MIT Department of Nuclear Science and Engineering

Doctoral Degree Requirements

Coursework Requirements

Core Modules: 22.11, 22.12, 22.13, 22.14, 22.14, 22.16.

Students may take the coursework, or may register as listener and take only the final exam. Students must complete all core module final exams by the end of the fourth term, and are allowed one re-take. A final exam gpa of 4.5 is needed to clearly pass the written qualifier. A final exam gpa of 4.0-4.5 will require a faculty review prior to the student embarking on doctoral research. Students earning a final exam gpa under 4.0 will not be permitted to progress further in the doctoral program.

Early Module Exams
First-year students are encouraged to petition to take early module exams for any modules in which they have a sufficient amount of prior coursework or research experience with the subject material. Eligibility for the early module exams will be decided by the module instructor, however students may use the syllabus and the self-evaluation material to evaluate whether to petition.

Early Module Exams:

- Are conducted prior to the term in which the module is offered (August for Fall modules; January for Spring modules)
- Results will be communicated prior to Registration Day
- Are only available to students during the first academic year
- Do not count toward the two allowed attempts at the module final exams

Field of Specialization Subjects (36 units)

- Nuclear Reactor Engineering: 22.211, 22.312, and one of (22.39, 22.313, or 22.315)
- Nuclear Reactor Physics: 22.211, 22.312 and one of (22.212, 22.213, or 22.251)
- Nuclear Materials: 22.71, 3.20 (thermodynamics) and one of (22.72, 22.74 or 3.21 (kinetics))
- Fusion: 22.611, 22.62, and one of (22.67, 22.615, or 22.616)
- Nuclear Science and Technology: 22.51, 8.511 and one of (22.90, 8.333, or 8.421)
- Nuclear Security and Policy: 6.431, (22.812 or 22.814), and (22.312 or 22.90)

Fields of specialization not on this list must be approved by the NSE Graduate Committee. Students can begin taking field-of-specialization subjects as early as their first graduate term, and will typically have completed at 1-2 by the end of their first year.

- A minimum GPA of 4.0 is required for the Field of Specialization. A FoS GPA of 4.0-4.5 will require review by the faculty prior to embarking on doctoral research; students achieving above 4.5 or higher will automatically fulfill this requirement.
- Students must submit a plan to satisfy their field-of-specialization requirement by the beginning of their second graduate term, and must complete all subjects by the end of the fourth term.

Advanced Subjects (24 units)

- Must be an approved program of **two advanced subjects** (24 units) that are closely related to the student's doctoral thesis topic
- Must complete with an average grade of B or better
- None may overlap with Field of Specialization requirement.
- Subjects may be from a different Field of Specialization list (as long as they do not overlap with the student's FoS subjects).
- Must be approved by both the thesis supervisor and the Registration Officer

Minor Subjects (24 units)

- Must complete at least 24 units of coordinated subjects outside the field of specialization and the area of thesis research
- Must consist of at least two graduate subjects or three undergraduate subjects
- Undergraduate subjects used to fulfill the minor requirement must be taken while registered as a graduate student in the department
- Must be approved by the Registration Officer.

Non-Coursework Requirements

Oral Examination

- Must be passed by the end of the fourth graduate term, in order to embark on doctoral research.
- Oral Exams are scheduled in early February and late May.
- Two attempts are permitted.
- To qualify: overall gpa of 4.0 or higher.
- Recommended: take all of the core module final exams prior.
- Recommended: pass at least two of the three field of specialization subjects.

The purpose of the oral is to examine:

- the student's ability to think logically, express a point of view, and defend it orally;
- the student's knowledge of a specialized field of research;
- the student's knowledge of the technical foundations of the field of research, including the ability to make connections and integrate across those foundations.

The oral examination is approximately 2 hours in length and is in two parts.

- Part I: the student will present a 5-10 page paper prepared in advance and submitted no less than 10 days prior to the oral exam date. The paper should review a field of research, critique it, and formulate a research plan to approach a specific problem in the chosen field. The examining committee will evaluate the content of the paper, the student's understanding of it, and the quality of the presentation.

