Aeronautics and Astronautics, which is not in the candidate's primary field of study. The aim of the Minor requirement is to broaden the

candidate's knowledge and perspective of fields that support the candidate's capabilities as an aerospace engineer. In consultation with his/her Thesis Committee, the student proposes a minor program with a set of subjects that is sufficiently different from the major field.

3.8 The Graduate Mathematics Requirement

The purpose of the Graduate Mathematics Requirement is to give students exposure to advanced mathematical concepts at the graduate level. Although mathematics is an integral part of all engineering curricula, it is our experience that additional math subjects can add significantly to the student's problem solving capabilities. A detailed description of this requirement is available on the department's website or by contacting the Academic Program staff.

3.9 The Thesis Proposal and Proposal Defense

The purpose of the thesis proposal and proposal defense is to ensure that the student has (a) performed an adequate literature search, (b) a deep understanding of their research field, (c) identified a problem that could produce a doctoral-quality contribution(s), and (d) a reasonable plan for how to proceed. The student prepares a thesis proposal document that is then distributed to an evaluation committee, which includes the student's Thesis Committee. The student then defends this proposal to the evaluation committee. Based on the proposal and the proposal defense, the evaluation committee may recommend actions to improve the student's proposal and his/her understanding of their research field. Details of the thesis proposal and proposal defense are given in Section 5.

3.10 The Doctoral Thesis and Thesis Defense

A major specific objective of the Doctoral Program is the successful completion of a research program and its summary in a doctoral thesis. Ultimately, it is the quality of the research and of the summary in the thesis that reflects the degree of success that a candidate achieves in the Doctoral Program. The Thesis Defense is discussed in Section 6.

An essential requirement in writing a thesis is to ensure that the document conveys information to the technically qualified reader. The style of presentation should be consistent with the style of technical reports found in the professional literature. Structurally, the thesis should begin with a clear introduction to the problem, its history, and importance. It should contain a description of the technical approach, a summary and discussion of results, the conclusions drawn from the results, and recommendations on research that might be undertaken in the future in the light of the results. If the thesis relies on experimental data found nowhere else, such data must be included in the document.

4. Rules of the Field Examination (FE) and Research Evaluation (RE)

In addition to the descriptions below, more information on the FE and RE are available on the department website including past exams, explanations of the assessment process, etc.

4.1 Admission to the FE and RE

Only graduate students registered in the Department of Aeronautics and Astronautics may take the FE/RE.

Anyone planning on taking the FE/RE must have an endorsement of a person that meets the requirements of a doctoral thesis advisor (see Section 3.5.2). Note: the endorser does not have to be the student's doctoral thesis advisor should the student be admitted to the doctoral program. The endorser must provide the following input:

- 1) length of time and the capacity in which the faculty has known the student, if the faculty member has limited knowledge of the student, an interview should be held; and
- 2) specific strengths and weaknesses of the applicant that may bear on the success of the student as a doctoral candidate.

The endorser is expected to make a presentation of the candidate's academic achievements at the faculty review following the FE/RE.

In order to be admitted to the FE/RE, the student must attain a minimum cumulative grade point average of 4.4 in technical subjects as a graduate student at MIT.

4.2 Scheduling of the FE/RE

The FE/RE is offered once each academic year, usually during the January Independent Activities Period (IAP).

All graduate students who are admitted to this department (with or without a prior SM degree) and who wish to be selected as doctoral candidates must take the FE/RE no later than the IAP which occurs between the third and fourth term following their initial registration as graduate students in the department. (Students who first register in February must take the FE/RE between the second and third term following their registration.)

A candidate for the SM degree who does not take the FE/RE during the time interval specified above must re-apply for graduate admission. A student who decides to take a leave of absence after having passed the FE/RE may defer the start of their doctoral program for up to 2½ years. For example, if a student passes the FE/RE in January 2016, he/she may start the doctoral program any time between then and September 2018. If a student does not return to continue their academic program by the end of the 2½ year period, he/she will also have to reapply to the graduate program and retake the FE/RE.

4.3 Field Examination Structure

The FE is solely an oral examination. Each student selects a single field for the FE based upon his/her research interests. The current set of fields is:

1. Aerospace Computational Engineering
2. Air-Breathing Propulsion
3. Aircraft Systems Engineering
4. Air Transportation Systems
5. Autonomous Systems
6. Communications and Networks
7. Controls
8. Humans in Aerospace
9. Materials and Structures
10. Space Propulsion
11. Space Systems

The content of the FE is specific to each field and is equivalent to two-to-four H-level graduate subjects in the field. The specific content for each FE is available through the department's Academic Programs Office on the department's webpage.

Prior to the oral examination, students will be given questions in a written form and allowed to prepare for 60 minutes. While the written questions will be the basis for most of the FE, additional topics may also be covered. Following the preparation period, the oral examination will then be conducted for a period of 45 minutes.

The standard for passing the FE is the demonstration of superior intellectual ability through skillful use of concepts, including synthesis of multiple concepts, in foundational, graduate-level material in a field of aerospace engineering. NOTE: this wording borrows heavily from the MIT Letter Grade description for an A.

4.4 Research Evaluation Structure

While the FE is focused on intellectual ability as demonstrated on foundational subjects in a field of aerospace engineering, the RE is a direct assessment of the student's ability to perform research. The RE will consist of a 20 minute presentation by the student **on research they have performed** followed by 25 minutes of questions.

The standard for passing the RE is the demonstration of a superior ability to solve research-oriented problems with guidance in a field relevant to aerospace engineering. The phrase "with guidance" is included to recognize that a student at this stage in his/her pursuit of a doctorate degree is not expected to conduct research without supervision; rather the expectation is that given guidance on the research problem including possible approaches, the student has a superior ability to solve research-oriented problems.

In preparing for the RE presentation, the student is encouraged to seek the advice of others including his/her advisor(s). The intent is that the student's preparation for the Research Evaluation

presentation is consistent with the best practices for preparing a research presentation for other purposes (such as a conference or seminar). In addition, the department will provide students with a Research Presentation Practicum opportunity to help prepare for the RE.

While a clear and concise presentation is important, **the major factor in the RE assessment is the student's ability to respond to questions from the examiners.** In particular, the student will be assessed on their critical thinking skills, their understanding of the technical material, and their ability to put their research into the context of the field as a whole.

4.5 The Faculty Review & Admission to Doctoral Program

After the examination process has been completed, the department faculty will review the performance on the FE, the RE, the academic achievements of the student, the quality of the research work in progress, and all additional evidence that attests to the student's potential to successfully conduct original research at the doctoral level. Following this review, the faculty will vote to decide on one of these three outcomes:

1. **Pass**
2. **No Pass**, but option to--
 - a) retake the FE and RE
 - b) retake the FE only
 - c) retake RE only
3. **Fail**, with no option to retake

A student that has passed will be admitted to the Doctoral Program; if the student has not completed an SM, the admission is conditional upon successful completion of an SM. A student who failed the FE/RE (with no option to retake) will not be admitted to the Doctoral Program.

4.6 Retake Policies and Procedures

1. Students who have passed the FE and been given the opportunity to retake the RE (outcome 2c above), may do so in April/May or the following January. All other students must do the retake the following January, subject to the usual FE/RE entrance rules.
2. For any FE/RE retake, the endorser may submit an amended written assessment of the student.
3. The only possible outcomes for any retake are **Pass** or **Fail**.

5. The Thesis Proposal and Proposal Defense

The purpose of the thesis proposal and proposal defense is to ensure that the student has

- a) performed an adequate literature search,
- b) a deep understanding of their research field,
- c) identified a problem that could produce a doctoral-quality contribution(s), and
- d) a reasonable plan for how to proceed.

5.1 Thesis Proposal Requirements

The candidate must prepare a thesis proposal consisting of:

- A clear, specific statement of the technical problem and the objectives of the proposed research
- A thorough, adequately referenced, summary of previous work done on the problem
- A plan for the initial approach to the problem, an outline of the major foreseeable steps to a solution of the problem, an estimate of the time that might be required, and a list of the facilities needed.

The purpose of the proposal is two-fold: the work leading to the proposal helps the candidate define the research problem and plan the initial phases of the research, while the proposal itself helps the faculty to determine whether the problem and research path are indeed of doctoral research caliber, and whether the candidate understands both sufficiently to begin exploration. Formally, it should include:

- A separate title page, including a proposed thesis title, the candidate's name, the date, and a list of the members of the candidate's Thesis Committee,
- An abstract contained on a single sheet,
- The proposal, which must address all elements as listed above (including a bibliography of cited references).

Examples of thesis proposals are available on the department's website.

5.2 Scheduling the Thesis Proposal Defense

The Thesis Proposal and Thesis Proposal Defense are evaluated by the student's Thesis Committee and one additional member (external to the committee, generally from faculty or senior research staff) whose recognized professional interests and achievements qualify them to judge the quality and merits of the proposed research. It is advisable that the candidate seeks and recommends to the Thesis Committee and to the Chair of the GradComm the persons who would serve in this capacity with expertise in the student's research. The Academic Programs Office will designate a department representative from the faculty in the department who will chair the Thesis Proposal Defense. The department representative could be a member of the Thesis Committee. Thus, the following people form the evaluation committee and must participate in the Thesis Proposal Defense:

1. the designated Department Representative,
2. the candidate's Thesis Committee, and
3. an external evaluator with expertise in the student's research topic.

In addition, any member of the faculty may attend and participate in the Thesis Proposal Defense.

The thesis proposal and proposal defense should be successfully completed **at most three regular terms (a regular term is the Fall and Spring terms) after being admitted to the doctoral program. It is the responsibility of the candidate to bring to the attention of the Thesis**

Committee, at some stage within this time period, the need to schedule the Thesis Proposal Defense. Once the Thesis Committee has agreed that the Thesis Proposal Defense should be scheduled, it is the responsibility of the candidate **to schedule a mutually convenient date with his/her Thesis Committee** and external evaluator, and to coordinate with the Academic Programs Office staff who will schedule a department representative.

At least **ten business days** prior to the Thesis Proposal Defense, the student must submit a Thesis Proposal Defense Application and provide a copy of the thesis proposal to his/her Thesis Committee, the external evaluator, and the Academic Programs Office staff (note: ten business days is equivalent to **two calendar weeks** unless there are MIT holidays during this time, e.g. Thanksgiving).

5.3 The Structure of the Thesis Proposal Defense

The typical process for the Thesis Proposal Defense is:

1. The Thesis Proposal Defense begins once the candidate and all members of the evaluation committee are present.
2. The candidate will then be asked to leave the room so that the evaluation committee can discuss the candidate's thesis proposal. The purpose of this discussion is to determine if the written thesis proposal is adequate to proceed with the thesis proposal defense; if the thesis proposal requires major revisions, the proposal defense presentation will not be made and feedback will be given to the candidate on the written document. If the proposal needs minor revisions, the evaluating committee may still proceed with the thesis proposal defense.
3. The student presents his/her thesis proposal. This presentation should not exceed thirty minutes. Questioning during the presentation should be only for clarification purposes.
4. The evaluation committee will then question the student on his/her thesis proposal and, more generally, his/her proposed research field.
5. Once all questioning is complete, the candidate will leave the room and the evaluation committee will discuss the candidate's performance. Upon reaching a recommendation, the members of the evaluation committee will discuss the results with the candidate.

The Thesis Proposal Defense is expected to be completed in 1.5 hours.

Examples of presentations from previous thesis proposal defenses are available on the department's website (under Academics->Graduate Program->Doctoral Degree).

5.4 Results of the Thesis Proposal and Proposal Defense

If the candidate has successfully demonstrated criteria a)-d) given in Section 5.0, the Thesis Proposal and Defense will be found adequate. Otherwise, the student's proposal, defense, or both will have been found inadequate. In these situations, the student must revise and/or re-defend the proposal in accordance with the findings of his/her evaluation committee. Furthermore, the evaluation committee may make specific recommendations to help the student improve his/her performance including, but not limited to, additional academic subjects to take.

The evaluation committee for a candidate that must revise or re-defend his/her Thesis Proposal should be the same as the first attempt including the chair of the Grad Comm (or designated representative). In the event that this is not possible, the Grad Comm is empowered to handle exceptions. A candidate who does not successfully write or defend his/her Thesis Proposal upon a second attempt will be required to withdraw from the doctoral program. Furthermore, the student

must successfully complete the proposal and defense within at most 6 months of the first attempt or be withdrawn from the doctoral program.

6. The Thesis Defense

Formally it is the responsibility of the Department faculty as a whole to accept or reject a thesis, and to recommend to the Institute faculty that a candidate be granted a degree. Accordingly, the candidate is required to present and defend the thesis orally, at a thesis seminar, to members of an *ad hoc* Thesis Defense Committee convened for this purpose, as well as other faculty members who wish to attend.

6.1 The MIT Degree Application Form

This form must be completed before the Thesis Defense can take place, and is subject to MIT deadlines.

6.2 The Thesis Defense Committee

It is required that the *ad hoc* Thesis Defense Committee include six members selected as follows: three members of the candidate's Thesis Committee including the Chair; a designated faculty department representative outside the candidate's area of research, provided by the Academic Programs Office; and two individuals (generally from faculty or senior research staff) whose recognized professional interests and achievements qualify them to judge the quality and merits of the thesis being presented. The department representative is responsible for running the defense, including moderating questions, taking notes in the official record book, and serving as an unbiased party. It is advisable that the candidate seeks and recommends to the Thesis Committee and to the Chair of the GradComm the persons who would serve in this capacity.

6.3 The Presentation of the Thesis to the Faculty

The procedure for the presentation, oral defense, and faculty assessment of the doctoral thesis consists of two parts: an appropriately scheduled thesis seminar, and a meeting of the six members of the Thesis Defense Committee and all other faculty present at the seminar to consider accepting or rejecting the thesis, or requiring that it be modified. The thesis seminar is open to all members of the academic community who wish to attend. The faculty meeting convened for the purpose of judging the merit of the thesis is open only to the six members of the *ad hoc* Thesis Defense Committee, who constitute the quorum, and to all other faculty members who were present at the oral defense and wish to participate in the discussion and vote.

6.4 Scheduling the Thesis Defense

For a thesis defense to be scheduled, the candidate must obtain the formal approval of the committee by working with the Graduate Administrator and the Academic Programs Office. Specifically, the following process must be followed leading up to the candidate's thesis defense:

1. The candidate gives to his/her Thesis Defense Committee a draft of the thesis, which, in the candidate's opinion, is complete, and upon which the candidate is prepared to have the research work judged by the faculty.
2. The candidate notifies the Academic Programs Office staff immediately that a thesis draft has been given to his/her Thesis Defense Committee with the intent of obtaining approval to proceed with the Thesis Defense. This notification must include telephone and email contact information for all members of his/her Thesis Defense Committee.
3. The Academic Programs Office will contact all members of the candidate's Thesis Defense Committee via email to confirm (1) that they have received the thesis draft and (2) that, within **ten business days** (2 calendar weeks), they must judge whether it is appropriate to

schedule a thesis seminar (see Note below). Furthermore, the earliest date that the candidate's thesis defense can occur is **thirty business days** (6 calendar weeks) after the date that the thesis draft has been submitted to the Thesis Defense Committee and the Academic Programs Office has been notified.

4. No later than **ten business days** (2 calendar weeks) before the thesis defense, the candidate must submit an electronic PDF copy of a proposed final draft of the thesis for distribution, to the following parties:
 - each member of the Thesis Committee,
 - every other faculty member or guest invited to participate in the *ad hoc* Thesis Defense Committee, and
 - the Academic Programs Office, for posting on the faculty wiki, which is available to all AA faculty members

Furthermore, the candidate will submit the following electronically to the Academic Programs Office at least **ten business days** (2 calendar weeks) before the defense, to be included in the thesis defense announcement:

- the thesis abstract and title
- the finalized time and location of the defense

Within the guidelines outlined above, the Chair of the GradComm is empowered to deal with all matters that arise from unforeseen absences at the scheduled time of thesis presentation.

Note: A candidate should not assume that once a thesis committee agrees to schedule a thesis seminar, the Committee considers the research and thesis satisfactory. In some cases, while a great amount of effort may have been expended, and an accomplishment of some form may be identified, the Thesis Committee may question the quality and importance of the results and may agree to schedule a thesis seminar in order to seek the counsel of the faculty-at-large whether the thesis is acceptable as a department document. In any case, the thesis committee should provide a frank assessment to the candidate of the adequacy of the research prior to agreeing to schedule a thesis seminar.

6.5 The Thesis Seminar

In the thesis seminar the candidate discusses, in a period of not more than 60 minutes, the motivation, methodology, results, and conclusions of the research. Afterwards the candidate is expected to defend the thesis in response to questions by the faculty and guests. The candidate is also expected to be available to answer questions that may arise at the closed faculty meeting, which follows the open presentation.

6.6 Evaluation of the Thesis

At the faculty meeting following the thesis defense, any member of the *ad hoc* Thesis Defense Committee and of the faculty in general may object to accepting the thesis. If the faculty present cannot agree on the merit of the thesis, the matter will be referred to the Department GradComm, who may choose to resolve the issue itself, or may appoint a special review committee which does not include members of the candidate's original Thesis Defense Committee.

There is seldom a question of acceptance when a clearly recognizable advance has been achieved and which has been presented in a definitive, explicitly technical report. In such a case, the

professional performance of the competent research worker will be evident to the technically trained colleague, even if the colleague is not a specialist in the field.

It may happen that a significant contribution has been made, but is so poorly presented in the thesis document as to be nearly unintelligible without an inordinate effort on the reader's part. Such a document is not acceptable; it is the candidate's obligation to prepare a written document and present an oral report that make the achievements clear to a reasonably well qualified, but inhomogeneous audience such as the department faculty. The candidate will not be recommended for the degree and the candidate's name will be withheld from the degree list until a satisfactorily completed document has been presented. The Thesis Committee is responsible for judgment on this point.

6.7 Modification of the Thesis and the Manuscript Prepared for Publication

The faculty will decide, at the meeting following the thesis defense, whether the thesis is acceptable as presented or whether it must be modified. If modifications are required, the faculty will specify whether it considers these modifications to be "major" or "minor."

Minor modifications may involve correction of typing errors, alterations of structure or style of presentation in order to conform to format standards set by the Institute Archives, and changes in content or emphasis which do not substantially alter the candidate's analysis, results, or conclusions.

Revisions associated with errors in analysis, with misinterpretation of the results, or with unwarranted conclusions will require "major" modifications. In such cases, the faculty may require another thesis presentation based on the revised thesis draft, to be scheduled for a later date in accordance with the rules for scheduling a thesis seminar.

6.8 Submitting the Thesis

After a thesis has been accepted by the faculty, all members of the Thesis Committee indicate their endorsement by placing their signatures on the title page of the original copy of the thesis document.

After these signatures have been obtained, the candidate submits the original and one copy of the thesis to the Academic Programs Office. Both loosely bound copies of the thesis document must be on archival bond paper. A member of the staff in the Academic Programs office verifies that these copies satisfy the requirements set by the Institute on style and format. If the document satisfies all requirements, the candidate receives a department receipt for the thesis and a final grade is obtained from the Thesis Chair and submitted to the Registrar's Office. At this point, a student will not be permitted to make changes to the thesis. The Chair of the Department GradComm signs on behalf of the faculty of the department and both copies of the thesis document are delivered to the Archives Office.

APPENDIX A Doctoral Program Checklist

Note: timings in this checklist are given in number of *terms* and refers only to regular fall and spring terms (i.e. not including summer terms)

- ___ English Evaluation Test (for non-native English speakers) **(at entrance)**
- ___ Graduate Writing Exam **(first term)**
- ___ A minimum cumulative grade point average of 4.4
- ___ Faculty endorsement for the Field Exam/Research Evaluation (FE/RE)
- ___ Field Exam/Research Evaluation **(within first three terms)**
- ___ Admission to the doctoral program
- ___ Formation of and first meeting with Thesis Committee **(within two terms of admission to doctoral program)**
- ___ Regular meetings with Thesis Committee **(at least twice per year)**
- ___ Update *Doctoral Program Record Form* **(after every Thesis Committee meeting and requirement satisfaction)**
- ___ Major program selection
- ___ Minor program selection
- ___ Thesis Proposal and Proposal Defense **(within three terms of admission to doctoral program)**
- ___ Satisfactory performance in the minor field
- ___ Satisfactory performance in the major field
- ___ Completion of Graduate Mathematics Requirement
- ___ Institute Residency Requirements
- ___ MIT Degree Application Form
- ___ A defense of the thesis **(within four terms of completion of thesis proposal and defense)**
- ___ A satisfactory thesis **(within four terms of completion of thesis proposal and defense)**

APPENDIX B

Doctoral Student Warning Policy

The Department's Graduate Committee meets at the end of each academic term to monitor student progress throughout the graduate academic program. At this end-of-term meeting, the Graduate Committee will authorize the Committee Chair to notify students by letter if they are not making appropriate progress. In addition, a warning from the Dean of Graduate Education can be requested that could eventually lead to a denial of registration. The following are the most common reasons for warnings or other actions:

- "U" grade on 16.THG
- GPA falling below 4.4
- Has not had first Thesis Committee meeting within two regular terms of admission to the doctoral program
- Has not successfully completed the thesis proposal and proposal defense within three regular terms of admission to the doctoral program
- Has not successfully defended thesis within four regular terms of passing the proposal defense

For most problems except a "U" grade: For a first occurrence, a warning letter from the department's Graduate Committee will request the student improve his/her performance, provide a program completion plan, or follow up with the Graduate Committee in an appropriate manner. For a second occurrence from either a continued or new problem, the department will issue a second departmental warning letter. In addition, the department will generally request a warning letter from the Dean of Graduate Education. On a third occurrence, the department will generally make a request to the Dean that the student not be allowed to continue his/her studies in the Department of Aeronautics and Astronautics.

For a "U" grade on 16.THG: For a first occurrence, a warning letter from the department's Graduate Committee will request the student improve his/her performance, provide a program completion plan, or follow up with the Graduate Committee in an appropriate manner. In addition, the department will generally request a warning letter from the Dean of Graduate Education. On a second occurrence, the department will generally make a request to the Dean that the student not be allowed to continue his/her studies in the Department of Aeronautics and Astronautics.

While the general policies for responding to students with insufficient progress are described above, individual circumstances will be accounted for in the application of these policies. Furthermore, students are encouraged to seek the assistance of their advisor(s), the Academic Program staff, or the Graduate Committee to help resolve any problems that are hindering their progress.

Steps to a Doctoral Degree in CEE

1. Begin planning Doctoral Program with academic advisor [Fall Academic Year 1 (AY1)]
2. Approval of **Doctoral Program** and admission to general exam through **Student Interview** [Fall AY2]
3. Selection of Exam Committee and Scheduling of **General Exam Part 2** for April or May AY2 [scheduling done in January AY2]
4. Complete **General Exam Part 1 and Part 2** [by end of AY2]
5. Complete **Responsible Conduct of Research** course [by end of AY2]
6. Formation of Doctoral Thesis Committee following completion of General Exam
7. **Approval of Doctoral Research Proposal** [by Dec. 31, AY3]
8. Meet regularly [minimum of twice per year] with Doctoral Thesis Committee
9. Doctoral Degree earned with satisfactory defense of the Ph.D. thesis [AY 5 or 6].

Doctoral Program

A Doctoral Program in CEE consists of 120 units of graduate level coursework, including a **3-Subject Core** and one breadth subject. The student should consult their faculty advisor when preparing their Doctoral Program. The **3-Subject Core** reflects core knowledge in the student's chosen field, which is tested in **Part 1 of the General Exam** (below). The three subjects are selected from an approved list of 4 to 5 subjects within a specific sub-group of CEE. The approved subjects are available at the CEE graduate forms page of the CEE website, <http://cee.mit.edu/graduate/forms> and are also included at the end of this document.

The remainder of the doctoral program consists of graduate subjects that complement the Core. In addition, the Doctoral Program must include one breadth subject. The breadth subject is drawn from a discipline that is distinct from the Core. Students may consider subjects in science writing, global languages (excluding ELS subjects), political science, business, law, and other branches of science and engineering. The Doctoral Program may incorporate subjects completed during a CEE Masters degree. In addition, up to 24 units of graduate credit taken outside MIT or taken in a non-CEE MIT SM degree may be transferred to the CEE Doctoral Program. All transfer credits must be related to the proposed doctoral research area. Students may petition for additional transfer credit [up to 24 additional units] if MIT does not have a comparable subject offered and the subject is not counted toward a different degree at MIT or elsewhere. The Academic Programs Office must approve transfer credits from outside of MIT. The Doctoral Program form can be downloaded from the CEE web site <http://cee.mit.edu/graduate/forms>.

Student Interview [Fall Term AY2]

During the Fall term, second year students are sent an email from the Graduate Academic Administrator (Kiley Clapper) announcing the upcoming Student Interview and requesting them to indicate if they wish to participate. Students select which of the two interviews to attend by contacting the appropriate Doctoral Program Officer listed below. Approval of the Doctoral Program and admittance to the General Exam are based on a review of academic and research performance. Students are expected to have a GPA ≥ 4.5 to be considered for the General

Exam. The Student Interview is held with a group of faculty and research staff, organized by research area (see below).

A minimum of one week before the Student Interview, the following should be submitted to one of the following Doctoral Program Officers

Prof. Dennis McLaughlin – Environmental Science and Engineering, CSE
dennism@mit.edu

Prof. Oral Buyukozturk - Mechanics of Materials, Structures, Geomechanics, Systems, CSE
obuyuk@mit.edu

- 1) A one-page summary of proposed doctoral research written for a general scientific audience.
- 2) The Doctoral Program form with advisor signature. Be sure to make a copy for your records.
- 3) A one-paragraph letter from the student's research advisor stating the student's strengths and weaknesses, and stating whether, or not, they support admission to the General Exam. If the advisor supports admission to the General Exam, they should also indicate willingness to supervise the student for the proposed doctoral work and willingness to provide and/or seek funding necessary for the duration of the degree. Also indicate if the student is on full or partial fellowship. This letter (or email) is sent directly from the faculty advisor to the Doctoral Program Officer, with a copy sent to the Graduate Academic Administrator, Kiley Clapper.

At the interview, the student briefly describes the research they plan to pursue, explaining how the proposed set of subjects supports their research and career plans. The student will also identify their breadth class. Faculty may give advice on classes to add or take away from the proposed Doctoral Program. After the student leaves the room, there is a 5 to 10 minute discussion, beginning with a reading of the faculty advisor letter. At the end of the discussion, a formal recommendation is made to admit or decline the student for the General Exam, and the recommendation may include formal requirements to alter the Doctoral Program.

After the Student Interviews: The Academic Administrator [Kiley Clapper] will confer with the Doctoral Program Officers to review decisions and recommendations made by the faculty. The Academic Administrator will 1) send an email (copy to advisor and Doctoral Program Officer) to the student with the outcome, admit or decline, and any recommendation by the faculty; and 2) send the hard-copies of the research summaries and Doctoral Program forms to the respective program Officers, and 3) collect signature from the Graduate Program Chair [Heidi Nepf].

Once the Doctoral Program form has been submitted, students may not change their selection of Core subjects. The remaining subjects in the Doctoral Program may be altered, with approval from the doctoral thesis committee. A Petition for Revision of Doctoral Program is available at the CEE grad-forms web site - <http://cee.mit.edu/graduate/forms>

Research Requirement and 1.THG

Research plays an integral role in the PhD degree, and this research effort is tracked academically through enrollment in 1.THG. In Course 1, we require graduate students to register for 1.THG every semester. The number of credit hours is determined in consultation with your advisor. Through enrollment in 1.THG, students are formally graded on research performance each semester, in accordance with MIT Faculty Rules and Regulations 2.62.3. <http://web.mit.edu/faculty/governance/rules/2.60.html>

Responsible Conduct of Research

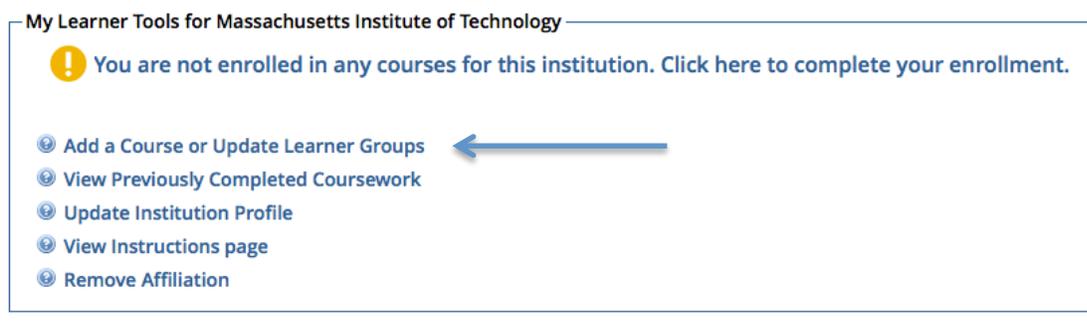
Each PhD student is required to complete MIT’s online course on the Responsible Conduct of Research within the first two years, i.e. by the end of Spring term AY2. If you are paid on an NSF grant, you are required to complete the course within 60 days of being assigned to the grant. You can access the course from this web site and following the instructions below. You will need an MIT certificate.

<http://osp.mit.edu/compliance/responsible-conduct-of-research-rcr/register-for-rcr-training>

1. On the bottom of the page, click on “accessing the site for the first time”



2. From there CITI will ask you to create a password.
3. After you have created your new password, click on “Add a course or Update Learner Group”



4. Go to question 4 and select, RCR for Engineers
5. You should then see that the course has been added

Massachusetts Institute of Technology Courses		
Course	Status	Completion Report
Responsible Conduct of Research for Engineers	Not Started	Not Earned

6. Complete The Integrity Assurance Statement before beginning the course
7. Once you have completed the course (12 modules with 80% or better on the individual quizzes) send a screen shot of your completion report to the graduate academic administrator, Kiley Clapper (kclapper@mit.edu).

General Exam Part 1 [Core Knowledge]

The General Exam Part 1 tests core knowledge within the students selected field of study, as represented by the **3-Subject Core** designated in the Doctoral Program. To pass General Exam Part 1, the student must receive a grade of A (including A-) in each of the subjects selected for the Core. The subjects identified in the 3-Subject Core are firm and rarely are exceptions permitted. In the circumstance where a subject is not offered for two consecutive academic years and there are no other options within the 3-Subject core list, a comparable level graduate subject may be substituted with approval from a student's advisor. The process for substitution is a memo, that includes the rationale for the substitution and the advisor's signature of approval, which is reviewed by the CEE faculty during the Student Interview.

If the student receives a grade less than A, they have the option of re-taking that subject to improve the grade, or taking and passing a separate written exam. The subject instructor prepares the separate written exam. It consists of an open-book question, which the student will have eight (8) hours to complete, e.g. 9 am to 5 pm. During the written exam, the student may not request information from any person other than the instructor and may not use information from the internet. All texts used by the student must be cited. The written exam should be completed in the term following the completion of the course to allow the student to study the material more deeply and improve their understating. If the instructor is not a member of CEE and declines to provide a question, a designated CEE faculty or Senior research staff within the appropriate area will write the exam.

General Exam Part 2 [Research Aptitude]

This exam tests the following skills. First, can the student formulate a research question, set out a plan of research, and interpret the results. Second, can the student clearly present and defend this research. Third, does the student have sufficient understanding of the field to answer a broad range of questions and to comment on relevant literature. The research presented by the student can be drawn from their SM or MEng thesis, their RA at MIT, or research conducted as part of a previous position. The research must be in the same field as the subgroup core listed in the Doctoral Program.

Part 2 of the General Exam must be completed by the end of the fourth academic term. In most cases, this exam occurs in April or May of AY2. Students should consult their research advisors when choosing the members of the evaluation committee (see requirements below). Your Part 2 general exam committee is encouraged to be similar or identical to the thesis committee. Students *must* submit the Part 2 Schedule Form [available at <http://cee.mit.edu/graduate/forms>] before the beginning of the term in which the exam will be held, which in most cases will be by end of January for exams on April/May of AY2.

The exam has three components.

- 1) A written document describing research completed.
- 2) A review of a relevant publication chosen by your advisor. The paper will be assigned one week before the presentation meeting.
- 3) A 30-minute oral presentation of research with significant questioning from committee.

Research Paper

The research paper should have a maximum of 10 pages, single-spaced, 12-pt font. The page limit includes figures, but not references. Students may ask their advisor for advice in the preparation of this document. Students may also get assistance from MIT's Writing and Communication Center, <http://writing.mit.edu/wcc>. The following elements must be included:

- Abstract - A concise summary of the motivation, research objectives, methods, and key results. A person unfamiliar with the topic should be able to understand the abstract.
- Introduction - Introduce the general topic and explain its relevance, e.g. what is the practical or fundamental importance of this topic. Demonstrate familiarity with previous studies related to the research. Clearly state the specific goals of the project.
- Methods – Describe and defend the methods.
- Results - Describe specific results from the research.
- Discussion - Compare and contrast the results with other studies. Explain the implications of the results to broader questions and/or applications contained in the motivation.

The student distributes the research report to their committee a minimum of one week before the presentation. The student should inquire whether each committee member prefers a pdf or hard copy, and deliver the preferred format.

Review of a Relevant Publication

Your advisor will select a single journal publication in your field. It may be a seminal paper from years ago or a brand new paper. It should not be longer than 20 pages and cannot be too broad, e.g. no general reviews of the field. You should be prepared to informally discuss the paper (no slides), focusing on a set of 3 to 5 questions that will be provided by the committee when the paper is assigned. The questions may include some of the following, or they may be more specific to the paper. Please prepare for the paper review on your own.