  This paper will have some similarities to a thesis prospectus, but the problem described will not necessarily turn out to be the student's doctoral thesis problem. If the student has previously carried out a SM thesis, the paper could describe that work. Topics to be explored in the paper

and in the examination will include the student's identification of open questions in the research field, the significance of the particular research problem selected by the student, and the proposed approach to the problem, including criteria against which research progress could be judged.

- Part II: the examining committee will ask questions designed to examine the student on her/his broad knowledge within the field of specialization. The committee will have wide discretion in leading the student to explore areas where she/he should have technical background.

- The oral examination committee will consist of at least four members. At least three members should be NSE faculty members or senior scientists. The chair should be a member of the NSE faculty but may not be the student's research advisor.

- The committee will assign a grade of *pass, marginal performance, or fail.*

- The chair of the committee will provide feedback to the student shortly after the oral examination. If the student receives a grade of *marginal performance* or *fail*, at least one other member of the committee will also provide feedback.

Further information on the oral examination can be found in the companion document entitled "Procedures for the PhD Qualifying Oral Exam".

Threshold Requirements for Undertaking Doctoral Research

By the end of the fourth term:

- Passing grade in the oral examination
- Core Module Final Exam GPA of 4.5 or higher.
- Field of Specialization GPA of 4.5 or higher.
- A GPA of 4.0-4.5 in either category will require faculty review; below 4.0 will not be permitted to embark on doctoral research.

The NSE faculty will meet twice a year to review the performance of doctoral students. These meetings will take place shortly after the oral examinations are concluded.

Students who have not been permitted to embark on doctoral research by the end of their fourth regular graduate term will not be allowed to register in the Department for more than two additional regular terms.

Students who have passed the qualifying exam may register for thesis in the term in which the exam was given, or the following term. The Thesis Prospectus is due during the first term of thesis registration, and students registered for thesis must also register for the Doctoral Seminar.

Thesis and Doctoral Research

General Institute information relating to theses for advanced degrees is to be found in the ODGE Graduate Policies and Procedures Manual: http://odge.mit.edu/gpp/degrees/thesis/.

Students are advised to speak to NSE faculty and/or research scientists engaged in research in areas of interest to them to explore possible thesis topics. A student should select a supervisor and, together, work

out a proposed program of thesis research. In some cases, joint thesis supervision by more than one faculty member may be appropriate. The program must be approved by the Department before research may be initiated (see **Thesis Prospectus**, below.)

Doctoral research may be undertaken in nuclear science and engineering or in a related field of research, and may be primarily theoretical or experimental, or can combine both approaches. Either the thesis supervisor or the reader must be a faculty member of the Nuclear Science and Engineering Department.

Department Regulations for Thesis Supervision – who is allowed to supervise a thesis:

1. **NSE FACULTY** (NSE faculty; NSE faculty emeritus; NSE professor of practice; faculty having dual and joint appointments with other departments).
2. **Non-NSE MIT Faculty and NSE (and affiliated labs — PSFC and MITR) *Senior* and *Principal* Research Scientists/Engineers.** A selection from category 2 requires an NSE faculty member as a thesis reader.
3. **Visiting Professors, NSE (and affiliated labs — PSFC and MITR) Research Scientists/Engineers, and *MIT* Senior and Principal Scientists/Engineers (including MIT-Harvard programs).** A selection from category 3 requires approval from the NSE Graduate Committee and requires an NSE faculty member as a thesis reader.

Where there is a single supervisor, there must also be a thesis reader. The reader will be solicited by the doctoral candidate after a thesis topic has been selected. The function of the reader is to read the prospectus and the final thesis report, and to comment on the progress and results of the work. Both the thesis supervisor and the reader will sign acceptance of the final written thesis.