- What is the most important result and why is it significant?
- What is the value of the paper to the broader field?
- What are the limitations of the work and results presented?
- What is the most significant uncertainty and how could it be reduced?
- How do the results of this paper relate to your research?
- Please show the full derivation of equation (5).
- Are all of the conclusions justified by the results?
- Are the boundary conditions realistic?
- Explain in physical (chemical, biological) terms why the relationship shown in Figure 7 makes sense, or does not make sense.
- How does this paper challenge the existing theory regarding _____ ?
- Propose a new research question or hypothesis that expands on the work presented in this paper, i.e. where would you go next? Defend your choice.

Oral Presentation Meeting

The student should schedule the committee meeting for 2 hours, with the expectation that the meeting will last between 1.5 and 2 hours. The student will begin by informally presenting their response to the question(s) posed by the committee beforehand regarding the paper chosen by the committee (see *Review of a Relevant Publication* above). The student should not prepare slides for this response. Necessary visuals or equations can be sketched on the black board.

Committee members may ask questions for clarification or to go into further depth. After twenty to thirty minutes, the committee chair will end this discussion and instruct the student to begin their research presentation. The student should plan a 30-minute presentation, but the actual presentation will take longer as faculty will interrupt with questions. The committee members are expected to have read the report and come prepared with questions. The committee members should push questions to the point at which the student says, "I don't know". The student should not be afraid of saying, "I don't know". It is at this point that the real scientific discourse begins, an exchange of ideas that provides a learning experience for the student. It is important to note that the research advisor is encouraged to ask questions, but he/she *should not answer questions*. The advisor may prompt the student with further questions to help the student answer on their own. This is a test of the student's understanding and research ability, not a test of the advisor's research ideas. The GE oral presentation also serves as a practice for the student in preparation for their thesis proposal, which has a similar format.

Thesis Supervisor

A student's thesis supervisor can be 1/MIT CEE Faculty member(s), 2/CEE Senior Research Scientist/Engineer, 3/ co-advised by a CEE and other MIT faculty member, 4/WHOI Scientist with an MIT CEE academic advisor (Joint Program students only). A thesis supervisor is responsible for certifying and signing the thesis. In the case of co-supervisors, both must certify and sign thesis.

Evaluation Committee for General Exam Part 2

The evaluation committee for Part 2 is comprised of a student's thesis advisor and a minimum of two faculty or senior research staff in CEE. In many cases, this group will become the Doctoral Thesis Committee, which has the same guidelines for committee composition. The chair of the evaluation committee must be within CEE and a faculty member or Senior Research Staff and cannot be the thesis advisor. The student invites the committee members and includes their names on the Part 2 Schedule Form. After the form is submitted, one additional CEE faculty member from outside the core area will be assigned to the committee. The role of the outside person is to promote active questioning, especially on a basic level. The goal is to test the student's ability to answer questions in a way that a non-expert will understand.

General Exam Part 2 Outcomes

After the exchange of questions and ideas has finished, or at the 1hr 40 min mark, whichever comes sooner, the committee chair will ask the student to leave and wait nearby. The faculty advisor will be given a few minutes to add their perspective on the student's performance that day, on the student's broader research ability, and any specific requirements for the student. The faculty advisor then leaves the room. The remaining committee chooses one of the following outcomes.

- 1) Pass with no additional requirements
- 2) Pass with additional requirements (see below)
- 3) Fail with option to retake – the committee must include a list of specific deficiencies.
- 4) Fail with no option to retake (only if this is a second attempt)

Additional requirements could include any activity that the committee feels will improve on a perceived deficiency in core knowledge or research skill. Here are some examples,

- Repeat a class as a listener to strengthen weakness in fundamental knowledge
- Write a detailed review of a particular experimental method or paper
- Take a public speaking course
- Meet with writing center staff to go over research paper
- Do a literature search in a specific area
- Re-write a section of the research paper
- Complete additional analyses on the data presented in the paper

The student is informed of the outcome directly after the meeting. The student should be waiting nearby. In addition, the outcome is officially recorded with an email written by the Committee Chair and sent to the Graduate Academic Administrator (kclapper@mit.edu) with copy to all committee members and the student. The following information should be included.

- Who was on the committee?
- What was the outcome?
- What are the deficiencies and/or what additional requirements have been made?

Completion of the additional requirements will be monitored by the faculty advisor and communicated to the Graduate Academic Administrator (Kiley Clapper) when completed.

Doctoral Thesis Committee and Approval of Doctoral Research Proposal

After passing Part 1 and Part 2 of the General Exam (typically at end of AY2), the student forms a Doctoral Thesis Committee and within one academic term schedules a defense of Doctoral Research Proposal, i.e. typically by the end of Fall Term AY3. The Doctoral Thesis Committee consists of a minimum of three MIT faculty or research staff, including a minimum of two members from CEE. The committee may have the same membership as the Part 2 Evaluation Committee. If appropriate, the student may invite members from outside MIT. The student invites one committee member to be the Chair. The Committee Chair must be a member of CEE and cannot be the student's advisor. Once the Thesis Committee is formed, the student prepares a Research Proposal and schedules a date to present the proposal orally to the Doctoral Thesis Committee. The proposed research must be in the field defined by the student's Core area. The objectives of the research should be prepared with guidance from the advisor. Because most doctoral research is funded by existing projects developed by the advisor, it may need to meet specific benchmarks. The proposed work must accommodate these constraints. The proposal should be a maximum of 15 single-spaced pages. The necessary components are given below. The oral presentation is 45 minutes, followed by 45 minutes of questions.

Required Components in the Research Thesis Proposal

The thesis proposal should be a maximum of 15-pages of single-spaced, 12-point font. Figures are included in the page count, but references are not. The following sections must be included.

- Abstract - A one-page (or less) summary of the topic, the objectives/hypotheses to be achieved/tested, and the methods. The abstract should be written for a general scientific audience, i.e. a person unfamiliar with the topic should understand what is being proposed and why it is important.
- Introduction - The goal of this section is to motivate the research. Convince the reader why the project is important. The following progression is recommended. Introduce the topic

and explain the broader relevance, e.g. what is the practical or fundamental importance. Demonstrate familiarity with previous studies. Identify knowledge gaps and connect to the proposed research.

Objectives and Hypotheses - Clearly state the research question to be answered and/or hypotheses to be tested and support it by explaining the logic that led to it. Preliminary data may be used as support.

Proposed Research - Describe the methods in sufficient detail to give a clear picture of how each research question will be answered and/or how each hypothesis will be tested. Include a time-line to demonstrate that the proposed work is feasible within the duration of a PhD degree. Describe specific expected results.

Defense of Thesis Proposal to Doctoral Thesis Committee

At least 10 days prior to the proposal defense, the student delivers copies of the written proposal to the committee members with a final schedule of when and where the presentation will take place. The student should ask each committee member for their preference for a PDF or hard-copy version of the proposal. After delivering the proposal to the committee, the candidate should neither solicit nor expect to receive feedback from any of the committee members, including the advisor, prior to the presentation. On the day of the proposal defense, the student brings a copy of the form, Record of Approval of Doctoral Thesis Research, which is available at <http://cee.mit.edu/graduate/forms>.

During and after the oral presentation, the Committee members ask questions related to the presentation, the written proposal and the general topic of the proposed research. The Committee may raise questions about the motivation, novelty, potential impact, and feasibility. As in the Part 2 evaluation, the research advisor is encouraged to ask questions, but should not answer questions. If necessary, the advisor may prompt the student with further questions to help them answer on their own. Remember that this is a test of the student's understanding and research ability. It is not a test of the advisor.

At the end of the question period, the student is asked to leave the room while the Committee (including the advisor) evaluates the candidate's performance in these areas: quality of written presentation, quality of oral presentation, technical quality of proposed research, feasibility of research within duration of degree, ability to respond to questions. The possible outcomes are:

- 1) Accept as written
- 2) Accept with modification
- 3) Fail with encouragement to retake within 6 months - the committee must include a list of specific deficiencies
- 4) Fail with specific notes on deficiencies

The Committee Chair records the outcome and any specific requirements for alteration on the form Record of Approval of Doctoral Thesis Research. The Committee Chair forwards the completed form to the Graduate Academic Administrator (Kiley Clapper) at the Academic Programs Office (Room 1-290) and provides a copy to the student.

After the approval of the thesis proposal, the student schedules regular meetings with the doctoral committee to demonstrate progress and receive feedback. Two meetings per year are strongly recommended, with a minimum requirement of one per year. In addition, the committee chair may require additionally meetings in response to significant problems or changes in research direction. Bring a copy of the form, Record of Doctoral Thesis Committee Meeting, to

each meeting. The form is available at <http://cee.mit.edu/graduate/forms>. Bring the original, signed form to CEE Academic Programs Office (1-290). Keep a copy of the form for your own records. The minimum requirement will be assessed during each CEE Grades Meeting (January and May) using the forms on file at the Academic Programs Office.

Approaching the Defense of your Doctoral Thesis

A few months before you plan to hold your doctoral defense, convene a final committee meeting. During this meeting your presentation should include an outline of your full thesis, highlighting results from each chapter, indicating papers published, in review or in prep, and including a detailed timeline for completion. Be sure to ask the committee for their opinion of what is the weakest component of your work and what they foresee as possible stumbling blocks for completion. If the meeting goes well, your committee will approve your outline and agree for you to proceed to scheduling your thesis defense. Be sure to have this approval noted on your *Record of Thesis Committee Meeting* form. Once the committee has given their approval, you can move forward with planning your doctoral thesis defense.

Checklist for Doctoral Thesis

MIT has three degree-granting cycles per year: February, June and September. Approaching the time when you will defend your thesis, you should register to be on the appropriate degree list. To register for the degree list go to student.mit.edu, select “online degree application” and follow the instructions. Once registered for the degree list you will receive a detailed email from the Graduate Administrator outlining the steps needed to complete your degree and organize your thesis defense.

Preparing for and Scheduling your Defense

The date of your defense must be at a minimum one week prior to the department’s thesis submission deadline. The date changes each year, so you will have to check with Graduate Academic Administrator to find out the date for your degree list. When planning your defense date, bear in the mind that the first draft of your thesis must be sent to your committee two weeks before your defense date. At least 10 days prior to your defense date please communicate the date, time and location with the graduate academic administrator and fill out the abstract template, which is available from the graduate academic administrator. Please also send an electronic copy, PDF preferred, of your thesis draft to be shared with the CEE faculty prior to your defense.

Planning the Public Presentation.

The formal thesis defense has two components, the public presentation, which anyone can attend, and a closed session with only your thesis committee. The public presentation should be 40 minutes long, with ten minutes for questions at the end. Encourage your labmates to attend the public portion and ask good questions. When thinking about your introduction for the public defense, keep in mind that it should be understandable to a broad audience. The closed session will range from 30 minutes to 1.5 hours long.

To book a room, please work with the administrative assistants in Pierce or Parsons. We suggest a reservation of 2.5 hours – with a start time 15 to 20 minutes before your scheduled defense start time and an end time 15 to 20 minutes past your projected meeting end.

Publicizing your Defense Date

Using the abstract template, add your thesis title, your name, your thesis supervisor’s name, day, time and location of the defense, and abstract. Please abide by the 350 abstract word limit. We strongly encourage you to include an image that represents your work, like and

interesting graph or chart on the template, and/or a picture of yourself. Once the template has been completed, send a pdf copy to the graduate academic administrator who will distribute your announcement electronically to the CEE community. In addition, print off 11 copies and post 5 in Parsons, using the public bulletin space in the hallways and kitchen, and 5 in Pierce, using the public bulletin space in the hallways and lounge, and also drop one off in 1-290.

Submitting your Thesis to the Academic Programs Office

After a successful defense you submit two signed copies of your thesis printed on acid-neutral or archival bond paper, by 5 pm the day of the department's deadline. Check with the Graduate Academic Administrator to find out the date for your degree list. Reminder, Graduate Academic Administrator will be responsible for retrieving the signature of the Chair of the Graduate Program Committee, please do not contact him/her directly. The copies must be unbound but secured between heavy cardboard covers with a binder clip. The front cardboard cover of each thesis copy should feature a photocopy of the top half of your thesis signature page (from the copyright up). You may simply tape or glue it on.

Congratulations! You have finished!

We look forward to seeing you at the hooding ceremony and graduation. Please let us know where you are headed next by filling out the Graduate Student Exit Form:
<http://cee.mit.edu/graduate/exitform>

The 3-Subject Core reflects core knowledge in the student's chosen field, which is tested in Part 1 of the General Exam. The subjects are selected from an approved list within one of the following sub-groups. All three subjects must come from the same core list.

Atmospheric Physics and Chemistry [choose three]

- 1.84 Atmospheric Chemistry
- 1.841 Atmospheric Composition in the Changing Earth System
- 1.842 Aerosol and Cloud Microphysics and Chemistry
- 1.83 Environmental Organic Chemistry
- 12.815 Atmospheric Radiation and Convection **/OR/** EPS 238 Spectroscopy & Radiative Transfer of Planetary Atmospheres

Civil Systems Engineering [choose three]

- 1.208 Resilient Infrastructure Networks
- 1.203 Logistical and Transportation Planning Methods
- 1.204 Computer Modeling: From Human Mobility to Transportation Networks
- Machine Learning and Statistics - choose one: 15.096 Prediction: Machine Learning and Statistics **/OR/** 1.151 Probability and Statistics in Engineering **/OR/** 15.077 Statistical Learning and Data Mining **/OR/** 6.867 Machine Learning

Engineering Physics for Urban Systems [choose three]

- 1.204 Computer Modeling: From Human Mobility to Transportation Networks
- 1.631 Fluid Dynamics and Disease
- 1.57 Mechanic of Materials: An Energy Approach
- 4.433 Modeling Urban Energy Flows for Sustainable Cities and Neighborhoods
- 8.333 Statistical Mechanics I

Environmental Chemistry [choose three]

- 1.75 Limnology and Wetland Ecology
- 1.76 Aquatic Chemistry
- 1.83 Environmental Organic Chemistry
- 1.84 Atmospheric Chemistry
- 1.841 Atmospheric Composition in the Changing Earth System

Environmental Fluid Mechanics [choose three]

- 2.25 Fluid Mechanics
- 1.63 Advanced Fluid Mechanics or 1.686 Nonlinear Dynamics and Turbulence
- 1.69 Introduction to Coastal Engineering or 1.685 Nonlinear Dynamics and Waves
- 1.72 Groundwater Hydrology
- 1.77 Water Quality Control

Environmental Microbiology

- 1.87 Microbial Genetics and Evolution
- 1.89 Environmental Microbiology
- and one of the following:*
 - HST 508 Quantitative Genomics
 - 6.874 Computational Systems Biology

Geotechnics / Geomechanics

- 1.s981 Advanced Soil Mechanics
- and two of the following*
 - 1.s982 Advanced Geotechnical Engineering
 - 1.37 Geotechnical Measurements and Exploration
 - 1.38 Engineering Geology
 - 1.72 Groundwater Hydrology

Hydrology [choose three]

- 1.72 Groundwater Hydrology
- 1.714 Surface Hydrology
- 1.731 Water Resource Systems
- 1.723 Computational Methods for Flow in Porous Media

Materials [choose three, but only one from outside CEE]

- 1.545 Atomistic Modeling and Simulation of Materials and Structures
- 1.570 Micromechanics and Durability of Solids
- 1.573 Structural Mechanics
- 3.22 Mechanical Behavior of Materials
- 3.36 Cellular Solids: Structure, Properties, Applications

Structures Mechanics / Engineering [choose three, but only one from outside CEE]

- 1.541 Mechanics and Design of Concrete Structures
- 1.573 Structural Mechanics
- 1.581 Structural Dynamics and Vibrations
- 2.093 Finite Element Analysis of Solids and Fluids I
- 3.22 Mechanical Behavior of Materials

Computational Science and Engineering [CSE/CEE]

for students enrolled in the CSE PhD program in the Center for Computational Engineering (CCE) and residing in CEE; or for students entering the CEE PhD program after completing the CDO SM program from the CCE.

Software Systems in CSE/CEE [choose three]

- 1.125 Arch & Eng. Software Sys - CSE approved Subject
- 1.001 Engineering Computation and Data Science
- 6.255 Optimization Methods
- 6.337J Introduction to Numerical Methods - CSE approved Subject

Flow Models in CSE/CEE [choose three]

- 1.204 Computer Modeling: From Human Mobility to Transportation Networks
- 1.208 Resilient Infrastructure Networks
- 1.723 Computational Methods for Flow in Porous Media
- 2.097 Numerical Methods for Partial Differential Equations – CSE approved Subject
- 2.096 Intro to Numerical Simulation – CSE approved Subject

Computational Science for Resource Engineering CSE/CEE [choose three]

- 1.723 Computational Methods for Flow in Porous Media
- 1.545 Atomistic Modeling and Simulation of Materials and Structures.
- 1.125 Architecting and Engineering Software Systems - CSE approved Subject
- 6.337 Introduction to Numerical Methods - CSE approved Subject
- 2.096 Introduction to Numerical Simulation – CSE approved Subject

Reference Materials for Incoming EECS Graduate Students



September
2015

**MIT Department of Electrical Engineering and Computer Science
Graduate Reference Guide – 2015-2016**

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Getting Started

Welcome to new students joining the EECS Department for the first time this fall. This document borrows heavily from, but ultimately replaces the memos of departmental policy from previous years, and is added to the EECS website by topic. [Note: All Graduate Office forms are also found on your EECS flash drive provided on Orientation Day.]

Orientation for new SM and PhD students will be held on Wednesday, September 2, 2015. This will be part of a full orientation schedule organized by the departmental Graduate Students Association (GSA), and the Institute-wide Graduate Student Council (GSC). The departmental orientation is administered jointly by the EECS GSA and the EECS Graduate Office. We hope to provide all the information that new students will need to become engaged in their graduate programs during the first term. Being present at this Orientation event is highly recommended.

Graduate Counselors are faculty members or research staff assigned to advise students on their academic programs and departmental requirements. For students starting in the fall, the Graduate Counselors are typically assigned during the prior summer. The assignment process of a Graduate Counselor seeks to select a person to complement the advice from the Research Supervisor. If it turns out that the same person is assigned to both roles, we will make every effort to assign a new Graduate Counselor. Graduate Counselors make themselves available to meet with their advisees in person on (or prior to) the two-week registration period in the fall and spring terms.

Special seminars are held in the fall term, as an enrichment option for incoming students. These seminars provide an opportunity to connect with faculty members, in order to discuss the EECS graduate program and/or graduate life in general. Incoming students can sign up for the seminars at the departmental orientation. The special seminars being offered in the fall semester 2015 include:

New Women in EECS Seminar (6.962)	Prof. Leslie Kolodziejski & Janet Fischer
Networking Seminar (6.962)	Prof. Leslie Kolodziejski & Janet Fischer
Intro to Research Seminar (6.961)	TBD

Registration is a process of signing up for classes (subjects), seminars, and thesis units. A day is reserved for this activity at the beginning of the fall and spring terms. While the registration process is online, students are still expected to meet with their Graduate Counselors to discuss their class selections, and to seek guidance on any of their questions or concerns. Graduate students can opt to take subjects for credit, pass/fail, or as listener. EECS graduate students can take no more than two subjects per term (exclusive of thesis units and seminars). Changes can be made to registration, by way of add/drop using the registration website. The Registrar has deadlines for adding and dropping in each term, and actions made after this date

will require an Institute petition (to be approved by the Office of the Dean for Graduate Education - ODGE) and will incur a petition fee.

Pre-Registration is a process that informs the departments about enrollment projections for subjects. The Registrar has deadlines for pre-registration, generally:

Month of May for summer and fall Registrations
Month of December for spring Registration

Summer Registration is expected for students who are at MIT carrying out research over the summer, and is required for students who receive summer funding of any kind. Summer tuition is subsidized by MIT for students taking thesis units only.

Students who are taking time off over the summer should negotiate this with their research supervisor and inform the EECS Graduate Office. International students carrying out summer internships need to arrange the appropriate visa status (Curricular Practical Training) with the International Students Office (ISO).

Research Supervisors are faculty members, or research staff, who supervise a graduate thesis, provide funding, lab space, and access to equipment. Generally students arrive at MIT EECS with a research advising relationship in place, which should be documented by turning in a Research Supervision Agreement (purple form) to the EECS Graduate Office.

If students have not secured a research supervisor by the time they arrive at MIT, they are expected to take the Intro to Research Seminar (6.961) in the first semester and work diligently toward finding a supervisor before the start of the second term. Once a research advising relationship is in place, this should be documented by turning in a Research Supervision Agreement (see EECS Flash Drive) to the EECS Graduate Office.

Who can supervise a Master's Degree? Who can supervise a PhD degree?

The EECS Department permits any faculty member at MIT to supervise research that will be used for a Master's thesis or for the PhD thesis. For the Master's thesis, only the research supervisor approves the thesis and assigns a grade. However, for the PhD degree, the thesis committee must include two faculty members from the EECS Department. The PhD thesis supervisor can be outside of the EECS Department and may reside in any other MIT department or division. Occasionally, a thesis supervisor will not be on the faculty of MIT, such as research staff at MIT Lincoln Laboratory or Charles Stark Draper Laboratory. Occasionally, a research supervisor may be a faculty member at a collaborating academic institution. In such cases, special approval of the Committee on Graduate Students (CGS) is required. Also, non-faculty members may be allowed to supervise thesis research; special approval is required from the CGS. Requests of such approval should be made to the

appropriate Area Chair (EE: Professor Gregory Wornell, CS: Professor Gerald Sussman) prior to beginning the thesis research.

Funding for EECS graduate students can be categorized in three different ways:

Fellowships can be from internal or external sources, and generally pay for a student's tuition, medical insurance, and a monthly stipend. Depending on the amount paid by the fellowship, supplementation by a research assistantship (RA) or teaching assistantship (TA) may be necessary.

Research Assistantships are provided to students performing research under a particular grant, and cover tuition, medical insurance, and a monthly salary (paid at the end of each month).

Teaching Assistantships are provided to students who assist with departmental teaching activities, and cover tuition, medical insurance, and a monthly salary (paid at the end of each month). Advanced teaching assistantships are known as Instructor G's.

The appointment periods for RA/TA are:

Fall (9/1 to 1/15) Spring (1/16 to 5/31) Summer (6/1 to 8/31)

A **Masters Degree (SM)** is a necessary first degree in the EECS graduate program. Students who have a Masters Degree from MIT (MEng or SM) or another institution do not need to earn another Masters Degree at MIT, and can proceed directly into the doctoral program.

The EECS Masters Degree has three components:

- * Coursework
- * Thesis Proposal
- * SM Thesis

The coursework requirement for the SM degree in EECS is 66 units, of which 42 must be from subjects designated as graduate level. This typically means that students take four EECS subjects totaling 48 units. The remaining 18 units can be satisfied by the units taken in the first year as subject 6.960 (Introductory Research in EECS).

An SM thesis proposal should be submitted by the end of the summer 2016, laying out the scope of research and its timeline, and providing appropriate references. A sample title page for the SM thesis proposal can be found on the EECS flash drive. The research supervisor approves the SM thesis proposal.

Students should join the most appropriate degree list (via WEBSIS) in order to let the Registrar know of their intention to complete a degree. MIT awards degrees in

June, September, and February of each year. Once on the degree list, the EECS Graduate Office will communicate with degree candidates about precise departmental deadlines and expectations. Please note that students must be registered in a term when their name appears on an MIT degree list.

The final SM thesis (2 copies on archival bond paper) should be submitted to the EECS Graduate Office by the end of the fourth term of graduate study. The SM thesis is certified by the research supervisor(s) and accepted by the EECS Graduate Officer. A sample title page for the SM thesis can be found on the EECS flash drive.

A letter grade, assigned by the research supervisor, for the SM thesis will be provided to the Registrar, and will appear on the MIT transcript, replacing the thesis grades previously submitted for the student. After completing all requirements for the SM degree, students will be paid at the doctoral rate for the next appointment period.

An **Engineers Degree (EE or ECS)** is an additional degree that students can pursue beyond the Masters, with a heavy component of coursework. Everything above also applies to the Engineers Degree, but the coursework requirement is 162 units, of which 90 units must be graduate level, which corresponds to 8 graduate subjects.

Students who have earned a MEng (or SM) degree at MIT can sometimes use the thesis to satisfy the Engineers thesis, provided their research supervisor certifies that the thesis is of superior quality. Students will still need to satisfy the coursework requirements noted above.

Qualifying for the Doctoral Program

Qualification is the process of approving a student to be in the doctoral program. It consists of two parts. The written portion of the qualifying process is accomplished via the successful mastery of the selected coursework, whereas the oral exam focuses on a discussion of a body of research. To be qualified, a student must pass both the technical qualifying evaluation and the research qualifying exam.

Technical Qualifying Evaluation (TQE)

As of September 2011, the TQE in all EECS areas consists of completing 4 graduate level subjects, from an approved list of appropriate subjects. The TQE grid (see EECS flash drive) has been designed to provide a degree of both depth and breadth.

Students submit a TQE plan by February 1st of their first year, laying out the subjects that they will use to satisfy the TQE by the end of the third term in residence. The TQE plan should be developed in consultation with the Graduate Counselor and Research Supervisor. If a student needs additional time to finish the TQE, they should file a departmental petition requesting a reasonable extension (see EECS flash drive).

Passing the TQE is accomplished by obtaining A's in at least three of the four TQE subjects. Passage of the TQE is noted in the EECS departmental database. If a student does not pass the TQE, by obtaining two or more B's in the proposed subjects, an oral exam committee will be formed to examine the student in the areas in which there may be deficiencies.

Research Qualifying Exam (RQE)

The RQE is primarily an oral exam, with a small written component, to be completed after passing the TQE, and by the end of the sixth graduate term. Students apply for the RQE by applying to a website; the web-address will differ for Area I (EE) students and Area II (CS) students. Students may designate three EECS faculty members who would be good choices for the student's RQE committee. Ultimately, the Area Chair will assign an RQE committee taking into account the student's preferences, but also balancing faculty loads and responsibilities.

The RQE committee consists of two faculty members, one of whom is the chair and the other is the committee member. The RQE committee solicits input from the student's research supervisor(s), and arranges a time to meet with the student, having reviewed a paper by the student that has been submitted in advance. The student gives a 30 minute presentation on their work (often the SM thesis work carried out at MIT). The faculty committee then asks the student about the work they have presented.

Following the meeting, the committee chair prepares a report qualifying the student, asking for continued work, or not qualifying a student. The results are recommended to the EECS Graduate Office, and if qualified, this is noted in the departmental database and forwarded to the Registrar's Office.

Doctoral Program

The Institute's **residence requirement** for the doctorate is four regular academic terms (not including summer sessions) of graduate work or equivalent. Residence credit for the SM or MEng counts toward the doctoral requirement as well. The average length of time spent by doctoral candidates at present is about 12 regular terms (including SM terms).

A **doctoral thesis proposal** is a requirement for the doctoral program, to be completed by the end of the eighth term as a graduate student. The document should be turned in to the EECS Graduate Office, along with research supervisor and reader agreements from the thesis committee (see below). The document should consist of a cover page, signed by the author (see example of a cover page that could be used for a SM, EE, or PhD thesis on the EECS flash drive), some description of the proposed content of the thesis, timeline to completion, and references. Upon submission, the proposal is routed to the Graduate Officer, for approval. Upon

approval, the proposal is filed in the student file. The thesis proposal is not a publicly circulated document.

An EECS **thesis committee** must consist of at least three members, two of whom must be EECS faculty members. At the time that the proposal is submitted, research supervisor and reader agreements must be turned in, signifying that the faculty members agree to be part of the thesis committee. The agreements can be found in hard copy in the Graduate Office or also found on the EECS flash drive.

The EECS Department believes that annual thesis **committee meetings** are helpful in directing the research, and speeding along the time to degree. Students are encouraged to have an initial thesis committee meeting at the time of the thesis proposal submission, and every year after that, leading up to the thesis defense. A form for documenting thesis committee meetings exists (see EECS flash drive), and additional copies can be found in the Graduate Office. The meeting dates and reports will be logged in the EECS database, and filed in the student file.

Each student in the EECS doctoral program must complete a **minor program**, approved by the EECS Graduate Officer or the student's Area Chair, consisting of two MIT subjects, at least one of which is an advanced graduate subject. The intent of the minor is to provide a broadening experience, and therefore the minor program field must not be directly related to a student's area of research. In fact, the subject matter may fall well outside of Electrical Engineering or Computer Science.

The subjects in the minor program should constitute a coherent study within a single discipline, and provide at least 18 credit units. One of the subjects may be introductory level. At least one of the subjects must involve study at an advanced level (typically graduate-level). The minor is proposed in advance of taking the subjects. Once approved, the minor program is logged in the EECS database, and will be checked for completion at the time that the student applies for a doctoral degree.

Each doctoral student is expected to take part in the department's teaching program. In order to satisfy this **teaching requirement**, the student must complete a one-term teaching assignment, usually as a compensated Teaching Assistant. The assignment may involve direct teaching or course development. If a student applies twice for a teaching assignment and no suitable position is available, then the requirement is waived. In some cases, students can petition to use teaching service outside of EECS subjects to satisfy the teaching requirement (examples, service as a TA for the summer Women's Technology Program, or as a TA in another department). In such cases, a departmental petition should be filed to document the teaching activity, and is approved by the EECS Graduate Officer.

When the thesis is substantially completed and the student has prepared a document of preliminary character that summarizes the work to the satisfaction of the thesis supervisor and committee, a **thesis defense** can be scheduled. The

candidate defends the thesis orally before the research supervisor and thesis readers, together with other guests whom the thesis committee may choose to invite. The thesis presentation is usually a publicly announced one-hour talk. If the defense is satisfactory, the student is instructed to proceed with the final write-up of the thesis, incorporating suggestions made during the thesis examination.

If all other requirements have been satisfied, the doctoral program is completed when the research supervisor signs the thesis, reports a grade of Satisfactory (SA), and when the student submits two copies of the thesis document to the Department Graduate Office. Doctoral theses are due approximately two weeks before the end of any regular term, and the last Friday before Labor Day during the summer term.

Degrees are awarded three times each year, according to degree lists that are closely monitored by the EECS Graduate Office, and which are then approved by the MIT Corporation. The degree dates are:

September (for theses submitted in the summer term)
February (for theses submitted in fall term or IAP)
June (for theses submitted in spring term)

Since MIT has one central Commencement each year, on the first Friday in June, students on the September and February degree lists can elect to receive their thesis at Commencement. Students who are not interested in participating in Commencement may receive their diploma (and doctoral hood) earlier, or immediately after Commencement by contacting the Registrar's Office. Upon request, the EECS Graduate Office can produce a letter for employers noting that the degree requirements have been completed in advance of a diploma being awarded.

Miscellaneous

On the topic of **additional employment**, the MIT Office of the Dean for Graduate Education (ODGE) Policies and Procedures state that a graduate student may not interrupt an academic program to accept employment on academic, administrative, or research staff, or as an hourly employee at MIT, Lincoln Laboratory, or the Charles Stark Draper Laboratory. This rule applies during the academic year or during the summer, unless the approval of the department head and of the appropriate academic dean has been obtained, and provided the work as an employee is not related to the student's thesis research. A thesis release form indicating such approval must be submitted to the Human Resources Department to effect such employment. A graduate student may not include as part of the thesis any material based upon work done while holding an academic or research staff appointment.

Graduate students who hold full time research or teaching assistantships, or who receive full support on a fellowship or traineeship, are not usually eligible for such

employment. A full time (100 percent) teaching assistant or research assistant is defined as 20 hours of work per week. A student who is a US citizen or permanent resident who applies to work, in addition to his or her RA or TA appointment, may be permitted additional compensated employment at MIT for no more than 10 hours per week during the academic year, especially to support student life and learning activities (e.g., staffing the front desk of a residence hall). Consult the EECS Graduate Office for approval before undertaking such employment. Regulations for international students are stricter, due to US immigration laws. For more information on this, please see the Graduate Policies and Procedures at the website: <http://web.mit.edu/odge/gpp>.

It is generally expected that EECS graduate students **register during the summer**, for thesis units only. If registered for thesis (or the introductory subject 6.960) the **summer tuition subsidy** will cover the cost of tuition. It is not unusual for students to take a summer internship to enhance their research experience. In such cases, students should not pre-register for summer, and should notify Janet Fischer of the EECS Graduate Office so that the registration is not processed. International students taking summer internships need to take the additional step of securing immigration clearance, known as **curricular practical training (CPT)**. CPT begins with a conversation with the International Students Office, where certain documentation will be needed. The EECS Graduate Office also monitors CPT, and manages the evaluation of the internship. The internship supervisor submits an evaluation, after which a grade is given for subject 6.999, to be taken in the fall term following a summer internship.

The EECS Department suggests and monitors a graduate program **timeline** that can be found in the box on page 11, which is designed to keep students progressing through the program. While the deadlines are serious and meant to be in the student's best interest, we do try to be reasonable, and exercise flexibility. If meeting a particular deadline is problematic, please seek the advice of the EECS Graduate Office as soon as possible.

Timeline and Deadlines

1st Term: Submit Research Supervision Agreement (purple) form

2nd Term:

- Submit TQE plan by February 1st
- Submit SM proposal by end of term, or August 31st at the latest

End of 3rd Term: TQE completed

End of 4th Term: Masters Degree completed

5th Term:

- Register or apply for the RQE
- Students who have not completed the TQE can continue in the program only with permission of the Committee on Graduate Students (CGS).
- Students who have not submitted the Master's thesis by the beginning of the term can continue in the program only with the permission of the CGS.

End of 6th Term:

- Students who have not qualified by completing the RQE and Master's thesis can continue in the program only with the permission of the CGS.

End of 8th Term:

- Submit doctoral thesis proposal.

9th Term:

- All requirements including minor program and teaching should be completed this term.
- Students who have not submitted a doctoral thesis proposal can continue in the program only with the permission of the CGS.

End of 14th Term: Continuation in doctoral program requires explicit approval of CGS.

Students may receive **warning letters** to alert them to an upcoming deadline, or if a deadline has passed. Such warning letters are typically sent as a pdf from the Graduate Officer to the student, copied to the Research Supervisor and Graduate Counselor. It is our preference that students meet the deadline, but if there are extenuating circumstances, students are allowed to **petition the department** (see EECS flash drive) for a reasonable extension.

If a deadline is not met, and there is not an approved petition on file, the student will be contacted by the Graduate Officer.

Similarly, the **Institute has a petition process** for other requests such as:

- Election of a dual degree
- Completion of an incomplete from a prior semester or year
- Choosing a thesis field not currently on the list of departmental thesis fields
- Adding or dropping a subject after the stated deadlines

Institute petitions require departmental and instructor approval, and are then reviewed by the ODGE (Room 3-138). A processing fee of \$50 is assessed to the student account for each petition that is approved.

Non-Resident Status

MIT allows qualified (post TQE and post RQE) doctoral students who have submitted a doctoral thesis proposal to apply for a reduced tuition status, if they are going to be away from MIT for a term (fall or spring) or academic year, and not using MIT resources. Non-resident status must be approved by the Department and the ODGE, at least one month before the term begins. This status is meant for students who are not at MIT using office or lab space, or living in MIT graduate dormitories. Tuition under non-resident status is 5% of regular tuition for the first three terms, and then 15% for a fourth, fifth, or sixth term. Students are generally not allowed to pursue non-resident status beyond six terms. At the point that the thesis is ready to be defended and submitted, a student would need to return to full-time graduate status. It is best to consult with Janet Fischer in the EECS Graduate Office before applying for non-resident status, and map out a plan for the remainder of the graduate program. The request form for non-resident status can be found on the EECS flash drive.

Tuition and Fees

MIT bills tuition in advance of each fall and spring semester. Accompanying each tuition charge is the student medical insurance charge, and the student life fee. Normally, an RA or TA covers the cost of the tuition and insurance, with the student responsible for paying the student life fee. A student could waive the student insurance through the MIT Student Insurance Office if they can prove in a timely manner that they have comparable coverage, typically from a parent or spouse.

The Registrar maintains several current tuition schedules, which are available here: http://web.mit.edu/registrar/reg/costs/graduate/grad_fallspring.html

Of particular interest to graduate students are the following tables and list:

- * Pro-ration tables - shows how tuition is prorated, should a student complete a terminal SM or PhD degree before the end of a fall or spring semester.
- * Graduate thesis tuition rules - illustrates various scenarios for students returning to complete a thesis after being withdrawn or on non-resident status.
- * Miscellaneous fees such as student life fee, late registration fee, thesis processing fee, etc.

Resources for EECS Graduate Students

Student Organizations:

- EECS Graduate Student Association (<http://eeecgsa.mit.edu/about/>)
- EECS REFS (peer support) (<http://www.eecs.mit.edu/refs/>)
- The Graduate Student Council (<http://gsc.mit.edu>)

EECS Faculty and Administration:

- EECS Graduate Office: <http://www.eecs.mit.edu/grad/index.html>
 - Janet Fischer (academic program)
 - Kathy McCoy (admissions and fellowships)
- Graduate Counselor
- Research (Thesis) Supervisor
- Area Chairs:
 - Area I (EE): Prof. Gregory Wornell
 - Area II (CS): Prof. Gerald Sussman
 - EECS Graduate Officer: Prof. Leslie Kolodziejki
- Department Head: Prof. Anantha Chandrakasan
- Area WEBSITES:
 - Area I (EE): <http://www.eecs.mit.edu/EEgradrequirements>
 - Area II (CS): <http://area2.eecs.mit.edu>

MIT Office of the Dean for Graduate Education:

- Dean for Graduate Education:
Dean Christine Ortiz
- Associate Dean for Graduate Education:
Dean Blanche Staton
- *Graduate Policies and Procedures* <http://web.mit.edu/gso/gpp/>

EECS Flash Drive

Please see in folder entitled “EECS Orientation DOCS 2015” for all Grad Office documents, and a collection of forms that have been referenced in this handbook. Hard copies of these forms can be found in the EECS Graduate Office, as well as on the EECS, ODGE or MIT websites.

Around the MIT Campus 2015
EECS Departmental Petition
EECS Minor Requirement-Instructions 2015
EECS Registration Trifold FT15
EECS Request for Additional Employment 2015
EECS Research Supervision Agreement PURPLE Form
Research Interests of Faculty and Staff 2015
Doctoral Thesis Comm Meeting Form
Doctoral Thesis Reader Agreement
Doctoral Thesis Supervision Agreement
Thesis Proposal Guidelines

Thesis Submission Guidelines
EECS Research Qualifying Exam (RQE) 2015
EECS TQE Plan- Instructions and Worksheet
MIT Medical Report Form 2015-16
MIT Resources for Graduate Student Families 2015
ODGE Graduate Student Petition
ODGE Non-Resident Status Petition
EECS Orientation FT15
EECS Reference Materials for Incoming Graduate
Students 2015 (this document)
EECS Connector 2015

**Guide to
Graduate Study in Mechanical Engineering
*at***

MIT

2015 – 2016 Edition

Department of Mechanical Engineering

Graduate Officer: Professor Rohan Abeyaratne

Admissions Officer: Professor Pierre Lermusiaux

Graduate Office: Ms. Leslie Regan
Graduate Administrator
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1 The Graduate Program in Mechanical Engineering

The Mechanical Engineering Graduate Program brings together faculty members and post-baccalaureate students into a community of scholars with a common interest in innovation, creativity and advanced professional study. It seeks to provide, in the atmosphere of a professional school, the widest possible opportunity for advanced study and investigation and for intimate association among workers whose common objective is to extend the boundaries of their profession.

The Mechanical Engineering (MechE) Department offers the following graduate degrees:

1. Master of Science in Mechanical Engineering (SMME)
2. Master of Science in Ocean Engineering (SMOE)
3. Master of Science in Naval Architecture and Marine Engineering (SMNAME)
4. Master of Science in Oceanographic Engineering (SMOGE, joint MIT/WHOI degree)
5. Master of Engineering in Manufacturing (MEng)
6. Mechanical Engineer's degree
7. Naval Engineer's degree
8. Doctor of Philosophy (PhD) or Doctor of Science (ScD), which differ in name only; (this includes the joint MIT/WHOI doctoral degrees)

A Master of Science degree is the first graduate degree offered in MechE. It is awarded for the completion of a program of advanced study, together with a thesis that is considered to be the centerpiece of a student's graduate experience.

The Master of Engineering in Manufacturing is a one-year professional degree program that prepares the student to assume a role of technical leadership in the manufacturing industries.

The Mechanical Engineer's degree offers preparation for a career in advanced engineering practice. It does so through a program of advanced coursework that goes well beyond the Master's level. This degree is not a stepping-stone toward the PhD.

The Doctor of Philosophy (or Science) is the highest academic degree offered. It is awarded for the completion of a program of advanced study and a significant original thesis.

In what follows, we describe how students can gain entry to the MechE graduate programs (sections 2 and 3) and what they must accomplish to obtain the various degrees (sections 4–9). Section 10 describes some of the means available at MIT to provide financial support to graduate students.

2 Entrance Requirements

Applications to the Mechanical Engineering (MechE) Graduate Program are accepted from persons who have completed, or will have completed by the time they arrive, a Bachelor's degree. Most incoming students will have a degree in mechanical engineering or ocean engineering. However, the department's admission criteria are not specific in this regard, and talented students with backgrounds in other branches of engineering or in science may gain entry.

To qualify for a graduate degree, applicants are expected to have at least an undergraduate-level exposure to most of the core MechE disciplines (solid mechanics, dynamics, fluid mechanics, thermodynamics, heat transfer, materials, control, design and manufacturing), and to be familiar with basic electric circuits and electromagnetic field theory. Those who are deemed deficient may be asked to make up courses in certain areas before they graduate. The make-up courses may be at the undergraduate-level (in which case they are relatively elementary and usually *cannot be applied toward graduate credit*), or at the graduate-level (in which case they carry graduate credit).

3 Admission

The method to apply to the Mechanical Engineering Graduate Program is via our online system. See <http://meche.mit.edu/academic/graduate/applying/> for more information.

All *official* transcripts must be submitted directly to the MechE Graduate Office, Room 1-112, Massachusetts Institute of Technology, 77 Massachusetts Avenue, Cambridge, MA 02139 but only *after* the student has been admitted.

The processing of applications for graduate study is done entirely by the department. The MechE Graduate Admissions Officer, together with a faculty committee, reviews all applications, rank-orders them, and admits the number of applicants that the department expects it can accommodate.

Foreign nationals applying from abroad may be admitted, but are not permitted to register at MIT unless they have full financial support for at least the first year. This can come in the form of a research or teaching assistantship from an individual MIT professor (Section 10 describes how to seek such support), though for many foreign students this support comes from their family, their government, or an international fellowship.

All applicants are required to submit their scores from the General Exam part of the Graduate Record Examination (GRE). Students from non-English-speaking countries are also required to take the IELTS (preferred) or the TOEFL exam. Students whose citizenship is from India are exempt from taking the IELTS or TOEFL exam. The minimum acceptable score for the IELTS exam is 7.0, and for the TOEFL exam it is 100 (ibt), or 577 (pbt).

Applications are due by December 15 of the previous year and decisions are reported in March.

4 Writing Ability Requirement

All incoming graduate students must demonstrate satisfactory English writing ability, or successfully complete appropriate training in writing. This requirement reflects the faculty's conviction that writing is an essential skill for an engineer with an advanced degree.

The MechE Department requires **all** incoming graduate students, native as well as foreign, to take the Institute's Graduate Writing Examination. This exam is administered in the summer before matriculation (<http://cmsw.mit.edu/graduate-writing-exam/>). Depending on the results, a student will either (a) pass the writing ability requirement, (b) be required to take a relatively short, but intensive, seminar-workshop in expository writing (21W.794 Technical Writing Workshop) during the Independent Activities Period in January, or (c) be required to take a course in writing. Several courses suitable for engineers and scientists are offered at MIT, and special courses are available for those for whom English is a second language.

In addition, MIT requires that all graduate students for whom English has not been the language of instruction in both elementary and secondary school take an English Evaluation Test. This test is separate from the aforementioned Graduate Writing Examination required by the department.

5 Master of Science (SM) Degrees

The requirements for the Master of Science degrees offered by the department pertain to (1) writing ability, (2) credit units, (3) thesis, and (4) a distribution requirement in the case of the three Ocean-related Master's degrees. The SMME degree *does not* have a distribution requirement. The specific requirements are as follows:

5.1 Writing ability

Students must successfully fulfill the writing ability requirement described in Section 4.

5.2 Credit units

- Students must successfully complete at least **72 graduate-level credit units** of coursework, not including credit received for thesis work. Following approval by the Graduate Officer and the Institute, certain advanced undergraduate subjects that go beyond the MIT MechE Department's undergraduate degree requirements may be used to satisfy up to 24 units of graduate credit.

- The program is expected to include at least three graduate-level MechE Department subjects (36 units).
- Students must take at least one graduate-level mathematics subject (12 units) offered by MIT's Mathematics Department. No waivers are allowed.
- A minimum grade point average of 3.5 (A=5, B=4, C=3, D=2, F=0) must be maintained in graduate school.
- Students are allowed to transfer credit toward their Master's degree from graduate subjects taken previously at MIT or another accredited institution, and *not used as part of the credits required for an undergraduate or graduate degree*. **The limit is 24 credit units** if the subjects were taken outside MIT. Transferred subjects must have a grade of B or higher. No thesis units may be transferred.

5.3 Thesis

In the MechE Department, the thesis is considered to be the centerpiece of a student's graduate experience. The student must complete an acceptable SM thesis under the supervision of an MIT faculty member or a Senior/Principal Research Scientist/Engineer who holds an appointment in the MechE Department. The thesis is an original work of research, design, or development. The supervisor signs and accepts the thesis upon completion.

If the supervisor is *not* a member of the MechE Department, a reader who belongs to the MechE Department faculty must also endorse the thesis.

Entering Master's degree candidates

- must notify the MechE Graduate Office, Room 1-112, of their thesis supervisor within six weeks of registration, and
- must submit a completed thesis by a due date set by MIT, typically no later than one week before the beginning of the examination period.

5.4 Distribution Requirements for Ocean-related master's degrees

- **Master of Science in Ocean Engineering (SMOE).** A graduate subject in each of the following areas is required: (i) Marine Hydrodynamics (2.20); (ii) a subject that emphasizes professional practice in ocean environment, such as Design Principles for Ocean Vehicles (2.22); and (iii) a subject in Acoustics and Sensing (e.g., 2.066), or Structural Mechanics (e.g., 2.080J), or Structural Dynamics (e.g., 2.060J).
- **Master of Science in Naval Architecture and Marine Engineering (SMNAME):** (i) Marine Hydrodynamics (2.20 or a more advanced subject) and (ii) at least 24 units in their area of concentration. (Background requirements in

Introduction to Naval Architecture (e.g., 2.701) and Ship Power and Propulsion (e.g., 2.611) can be waived if previously taken as an undergraduate; otherwise, these subjects need to be taken at MIT.)

- **Master of Science in Oceanographic Engineering (SMOGE):** The MIT/WHOI Joint Program Handbook for Oceanographic Engineering lists the requirements for this degree. (Please see <http://mit.who.edu/handbooks> for the current handbook.)

* * *

A typical Master's degree consists of six twelve-unit subjects plus a thesis, and takes a full-time student three regular (fall and spring) terms to complete. Students with a research assistantship will not be able to finish in less than this time because of the limitation on the number of subjects they are allowed to take per term (see Section 10). At the same time, there is no reason, other than the uncertainties of research, why they should take longer. The faculty believes that a typical Master's degree in Mechanical Engineering should not take longer than one and a half years (three full terms plus the intervening summer) and will strive to implement this duration in its graduate program.

The Master's thesis is essentially a research (or development, or design) apprenticeship under a faculty supervisor, and as such is usually the major contributor to the student's professional maturation. Incoming students are urged to find a thesis project and supervisor without undue delay. There are several reasons for avoiding delay. For one thing, the SM thesis is a substantial piece of work and takes time to mature. For another, a student who begins thesis work associates him/herself not only with a faculty member, but usually also with a research group or laboratory where s/he meets other faculty and experienced graduate students from whom to learn and get good advice. It is usually a mistake to think that the degree can be attained more efficiently by taking the coursework first, and putting off the thesis work to the last term.

A student's thesis supervisor usually also serves as the academic advisor. If the thesis supervisor is not a MechE Department faculty member, the student should seek academic advice from an MechE faculty member whose research interests are close to his/her own (such as the departmental thesis reader), or from the Graduate Officer.

5.5 Double SM Degrees

- Students registered in **another engineering department at MIT** who wish to earn a Master of Science in Mechanical Engineering, Ocean Engineering, Naval Architecture and Marine Engineering, or Oceanographic Engineering simultaneously with a Master's degree with specification in their own department may do so by satisfying both departments' requirements, with the credit unit requirements satisfied **separately**, but with a common thesis. Such programs of study **must be approved in advance** by the Graduate Admissions Officers of both the departments involved. A student who had previously applied for, but was denied, admission to the MIT MechE Department is not eligible to get a dual

degree from the MechE Department. The Department's procedural requirements are the following: (i) A petition for the dual master's degree in the MechE Department must be filled out, and adhered to. The student must be *admissible* to the MechE Department. (ii) The student must select a MechE faculty member as a thesis reader. That faculty member must accept this responsibility **by signing the petition**. (iii) Items (i) and (ii) must be completed well in advance of thesis completion, but no later than June 1 of the year *before* the student expects to graduate.

- The preceding also applies to students registered in **Mechanical Engineering** who wish to earn an SMME degree simultaneously with one of the Ocean-Engineering Master's degrees offered by the department. In this case item (ii) above is modified as follows: the MechE faculty member who serves as the thesis advisor must accept this responsibility **by a letter** to the MechE Graduate Admissions Officer, and ensure that all requirements for the dual degree are met.

6 Master of Engineering (MEng) in Manufacturing

The Master of Engineering in Manufacturing is a one-year professional degree program that is intended to prepare the student to assume a role of technical leadership in the manufacturing industries. The degree is aimed at practitioners who will use this knowledge to become leaders in existing as well as emerging manufacturing companies. The requirements for this degree are (1) writing ability, (2) an integrated set of lecture/laboratory-based subjects for a total of 90 credit units, (3) a professional seminar, and (4) a thesis project for 24 credit units. A minimum grade point average of 3.5 must be maintained in graduate school. The following subjects are required, however, exceptions can be made with approval of the MEng in Manufacturing Coordinator.

6.1 Writing ability

Students must successfully fulfill the writing ability requirement described in Section 4.

6.2 The core subject areas (90 units) are

Manufacturing Physics (24 units): 2.810 Manufacturing Processes and Systems; 2.830 Process Optimization and Control.

Manufacturing Systems (24 units): 2.854 Introduction to Manufacturing Systems; 15.762J (ESD.267J) Supply Chain Planning; 15.763J (ESD.268J) Manufacturing System and Supply Chain Design.

Business Fundamentals (18 units): 2.961 Management in Engineering, 2.S982 New Process Development — “Bench to Money”.

Product Design (12 units): 2.739J Product Design and Development or 2.744 Product Design.

Restricted Elective (12 units): 2.120 Introduction to Robotics; 2.171 Analysis and Design of Digital Control Systems; 2.675 Micro/Nano Engineering Laboratory; 2.740 Bio-inspired Robotics; 2.76 Global Engineering; 2.821J Selection and Processing of Structural Materials; 15.871 Introduction to System Dynamics; 15.872 System Dynamics II.

6.3 Professional Seminar in Global Manufacturing Innovation and Entrepreneurship (2.888)

6.4 Thesis Project (24 units)

The thesis project is intended to give each student experience in a manufacturing industry, working on problems with both strategic breadth and technical depth. It is an integrating experience to help pull together the diverse topics treated in class. The projects will explore innovations in technology, systems and business strategy.

7 Mechanical Engineer's Degree

The Mechanical Engineer's degree provides an opportunity for further study beyond the Master's level for **those who wish to enter engineering practice** rather than research. This degree emphasizes breadth of knowledge in mechanical engineering and its economic and social implications, and is quite distinct from the PhD, which emphasizes depth and originality of research. The Mechanical Engineer's degree is **not** a stepping-stone toward the PhD.

The overall course of study and thesis *must comprise a coherent program in Mechanical Engineering*. The candidate is required to prepare a plan of study and to submit it to the MechE Graduate Officer for approval by the Engineer's Degree Subcommittee. The student will be considered a Mechanical Engineer's Degree candidate when this plan is approved.

The Engineer's degree has four requirements: (1) writing ability, (2) a program of coursework, (3) a thesis, and (4) a qualifying examination. These are described below.

7.1 Writing ability

Students must successfully fulfill the writing ability requirement described in Section 4.

7.2 Program of coursework

The requirements are as follows:

- 162 graduate-level credit units (including credited units taken during the Master's degree program and thesis work done under 2.999 (see below)).

- At least one subject from eight of the following eleven areas:
 - ♦ Mechanics of Solids
 - ♦ Materials
 - ♦ Fluid Mechanics
 - ♦ Thermodynamics/Heat Transfer
 - ♦ System Dynamics & Control
 - ♦ Dynamics
 - ♦ Design
 - ♦ Manufacturing
 - ♦ Nanotechnology
 - ♦ Energy
 - ♦ Bioengineering

- One subject on management/economics as approved by the Mechanical Engineer's Degree Subcommittee.

Students entering the Graduate School with a Master's degree are permitted to transfer **no more than 24 units** of graduate credit from another school to the MIT record. No thesis units may be transferred. Subjects being transferred to MIT records should have a grade of B or higher.

7.3 Thesis

The thesis may be an extension of a suitable applications-oriented SMME/SMOE/SMNAME/SMOGE thesis, or it may be a separate piece of work. An important requirement is that the thesis deal with the solution of real, practical engineering problems, including both their technical and socio-economic aspects. Students are required to submit a specific thesis proposal to the Mechanical Engineer's Degree Subcommittee shortly after embarking on the program. Students who enter the program with an SM degree from another school must do a separate Engineer's thesis.

The thesis work described in the preceding paragraph is carried out under the subject 2.999. A student may receive a maximum of 12 units of credit for their thesis work, with the student's thesis advisor determining the actual amount of credit. The credit units for 2.999 (not to exceed 12 units) may be counted towards the 162 total credit unit requirement.

7.4 Qualifying examination

Candidates should take the Mechanical Engineer's degree qualifying examination during their first year of residence. These exams are given by the Mechanical Engineer's Degree Subcommittee, usually in January and May. The examination is an oral one in which the students make a twenty-minute presentation of their thesis proposal and work to date, placing approximately equal emphasis on the technical aspects of the work and on its usefulness in engineering applications in general. Questions on the thesis and related areas will be asked, and the Subcommittee will render its judgment based on both the technical content of the work and its utility in engineering practice.

The qualifying examination for the Mechanical Engineer's degree may be waived for candidates with either 3 years military or 5 years industrial post-Bachelor's Degree experience, and with concurrence from the MechE Graduate Officer.

8 Naval Engineer's Degree

Naval Engineering is considered to include all the arts and sciences as applied in the design, construction and operation of surface and sub-surface marine vehicles. The Naval Engineer's degree provides an opportunity for further study beyond the Master's level and is intended for those who wish to enter engineering practice, or who plan a career in the design, acquisition, repair, and modernization of ships and ship systems. This degree emphasizes breadth of knowledge in naval engineering and is quite distinct from the PhD, which emphasizes depth and originality of research.

The overall course of study and thesis must comprise *a coherent program in naval engineering*. The candidate is required to prepare a plan of study and to submit it to the MechE Graduate Officer for approval by the Naval Engineer's degree Subcommittee. The student will be considered a Naval Engineer's degree candidate when this plan is approved.

Requirements for the Naval Engineer's degree are similar to those for the Mechanical Engineer's degree outlined in Section 7 above, with the following differences.

8.1 Credit units

The credit requirements are as follows:

1. 162 graduate-level credit units (including credited units taken during the Master's Degree program and no more than 12 units of credit received for thesis work (see below)).
2. At least one subject from eight of the following eleven areas (subjects from various MIT departments are normally taken to satisfy this requirement):

- | | |
|--------------------------------------|--------------------------------------------|
| ♦ Mathematics & Numerical Methods | ♦ Structural Mechanics |
| ♦ Dynamics | ♦ Acoustics |
| ♦ Hydrodynamics | ♦ Ship Production |
| ♦ Materials & Fabrication Technology | ♦ Naval Architecture & Systems Engineering |
| ♦ Power and Propulsion | ♦ Ship Design |
| ♦ Probability & Statistics | |

3. Ship design is an integral part of the Naval Engineer's Degree curriculum. Candidates are required to complete both a conversion design project (2.704) and a 24-credit new design project (2.705) during their course of study.

8.2 Thesis

Students must do a thesis that demonstrates the educational maturity and breadth expected of candidates for this degree. An important requirement is that the thesis deal with the solution of real, practical engineering problems, including both their technical and socio-economic aspects. It must be at least equivalent to an advanced master's thesis, and may be an extension of a suitable applications-oriented SMME/SMOE/SMNAME/SMOGE thesis, or it may be a separate piece of work. Students who enter the program with an SM degree from another school must do a separate Naval Engineer's thesis. Students are required to submit a specific thesis proposal to the Naval Engineer's Degree Subcommittee shortly after embarking on the program.

A maximum of 12 units of credit for thesis work may be counted towards the 162 unit credit requirement.

8.3 Qualifying examination

Candidates should take the Naval Engineer's degree qualifying examination during their first year of residence. These exams are given by the Naval Engineer's Degree Subcommittee, usually in January and May. The examination is an oral one in which the students make a twenty-minute presentation of their thesis proposal and work to date, placing approximately equal emphasis on the technical aspects of the work and on its usefulness in engineering applications in general. Questions on the thesis and related areas will be asked, and the Subcommittee will render its judgment based on both the technical content of the work and its utility in engineering practice.

The qualifying examination for the Naval Engineer's degree may be waived for candidates with either 3 years military or 5 years industrial post-Bachelor's Degree experience, and with concurrence from the MechE Graduate Officer.

9 Doctoral Program (PhD/ScD)

The highest academic degree is the Doctor of Science, or Doctor of Philosophy. At MIT, these degrees differ in name only. The doctorate is awarded upon the completion of a program of advanced study, principally at the Institute, and the performance of significant original research, design or development.

9.1 Admission into the doctoral program

1. Students from outside MIT may apply to the doctoral program if they will have completed a master's degree in engineering by the time they enroll for the PhD; see Sections 2 and 3.

2. Students who are in the MechE Department's SM program, and wish to continue for a PhD, will automatically be enrolled in the doctoral program effective the day on which they submit their master's thesis provided they have maintained a cumulative GPA of 4.5 or better in graduate-level subjects at MIT.

All students must take and pass the doctoral qualifying examinations according to the timeline given below. A student is considered to be a (qualified) candidate in the doctoral program upon passing the qualifying examinations.

9.2 Requirements for a doctoral degree

The five basic requirements for the doctoral degree are:

- (1) the writing ability requirement, which all graduate students must satisfy;
- (2) the doctoral qualifying examination;
- (3) a major program of advanced study;
- (4) a minor program of study in a field different from that of the major; and
- (5) a thesis.

Details of the five basic requirements are given below, followed by the rules (procedure, schedules, etc.) that pertain to the doctoral program.

9.2.1 Writing ability requirement

Students must successfully fulfill the writing ability requirement described in Section 4.

9.2.2 Doctoral qualifying examination

The purpose of the doctoral qualifying examination (QE) is to determine whether the applicant possesses the attributes of a successful doctoral candidate at MIT: mastery of the mechanical/ocean engineering disciplines coupled with ingenuity and skill in identifying and solving unfamiliar problems.

Students who entered the MechE graduate program prior to Fall 2015: A student must take the QE (for the first time) before the end of three regular semesters (fall and spring) after admission to the PhD program.

Students who entered the MechE graduate program in Fall 2015 (and thereafter): A student whose highest degree (at entry to the graduate program) is a Bachelor's degree, must take the QE (for first time) no later than the end of 5 regular semesters (fall and spring). A student entering the graduate program with a Master's degree must take the QE no later than the end of 3 regular semesters (fall and spring).

In rare and extraordinary circumstances, a student may be granted one extra semester, but only by prior petition to the Graduate Officer.

Doctoral qualifying examination. (This version of the exam will be offered for the last time in January 2017.)

The QEs are offered twice yearly (January and May) during a two-week period. It consists of two parts:

- (i) A set of three subject area examinations which candidates may choose from the following approved list (the subject or subjects most suitable for preparation for these exams are included in parentheses):
- Dynamics (2.032) **or** Acoustics (2.066)
 - Mechanics of Solid Materials (2.002, 2.071), **or** Structural Mechanics (2.080J)
 - Fluid Mechanics (2.25), **or** Hydrodynamics (2.20), **or** Geophysical Fluid Mechanics (12.800)
 - Computational Engineering (2.097J or 2.29)
 - Thermodynamics (2.42)
 - Heat and Mass Transfer (2.52 or 2.55)
 - System Dynamics and Control (2.140 and 2.151) **or** Signal Processing (6.003¹) **or** Probability and Random Processes (6.431 and 2.22)
 - Biomechanical Engineering (2.795J or 2.798J)
 - Optics (2.710)
 - Manufacturing (2.810)
 - Design (2.744, 2.75, 2.739) **or** Mechanical Elements and Systems Design (2.75)
 - Micro and Nano Engineering (2.37)

Both the list of subjects and the format of each subject exam undergo some metamorphosis: New subjects may be made available with one term's advance notice; existing subjects may be discontinued, but only upon at least two years' notice.

- (ii) A Research Presentation. This thesis-area examination is currently a forty-five-minute exam in which the candidate presents and is questioned on his/her own

¹ The Institute no longer gives graduate (G) credit for 6.003.

original research, such as a previously completed SM thesis or initial work toward the doctoral thesis.

The Mechanical Engineering Faculty as a whole review each student's performance in the qualifying examinations and make decisions regarding passing, being allowed to repeat the exams, or failing. Candidates who are permitted to repeat the exams must do so the next time they are offered. **In no case is a candidate allowed to repeat more than once.**

Doctoral qualifying examination (from May 2017 onwards)

The QEs are offered twice yearly (January and May) during a one-week period. In order to be eligible to take this examination the student must have maintained a cumulative GPA of not less than 4.5 in the MIT graduate program. In addition, the candidate must have obtained 2 A's and 1 B or better in graduate-level MechE department classes at MIT².

The QE consists of three components: (A) two subject area examinations exploring the student's breadth of knowledge in selected MechE disciplines, (B1) a third subject area examination exploring the student's depth of knowledge in the student's chosen area of research, and (B2) an examination of the student's research skills. The latter two examinations, B1+B2, are blended into one, and conducted together in the same setting, but are graded separately.

Specifically, the student will take:

(A) Two Oral Qualifying Examinations (OQEs) on Day 1, each consisting of a 30-minute oral examination in two core subject areas selected by the candidate (from an approved list), and

(B) One Research Qualifying Examination (RQE) on Day 2, consisting of one 60-minute oral examination in the student's field of research (see list below) that explores the student's research skills and depth of domain knowledge in the related area.

The student must pick 3 *distinct* qualifying examination areas from the approved list of subject areas below, choosing at least 2 from the C (core)-List and not more than 1 from the S (specialized)-List. This choice must be made when the student applies to take the QE. If the student has selected 1 subject area from the S-List, the RQE must be in that field. If all 3 subject areas have been selected from the C-List, the student must indicate the one that the RQE is to be in. New subject areas may be added to these lists with one semester's advanced notice; existing subjects may be removed, but only with a minimum of two year's notice.

During the RQE the student will make a ~ 20-min presentation of his/her original research (such as work for a previously completed SM thesis (at MIT or elsewhere) or

² Exceptions may be granted by the Graduate Officer in the case of an incoming student with an SM degree, who may want to take the QE after one semester at MIT.

initial work at MIT towards a doctoral thesis); respond to questions on that research for ~ 15 minutes; and subsequently answer questions in the broader subject area corresponding to the chosen research field (within the bounds of the content spanned by the corresponding subject(s) noted in the C/S-list below). The student's research skills and depth of knowledge in the research subject area will be graded separately.

The MechE department faculty as a whole review and discuss each student's performance in the qualifying examinations, together with their GPA and other holistic aspects of their performance in the graduate program at MIT, and make decisions regarding passing, being allowed to repeat the exams, or failing.

A student who passes the research skills part of the RQE, as well as passes at least 2 of the 3 subject area examinations, would pass the doctoral qualifying examination. A student who passes both parts of the RQE but does not pass 2 of the 3 subject area examinations may be asked to retake only the OQE (Day One). A student who passes 2 or more of the subject area exams but does not pass the research skills part of the RQE may be asked to retake only the (complete) RQE (Day Two).

Feedback will be provided to the student after the results of the exam have been decided upon.

Candidates who are permitted to repeat all or part of the exams must do so the next time they are offered. **In no case is a candidate allowed to repeat more than once.**

Core subject areas: C-List

The subject or subjects most suitable for preparation for these exams are included in parentheses.

Fluids (2.25) *or* Hydrodynamics (2.20), *not both*

Solid Mechanics (2.071) *or* Structures (2.080J), *not both*

Thermodynamics (2.42)

Heat Transfer (2.55 *or* 2.51+2.52J)

Manufacturing (2.810)

Dynamics (2.032)

Machine Design (2.72) *or* Product Design (2.744 *or* 2.739J), *not both*

System Dynamics & Controls (2.140 *or* 2.151)

Stochastic Dynamical Systems (2.22)

Micro and Nano Engineering (2.37)

Specialized subjects/fields: S-List

Optics (2.71 or 2.717)

Acoustics (2.066)

Computational Engineering (2.097J or 2.29)

Biomechanical Engineering (2.795J or 2.798J)

9.2.3 Major

The major is a program of advanced study which gives the candidate both depth and breadth in a field of engineering or science approved by the MechE Department's Graduate Committee. Examples are: (i) Mechanics; (ii) Product Realization; (iii) Controls, Robotics and Instrumentation; (iv) Energy Science and Engineering; (v) Ocean Science and Engineering; (vi) Biomechanical Engineering; (vii) Micro and Nano Engineering. The Graduate Officer may approve appropriate alternatives.

The set of major subjects should bring candidates to the state of the art in their chosen field, insofar as that is possible via coursework. Candidates must satisfy their Doctoral Committee and the Graduate Officer that their proposed program meets this intent. The major represents the principal component of the candidate's coursework.

The program of study comprised of the major, minor, and additional supporting subjects will typically consist of **at least 144 graduate-level credit units** (12 subjects). Graduate-level subjects taken toward a Master's degree may be used to satisfy the requirements of the doctorate. Graduate-level subjects taken at another graduate school may also be counted toward the MIT doctorate, if approved by both the Graduate Officer and the candidate's thesis committee. The limit is 72 credit units for subjects taken outside MIT.

9.2.4 Minor

The minor is a program of advanced study that develops competence in an area different from the candidate's principal field of interest. Three subjects (not less than 24 units) must be taken in a coherent field different from the major. These subjects may be taken inside or outside the department.

If the minor is in an area of mechanical engineering or in mathematics, all three subjects must be at the graduate-level. In other fields, some undergraduate subject content may be acceptable, depending on the remoteness of the field from mechanical engineering and on the prerequisites required for graduate subjects.

Students who have a Bachelor's or Master's degree in a field distinctly different from mechanical engineering may receive complete or partial credit toward the minor. With this exception, all minor subjects must be taken while the student is registered in graduate school.

The minor program must be approved *in advance* by the student's thesis committee and by the Graduate Officer, who places on file a record of the anticipated program as soon as it is formulated. Any subsequent modifications must have the Graduate Officer's approval. A minimum grade point average of 3.5 must be attained for the subjects that comprise the minor.

9.2.5 Doctoral Thesis

The thesis is a major, original work that makes a significant contribution in its field. It is the principal component of the doctoral program, and the part that serves as the major indicator of a candidate's abilities.

The thesis is supervised by a faculty advisor and monitored by a doctoral thesis committee, which must include at least three MIT faculty members (including their advisor), and at least two of the three MIT faculty members must be MechE faculty.³ The doctoral committee is usually chaired by the thesis advisor, unless the advisor is not a member of the MechE faculty, in which case a MechE faculty member must chair the committee. *At least one of the committee members must be from outside the research group with which the candidate is associated.* The candidate may also invite qualified people from outside the MIT faculty to serve as additional members of the committee.

Work already accomplished elsewhere, not under the supervision of a member of the MIT faculty, cannot be accepted in full or partial fulfillment of the thesis requirement.

9.3 Rules and procedures of the doctoral program (post-qualifying examination)

A student is considered to be a (qualified) candidate in the doctoral program upon passing the qualifying examinations. The candidate is responsible for initiating the various parts of the program and for keeping his/her **Doctoral Program Record (DPR)** (informally called the "online History Card") up to date; this may be found on the MechE Department website by navigating to MechE Resources > MechE Forms > View Grad Student Cards. The doctoral program should be undertaken as follows:

1. The candidate selects a field of principal interest, finds a faculty member who is willing to act as **thesis advisor**, and defines, at least tentatively, an area of research for the thesis. If the advisor is not in the MechE Department, the student must also find a faculty member from within the department who will act as **doctoral committee chair**.
2. The candidate must **meet with the Graduate Officer**, in person, no later than the end of the second semester after passing the qualifying examination. Topics to be discussed will include the tentative choice of thesis committee members along with the programs of study for the major and minor.
3. As soon as possible after that, and under no circumstances later than the end of the first year after passing the qualifying examinations, the student must form the **thesis**

³ Senior or Principal Research Scientists and Engineers **who hold an appointment in the Mechanical Engineering Department** may supervise PhD students.

committee, having obtained *prior approval* of the membership from the thesis advisor and the Graduate Officer. The names of the committee members should be entered on the DPR.

The committee is formed according to the Section 9.2.5 Doctoral Thesis (above). In recruiting the most appropriate members for the thesis committee, it is often helpful (but not required) for the candidate to have a written document (a rough “pre-proposal”) describing preliminary ideas for the thesis research. The doctoral committee, together with the thesis advisor, will be the student’s primary source of advice and guidance. They will monitor and guide the research and act as mentors in the selection of the major, minor, and additional subjects as the student’s education evolves.

4. As soon as possible after forming the thesis committee — *and under no circumstances later than the end of the first year after passing the qualifying examinations* — the student must have a **doctoral thesis proposal** in place.

This is a proposal, and not a doctoral thesis summary. The proposal represents a plan for work in progress, rather than a binding contract; the actual work will be guided and reviewed by the thesis supervisor and the thesis committee, and may evolve in unexpected directions.

The doctoral thesis proposal must be available to the MechE department faculty for review and comments. *The proposal is typically limited to six pages of text and figures.* Its purpose is to let the faculty know what the candidate intends to do, and how s/he intends to go about it. It should provide sufficient literature citations to indicate awareness of previous work, and enough detail to show how the work is expected to advance the state-of-the-art. The cover page should carry the student’s name, the tentative thesis title, the names of the thesis committee members, and the submission date. Feedback from the departmental faculty should be welcomed and taken constructively.

The candidate must provide the Graduate Office with electronic and hard copies of the thesis proposal, as well as an electronic copy of an **abstract** of the proposal. The Graduate Office will distribute copies of the abstract to all MechE faculty. Once this requirement has been fulfilled it should be so recorded on the DPR.

5. As soon as possible after forming the thesis committee — *and under no circumstances later than the end of the three regular semesters after passing the qualifying examinations* — the student must have in place a proposed program of study for the **major and minor**.

The candidate must get approval of their major and minor list of subjects from the doctoral committee at its first meeting. It must then be submitted for review and approval to the Graduate Officer. The programs of study for the major and minor should be entered on the DPR. Subjects may be added to, or taken out of, these programs with the approval of the thesis committee and Graduate Officer.

6. The candidate shall arrange **regular meetings with the doctoral committee**, at least once each regular semester (fall and spring), and obtain the committee's comments on his/her work. The chairman of the committee should make a notation of each meeting on the DPR together with a brief summary of the student's progress. The committee will forward to the Graduate Officer a recommendation as to whether the candidate may or may not continue doctoral work. A student whose progress is unsatisfactory may be required by the department, upon a suitable recommendation (typically a U-grade for thesis research) from the student's Thesis Advisor/Thesis Committee, and/or MechE Graduate Officer, to withdraw from the doctoral program.

7. When the thesis is completed, it shall be presented orally in an **open meeting** of MIT faculty, staff, and students. After the presentation, the thesis is either accepted or rejected **by the thesis committee and any other departmental faculty members present**. The faculty signatures and result should be entered on the DPR.

The thesis presentation is to be scheduled by the doctoral candidate. The student is responsible for obtaining a time and place for the presentation, and for arranging through the Graduate Office to send an announcement of the presentation to the departmental faculty. ***The thesis defense must be scheduled and announced at least two weeks in advance.*** One copy of the thesis must be delivered to the Graduate Office, and one copy should be delivered to each member of the doctoral committee ***at least two weeks prior to the presentation.*** The copy in the Graduate Office will be available for the faculty at large.

The thesis must be defended, and the candidate must submit final, archival copies of the thesis to the Graduate Office, by an end-of-term due date established by MIT (see the Graduate Office). If this deadline is not met, the thesis cannot be accepted in the current term.

The key dates and timeline described above is summarized on the next page.

Key dates and timeline

When each of the milestones listed here has been achieved, this information should be recorded in the student's Doctoral Program Record (DPR) — the “online History Card.”

● During 1st term after qualifying	<ul style="list-style-type: none">• Identify thesis advisor (and if needed the thesis committee chair).• Identify general area of thesis research.
● Within 2 semesters	<ul style="list-style-type: none">• Meet with Graduate Officer to discuss tentative plans for membership of the thesis committee, major & minor curricula.
● Within 1 year of qualifying	<ul style="list-style-type: none">• Form thesis committee after getting prior approval of the membership from thesis advisor and the Graduate Officer.• Write thesis proposal (up-to 6 pages). After obtaining committee approval, submit the proposal and an abstract to the Graduate Office for circulation to the Department faculty.
● Within 3 semesters of qualifying	<ul style="list-style-type: none">• Obtain committee's and Graduate Officer's approval of major & minor curricula.
● At least once each regular semester (fall & spring)	<ul style="list-style-type: none">• Meet regularly with thesis committee.• After each meeting thesis committee chair to record progress on DPR.
● 2 Weeks prior to Defense Date	<ul style="list-style-type: none">• Student to schedule defense and inform Graduate Office so they can announce it.
● At least 2 weeks prior to Defense Date	<ul style="list-style-type: none">• Give thesis draft to thesis committee and Graduate Office.
● Immediately after Defense	<ul style="list-style-type: none">• Thesis committee and other department faculty members to sign DPR and record the result.

9.4 Interdisciplinary doctoral programs

Graduate students registered in the Department of Mechanical Engineering may elect to participate in several interdisciplinary doctoral programs of study including those listed below. Students must fulfill all of the MechE Department requirements as described above, and in addition satisfy the specific requirements of the particular interdisciplinary program. The interdisciplinary programs currently available include the following.

9.4.1 Computational Science and Engineering (CSE)

The Computational Science and Engineering doctoral program allows students to specialize in a computation-related field of their choice through focused coursework and a doctoral thesis. The emphasis of the thesis research is on the development of new computational methods and/or the innovative application of computational techniques to important problems in engineering and science. This program is administered jointly by the MechE Department and the Center for Computational Engineering, and students receive a doctoral degree in Mechanical Engineering and Computation. For more information see <http://computationalengineering.mit.edu/cse>.

9.4.2 Joint Program with the Woods Hole Oceanographic Institution

The Joint Program with the Woods Hole Oceanographic Institution (WHOI) is intended for students whose primary career objective is oceanography or oceanographic engineering. Students divide their academic and research efforts between the campuses of MIT and WHOI and receive a degree in Oceanographic Engineering. The program is described in detail at <http://mit.whoi.edu/>.

9.4.3 The Program in Polymers and Soft Matter (PPSM)

The Program in Polymers and Soft Matter offers students an interdisciplinary core curriculum in the science and engineering of polymers, gels and other soft matter systems. Fields of research include functional polymers, gels, surfactants and colloids, controlled drug delivery, nanostructured soft materials, polymers at interfaces, biomaterials, molecular modeling, polymer synthesis, biomimetic materials, polymer mechanics and rheology, self-assembly, and processing of complex fluid systems. For more information please see the PPSM website <http://polymerscience.mit.edu/>.

10 Financial Support and Thesis Supervision

10.1 Types of financial aid available

The Mechanical Engineering Department offers three types of financial assistance to graduate students: fellowships, research assistantships, and teaching assistantships.

A fellowship provides students with a direct grant, and leaves them open to select their own research project and supervisor. A number of students in the department are

supported by fellowships from outside agencies, and a few are available from MIT. However, the department itself has relatively few fellowships to offer.

The majority of students in the MechE department are supported by research assistantships, which are appointments to work on particular research projects with particular faculty members. The faculty members procure research grants for various projects, and hire graduate students to carry out the research. The research is almost invariably structured so that it becomes the student's thesis. A fulltime RA appointment provides a full tuition scholarship (i.e. covers all tuition) plus a salary that is adequate for a single person. In return for a fully funded education, RAs are required to do a certain amount of work for the grant that funds them. In most cases, this work becomes the student's thesis project. Consistent with this requirement, *an RA may register for no more than 24 units of classroom work* (typically two subjects) per regular term, and must do at least the equivalent of 24 units of thesis work (i.e. research on the project) per term. The summer term is usually spent on thesis work.

Teaching assistants are appointed to work on specific subjects of instruction. As the name implies, TAs usually assist a faculty member in teaching, often grading homework problems and tutoring students. In the Mechanical Engineering Department, TAs are seldom used for regular full-time classroom teaching. *TAs are limited to 24 units of credit per regular term, including both classroom subjects and thesis.* A TA appointment usually does not extend through the summer.

Experience has shown that the optimum graduate program consists of about equal measures of coursework and research, consistent with an RA appointment. One advantage of a fellowship is greater freedom in choosing a research project and supervisor. Another is that, unlike an RA, a fellowship student is not limited to two courses per term, and may therefore be able to finish a degree in a somewhat shorter time.

A teaching assistantship gives the student teaching experience and can also be extremely valuable for reviewing basic subject material: for example, in preparation for the doctoral general exams. It does not, however, leave much time for thesis research, and may extend the time that the student will need to complete a degree.

10.2 How to get a research assistantship or teaching assistantship

Once a student is formally admitted to the department, he/she is eligible for an assistantship. At this point it helps to understand how the funding of graduate research works in MIT's Engineering School. The faculty write proposals for specific research, and when they receive funding, they hire graduate Research Assistants to do the research with/for them. The MechE Graduate Office distributes lists of admitted students to all MechE faculty members, noting each student's interests, previous university affiliation, grade point average, etc. From these lists, the faculty select candidates for the positions they have available. They make their final selections after reviewing the students' application files. At that point, they contact a student, with a specific offer for a research assistantship. A particular student may get offers from several professors, in which case he/she has to make a choice about which one to accept.

The graduate research enterprise is thus somewhat like a free enterprise system, with the individual professors looking for the best students for their research projects and the students looking for the most interesting or satisfying research experience.

What can students who have just been accepted do to improve the chances in this process? The first step is to carefully read the Research areas as listed on the MechE website <http://meche.mit.edu>. From these areas students can identify the faculty members they would like to work with, and should feel free to write, e-mail, or telephone them; they should not be shy about making the professors aware of any special qualifications that they (the students) might possess (previous research experience, etc.).

Students seeking research assistantships should be aware that many, if not most, commitments are made after April 15. Positions become available through the spring and summer, depending on when the research grants come in, and a significant fraction of new research assistantship offers are made after the beginning of the fall term. Most graduate students end up with funding by the end of their first term.

Teaching Assistantships are relatively few in number, and are usually offered to students who are already at MIT and known to the departmental faculty. A student who has a keen interest in serving as a TA in a particular subject can make it known by contacting the faculty member in charge (listed in the MIT Bulletin under the description of each subject).

10.3 How to find a thesis supervisor if you have independent funding

Students who have fellowships or are privately funded need to associate themselves with a faculty member who will supervise their thesis research. They should choose a supervisor in much the same way as another student would try to secure an RA, identifying prospective faculty members and checking whether there are projects they can work on. Research requires money, and even though these students require no salary from the department, they are well advised to find a supervisor who has some funding for the intended work. Although their obligations to the research are not the same as those of an RA, in practice they end up working just as hard in order to finish their theses in a reasonable time. It is usually a good idea to associate with a supervisor as soon as possible after arrival at MIT. The student then becomes part of a research group, gets a desk to work at, and is in a position to get advice and learn from his/her supervisor and from the more experienced students in the research group.

10.4 Rules for students who do thesis work off-campus

All such students are required to have a MechE faculty member as either thesis supervisor or co-supervisor, have passed the doctoral qualifying examination and have submitted a thesis proposal. Prior to embarking on work away from campus, a student must submit to the Graduate Officer a plan for finishing the degree, including thesis topic, timetable of academic courses at MIT, timetable of planned non-residential periods, and names and coordinates of off-campus supervisors. Both the thesis advisor and the Graduate Officer must approve the plan by signature. Students with off-campus

co-supervisors (SM as well as PhD candidates) must arrange joint meetings with both their on- and off-campus supervisors at least once every regular term.

Additional MIT requirements are described at the website of the Office of the Dean for Graduate Education (ODGE): <https://odge.mit.edu/gpp/degrees/>

DEPARTMENT OF
MECHANICAL ENGINEERING
QUALIFYING EXAMS

GUIDELINES AND FORMATS

Revised 09.25.2015

QUALIFYING EXAMINATION
IN
DYNAMICS

Topics

The Dynamics qualifying examination is at the level of our introductory dynamics subject 2.032. Highlights of this subject include:

- Kinematics
- Momentum principles
- Lagrangian mechanics
- Three-dimensional rigid body dynamics
- Vibration of discrete and continuous systems
- Gyroscopic effects

Format

The proposed exam will consist of two separate parts:

- A one (1) hour written exam (Closed Book)
- A separate oral exam consisting of 20 minutes to review the question followed by a 20 minute oral questioning period.

ACOUSTICS

Course 2.066

Format:

The proposed exam will consist of two separate parts:

- A one (1) hour written exam (Closed Book)
- A separate oral exam consisting of 20 minutes to review the question followed by a 20 minute oral questioning period.

QUALIFYING EXAMINATION
IN
SOLID MECHANICS

Topic

Course 2.071.

Format

The format will consist of a single oral examination.

- Students will be given 45 minutes to review, and to prepare responses to, two (2) submitted questions, which will be the same for all candidates.
- After preparation, students will be examined orally on their responses with a 45 minute questioning/examination time in which the candidates are expected to present solutions to both of the posed problems.
- Grading will consist of a single number in the range 0 - 20. The minimum passing mark will be 14.

QUALIFYING EXAMINATION
IN
STRUCTURAL MECHANICS

Topics

Fundamental concepts of structural mechanics with applications to marine, civil, and mechanical structures. Residual stresses. Thermal effects. Analysis of beams, columns, tensioned beams, trusses, frames, arches, cables, and shafts of general shape and material, including composites. Exact and approximate methods, energy methods, principle of virtual work. Yield and failure criteria. Elastic buckling of columns, plates and sections.
RECOMMENDED SUBJECT 2.080J.

Format

The format will consist of a single oral examination.

- Students will be given 45 minutes to review, and to prepare responses to, a set of one or more submitted questions, which will be the same for all candidates.
- After preparation, students will be examined orally on their responses with a 40 minute questioning/examination time in which the candidates are expected to present solutions to both of the posed problems.
- Grading will consist of a single number in the range 0 – 20. The minimum passing mark will be 14.

QUALIFYING EXAMINATION
IN
FLUID MECHANICS

Topics Covered

For the immediate future, the content will remain based on the subject matter covered in 2.25 Fluid Mechanics. Principal topics include conservation laws (mass, momentum, energy, angular momentum) for moving and deforming fluids, control volume techniques, dimensional analysis, viscous-dominated flows and lubrication theory, inviscid flows, potential flow theory and boundary layer analysis. As new subjects emerge we may introduce several options of fluid mechanics, enlisting additional examiners as needed.

Format

- There will be one oral examination. The applicant will have 30 minutes to review the question and then they will have 30 minutes for the oral part.

QUALIFYING EXAMINATION
IN
HYDRODYNAMICS

Topics

Equations governing conservation of mass and momentum. Similitude and model testing. Ideal vortical and potential flows in two and three dimensions, including the concepts of lift and added mass. Lifting-surface theory for steady, unsteady, and cavitating hydrofoils. Real (viscous) laminar and turbulent flows, Reynolds stresses, laminar and turbulent boundary layers. Rudiments of linearized free-surface waves, including wave kinematics, superposition, dispersion, energy density and group velocity, and the effect of finite water depth. Water wave loads and motions of bodies in waves, ship wave resistance. Hydrodynamics of slender bodies. Application to floating and submerged vehicles.

RECOMMENDED SUBJECT 2.20.

Format

- There will be one examination. The applicant will have 30 minutes to review the question and then they will have 30 minutes for the oral part.

QUALIFYING EXAMINATION
IN
GEOPHYSICAL FLUID DYNAMICS

Topics

Equations for mass, momentum, and energy and their application in fixed and rotating systems. Vorticity and potential vorticity. Geophysical boundary layers. Fluid-density effects, including density-driven flows. Scales and scaling of ocean flows. Oceanic circulation.
RECOMMENDED SUBJECT 12.800.

Format

- There will be one examination. The applicant will have 30 minutes to review the question and then they will have 30 minutes for the oral part.

Subject & Research Qualifying Examination in Thermodynamics
MIT, Mechanical Engineering
Effective May 2012

Thermodynamics is one of the foundations of Mechanical Engineering. It is concerned with the rules governing energy conversion including mass and energy conservation, entropy balance and the properties of substances. It is applied extensively for the analysis and design of power and propulsion systems, refrigeration and energy conversion.

The qualifying exam focuses on single-component equilibrium thermodynamics.

Format of Research Exam

The thesis exam will continue to be the same as in most other areas, that is a total of 45 minutes for presentation and discussion.

Format of Subject Exam

Only an oral closed book exam will be offered. Students will be given a written problem statement and 30 minutes of preparation time. Then, students will demonstrate solving this problem to the faculty in a time period of 30 minutes including questions by the faculty. The problem typically contains calculations as well as conceptual questions.

Class Preparation

Students are expected to have a graduate level knowledge of undergraduate thermodynamics, in particular those thermodynamics focused topics covered in 2.005/6. To prepare for this exam, it is suggested that students take 2.42 - General Thermodynamics or an equivalent graduate-level class.

QUALIFYING EXAMINATION
IN
HEAT AND MASS TRANSFER

Objective and Scope

The purpose of this examination is to evaluate the candidate's depth in and understanding of the fundamental principles of heat and mass transfer. The student is expected to recognize, formulate, and solve problems and applications involving conduction, convection, radiation, mass diffusion, and phase change. He or she should be able to determine temperature distributions inside solid bodies, to predict heat transfer and mass transfer rates at solid-fluid interfaces for all types of flow conditions, to estimate radiation heat exchange between solid surfaces, and to evaluate the performance of heat and mass exchangers.

Preparation Guidelines

The examination will be based on material normally covered in the undergraduate core curriculum plus the elective 2.51 in Mechanical Engineering at M.I.T., but will presume the maturity and experience commensurate with a graduate student at the Master's level. The primary undergraduate subject to which the examination will relate is 2.51. Other related subjects are 2.005 and 2.006. A good graduate core course to prepare for the exam is either 2.52 (Modelling and Approximation of Thermal Processes) or 2.55 (Advanced Heat and Mass Transfer).

Recommended Textbooks

General Texts:

Mills, *Heat Transfer*, 2nd ed., Prentice Hall, 1997.

Lienhard and Lienhard, *A Heat Transfer Textbook*, 4th ed., Phlogiston Press, 2015. Also see <http://web.mit.edu/lienhard/www/ahtt.html>.

Convection:

Bejan. *Convection Heat Transfer*, 2nd ed., John Wiley & Sons, Inc. 1995.

Kays and Crawford, *Convective Heat and Mass Transfer*, 3rd ed., McGraw-Hill, Inc. 1993.

White, *Viscous Fluid Flow*, 2nd ed., McGraw-Hill, 1991.

Design and Applications:

Duffie and Beckman, *Solar Engineering of Thermal Processes*, 2nd ed., John Wiley & Sons, Inc., 1991.

Rohsenow, Harnett, Cho, *Handbook of Heat Transfer*, 3rd ed., McGraw-Hill, 1998.

Hewitt, *The Heat Exchanger Design Handbook 1998*, Begell House, N.Y., 1998

Kays and London, *Compact Heat Exchangers*, 3rd ed., McGraw-Hill, 1984.

Heat Conduction:

Arpaci, *Conduction Heat Transfer*, Ginn Press, 1991.

Carslaw and Jaeger, *Conduction of Heat in Solids*, 2nd ed., Oxford Univ. Press, 1959.

Radiation:

Brewster, *Thermal Radiative Transfer & Properties*, A. Wiley-Interscience Publication, 1991.

Edwards, *Radiation Heat Transfer Notes*, Hemisphere Publishing Corp. 1981.

Modest, *Radiative Heat Transfer*, McGraw-Hill, Inc. 1993.

Siegel and Howell, *Thermal Radiation Heat Transfer*, 3rd ed., Hemisphere Publishing Corp., 1993

Mass Transfer:

Mills, A. F., *Mass Transfer*, Prentice-Hall, Inc., Upper Saddle River, 2001.

Format

- There will be one examination. The applicant will have 30 minutes to review the question and then they will have 30 minutes for the oral part.

QUALIFYING EXAMINATION
IN
SYSTEM DYNAMICS AND CONTROL

Basic Coverage

Exams are to cover material at the advanced undergraduate level, typically covering what is in corresponding MIT undergraduate subjects. They should not expect knowledge of material given in advanced graduate subjects, but may touch upon basic material in introductory or core graduate subjects.

Relevant classes

2.140 and 2.151

Format

- A one (1) hour written exam (Closed Book) and
- A separate oral exam consisting of 20 minutes to review the question followed by a 20 minute oral questioning period.

QUALIFYING EXAMINATION
IN
SIGNALS AND SYSTEMS

Topics

Time domain concepts for linear, time-invariant systems, such as impulse response and convolution. Integral transform techniques for linear systems, including continuous and discrete Fourier, Laplace, and Hilbert transforms. Sampling theorem and reconstruction. Modulation and demodulation of signals. Analog and digital filtering. Transfer function for system with linear feedback, including concepts such as open- and closed-loop gain and phase response. RECOMMENDED SUBJECT 6.003.

Format

- A one (1) hour written exam (Closed Book) and
- A separate oral exam consisting of 20 minutes to review the question followed by a 20 minute oral questioning period.

QUALIFYING EXAMINATION
IN
PROBABILITY AND RANDOM PROCESSES

Course 6.431 and 2.22

Format:

- A one (1) hour written exam (Closed Book) and
- A separate oral exam consisting of 20 minutes to review the question followed by a 20 minute oral questioning period.

QUALIFYING EXAMINATION
IN
BIOLOGICAL ENGINEERING

Topics: This exam covers the mechanics of biological systems, from single molecules to whole tissues, as well as biologically-relevant topics in transport and fluid flow.

Preparation: Students wishing to take this exam would be recommended to be well-versed in those topics included in two graduate subjects: 2.795: *Fields, Forces and Flows in Biological Systems*, and 2.798: *Molecular, Cellular and Tissue Biomechanics*.

Purpose: The exam is based on the student's ability to read, comprehend, and analyze one or two publications from the relevant literature.

Logistics: Each student is given a copy of the paper at 9:00 am on the first day of the exam. They are then asked to submit a short written analysis of the paper by the morning of the second day. On the third day, a committee of three or more faculty examines each student on their written critique and related topics. The oral exam is between 20 and 50 minutes in length. The student should prepare a short presentation (no more than half of the length of the exam) to be used as a basis for questioning.

QUALIFYING EXAMINATION
IN
OPTICS

Material Covered

Geometrical Optics

- Ray theory, thick/thin lenses, ray propagation matrices
- Optical systems: primate eye, telescope, microscope
- Aberrations, simple aberration correction methods

Physical Optics

- Wave equation, plane & spherical wave solutions
- Light propagation in matter, polarization
- Optical resonators, optical gain, lasers
- Fresnel & Fraunhofer diffraction
- Interference/interferometers, diffraction gratings, holography
- Coherent/incoherent image formation

Two-dimensional non-causal signal processing

- Bandwidth, sampling, space-bandwidth product
- Spatial filtering, convolutions & correlations
- Inverse problems, resolution

Class preparation

Necessary - Optics

Basic (introductory, no background necessary; includes basic E&M) undergraduate/graduate optics. 2.71 (U), 2.710 (G), prereq. 2.003.

Optional - Optical Engineering

Advanced graduate class on optical sensing and imaging, emphasis on information and design. 2.717 (G)

Other Optics subjects around M.I.T.

6.161 (U), 6.631 (G), 6.634 (G), 6.637 (G), 8.421 (G), 8.422 (G)

Format

- Written exam *standard department format* (Closed Book) Duration 1 hour and
- Oral exam (*non-standard format*) Duration: 40 min/student
 - Part 1: (~25 min)
 - Student is given a collection of two-three research papers focused on a research topic, one week before the exam
 - The topic and papers are decided by the exam committee in consultation with the student's research advisor and taking into consideration the student's research topic
 - The student presents a 15 min long summary of the papers and then answers questions by the committee.
 - Part 2: (~ 15 min)
 - Free-form questions on the subject matter covered by 2.71/2.710 Optics as follow-up to previous questioning.

QUALIFYING EXAMINATION
IN
MANUFACTURING
(Final Version)
July 11, 2007

The doctoral qualifying exam in Manufacturing requires a graduate student understanding of the material contained in the undergraduate Subject 2.008. An important component of this includes how materials behave in manufacturing processing conditions. This includes elements of solid mechanics found in 2.001 and elements of fluid mechanics and heat transfer found in the undergraduate courses 2.005 and 2.006. All students are expected to have an understanding of basic manufacturing processes. This would include at least machining, casting, injection molding, and forming processes. This understanding of manufacturing processes should go beyond the physics and include the issues of cost, variation, quality, time and rate. It is also important that the candidate understands the relationship between design and manufacturability, and between design, manufacturability and system design. All students should have a basic familiarity with standard systems configurations such as transfer lines, flow lines, job shops, assembly systems and the Toyota Production System, including manufacturing cells.

The manufacturing exam requires familiarity with a few systems tools which can prove useful for characterizing system problems, these include SPC, reliability (MTTF, MTTR, Buzacott's result, zero buffers, infinite buffers), Little's Law, the M/M/1 Queue, and the treatment of random variables, in particular the Expectation and Variance operators. All of these elements will need to be integrated in order to analyze real problems and give insights into the fundamental mechanisms, as well as the potential trade offs between alternatives.

If you have not taken 2.008 or an equivalent, a recommended preparatory graduate subject is 2.810.

Format

- A one (1) hour written exam (Closed Book) and
A separate oral exam consisting of 20 minutes to review the question followed by a 20 minute oral questioning period

QUALIFYING EXAMINATION
IN
PRODUCT DESIGN

Basic Coverage

Exams cover material at the advanced undergraduate level.

Relevant Undergraduate Classes

2.007, 2.72, 2.009

Graduate Classes in Design

2.739, 2.744, 2.76

Format

- A one (1) hour written exam
- An oral exam in which students are given 20 minutes to prepare answers to a short series of questions and then are asked to defend their answers to faculty members during a 20 minute oral questioning period.

Books Useful for Review

- Mechanical Engineering Design by Shigley and Mischke
- Product Design and Development by Ulrich and Eppinger

Exam Overview

For these exams, students are expected to have a deep and thorough understanding of material taught in the undergraduate design courses. Typical questions may focus on

- design of machine elements and the systems in which they are used
- questions about how a given system functions and about the strengths and weaknesses of the system.
- issues that must be understood when developing a product. Among these are, for example, product quality, product cost, product safety, manufacturability, product architectures, customer needs, product specification, concept generation, concept selection, concept testing, and prototyping.

9/28/2015

QUALIFYING EXAMINATION
IN
MECHANICAL ELEMENTS AND SYSTEMS DESIGN

For these exams, students are expected to have a deep and thorough understanding of material taught/incorporated and practiced in the undergraduate design course. All students are expected to have an understanding of the types of basic machine elements, how to model and optimize them, and how they are best used to create functional mechanical systems. All students should be familiar with standard elements, for example bolts, gears, bearings, shafts, structural elements/sub-systems, actuators, sensors, drives, linkages and springs/flexures. If you have not taken 2.72 or an equivalent, a recommended graduate preparatory subject is 2.75, 2.76. Typical questions focus on :

- Conceptual design of machine elements or systems
- Modeling, design and selection of machine elements
- Synthesis, modeling and design of machine systems
- Questions about how a given element or system functions
- Contrast/compare the strengths and weaknesses of elements and systems
- Practical issues in mechanical system design, for example, cost vs. performance, safety, design verification testing, fabrication and manufacturability

Basic Coverage

Exams cover material at the advanced undergraduate level.

Relevant Undergraduate Class

2.72

Graduate Classes in Mechanical System Design

2.75, 2.76

Format

- Students are given a selected technical paper to read, or other forms of documentation of a design. This reference material will be provided at least 3 days before the exam. This material may also include example questions for students to consider in preparing for the exam. Students may use publicly available resources as part of understanding the reference material and questions, but may not discuss the exam with any other people. Students must sign a certification to this effect.
- An oral exam in which students are given 40 minutes to present their understanding of the reference material and design issues, and are asked

to defend their answers to faculty members. The discussion will be initiated from design issues raised in the reference, and may extend into questions of how the designs work, fundamental physics and tradeoffs, as well as how to improve the designs for some performance metrics.

Books Useful for Review

- Mechanical Engineering Design by Shigley and Mischke
- Precision Machine Design by Slocum
- Fundamentals of Design available free on web.mit.edu/2.75

9/28/2015

QUALIFYING EXAMINATION
IN
MICRO/NANOENGINEERING
EFFECTIVE MAY 2015

Topic

Course 2.37: Fundamentals of Nano Engineering

Faculty Committee

Prof. Hadjiconstantinou, Prof. Fang, Prof. Karnik, Prof. Hart, Prof. Kolpak

Format

The format will consist of a single oral examination.

- Students will be given 30 minutes to review, and to prepare responses to the submitted question(s).
- After preparation, students will be examined orally on their responses with a 30 minute questioning/examination time in which the candidates are expected to present their solution(s).
- Grading will consist of a single number in the range 0 - 20. The minimum passing mark will be 14.

Subject & Thesis Qualifying Examination in Computational
Engineering
MIT, Mechanical Engineering

A significant number of graduate students in the Mechanical Engineering Department perform research with a strong focus on computational engineering, in particular including the development of numerical methods and tools. More specifically, the subtopics in computational engineering include i) computational fluid dynamics, ii) computational solid mechanics, iii) solution of partial differential algebraic equations, iv) molecular-level simulation and v) optimization/parameter estimation. The qualifier exam in Computational Engineering (oral subject exam and thesis exam) will address this type of research. It is offered since May 2011.

Format of Research Exam

The thesis exam will be the same as in any other area. Additional faculty will be invited if their expertise is needed for a particular thesis topic.

Format of Subject Exam

A written exam is not suitable for a computational engineering exam and therefore only an oral exam will be offered based on critical presentation of a journal article (or similar publication) from the literature. This will be in the general area of research interests/class preparation of the student but not closely related to their research work. Typically, each student will have a separate article to review. The articles will be given to the students a week in advance of the oral exam. At the exam date, the students will give a 15 minute presentation of the article followed by a 15 minute discussion with the faculty. The discussion covers computational engineering focusing on the article and the material covered in the class(es) taken by the student.

Class Preparation

Students are required to have taken one or more of the following classes. Student that have taken a similar subject at MIT or another institution, can petition a substitution

- 2.097J Numerical Methods for Partial Differential Equations
- 2.29 Numerical Fluid Mechanics
- 2.37 Molecular Mechanics