Doctoral Supervision Committee Regulations

Must be composed of at least 3 members, including

1. Thesis supervisor(s)
2. Reader
3. Additional committee members

A minimum of two (2) members should be MIT affiliates. External committee members require NSE Graduate Committee approval.

Other Requirements:

- The supervision committee will meet at least once each academic year to review the doctoral student's research. The committee may meet more frequently, at the discretion of the thesis advisor. The purpose of this review is to see that adequate progress is being made toward completion of the research. This meeting could follow the student's doctoral seminar presentation.
- At the conclusion of the meeting, a Committee Meeting Form must be signed by the student and committee members and returned to the NSE academic office (24-102). It is the student's responsibility to obtain the signatures and return the form to the NSE academic office.
- The meetings with the doctoral supervision committee are to be organized by the student. The purpose is to insure that the supervisor, reader, and student are all in agreement with respect to the scope and quality of the thesis work. All participants will sign the summary report prepared by the thesis supervisor.

NSE Doctoral Degree Requirements
Last update: February 22, 2018. Applies to students entering June 1, 2018 or later.

Thesis Prospectus

To facilitate the Department approval of the research subject, each candidate shall submit a brief thesis prospectus. One copy of the approved prospectus must be submitted to the NSE academic office.

This prospectus should be a few typewritten pages long and should contain:

- a descriptive title of thesis
- the date of general exam
- signatures of doctoral supervision committee members, including supervisor(s) and faculty reader
- general description of the problem; its significance; and background information relating to the problem.
- an approved copy of the form listing the subjects to be taken to satisfy the coursework requirements, including the advanced subject and minor requirements must be attached to the thesis prospectus for review by the thesis supervisor

Doctoral Seminar Requirement

All students registered for doctoral research are required to register for the Seminar in Nuclear Science and Engineering, 22.911 (Fall) and 22.912 (Spring). In 22.911 and 22.912 they will present:

(i) a seminar on their thesis research, and
(ii) at least one additional technical presentation in oral or poster format each year at an occasion agreed to by the faculty in charge of the seminars in the student's area. Examples of acceptable technical presentations include (but are not limited to) a lecture at the NSE Freshmen Seminars, a lecture in a Course 22 undergraduate class, a talk at the Freshmen Open House, a poster/talk at the NSE Graduate Research Expo, a presentation at a professional conference.

Research Progress

In addition to the required annual thesis committee meetings, the NSE Graduate Committee reviews student progress at least annually (but usually twice a year). The purpose is to see that adequate progress is being made toward completion of the research. Unsatisfactory progress may result in a wanring or denial of further registration and may have consequences on student funding.

Thesis Defense and Thesis Document Preparation

At least one week prior to the scheduled thesis defense, students must submit electronically

- the draft thesis document
- the executive summary document
- notice of the thesis defense should be attached to the front of the executive summary document and should list the names of the committee members, date, time, and place of the scheduled defense
- approval from the thesis supervisor for both of the above documents
- student may not advertise the thesis defense until informed by the Academic Office that all materials have been received and approved

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Thesis Defense

- The candidate will be examined on the content of the thesis and on topics immediately related to it. The thesis defense may be scheduled to occur at any time after eight days have elapsed following submission of the thesis to the NSE academic office, in conformity with Institute and Department requirements for thesis presentation, but before the date grades are due for that term.
- The candidate shall arrange a time for the defense to meet the convenience of the thesis defense examining committee.
- The examining committee shall include at least three members of the MIT faculty (of whom the supervisor(s) and reader may be two).
- The chairman of the committee shall be an NSE faculty member who is not a supervisor or reader.
- Thesis defense examinations are open to the public.
- A notice of thesis defense must be emailed to all NSE faculty, staff and students at least one week prior to presentation.
- The chairman of the thesis defense committee will inform the NSE academic office of the result of the defense. Acceptance will be endorsed by the signatures of the supervisor and reader on the thesis title page after the thesis defense.

Final Thesis Document

As indicated in the ODGE Graduate Policy and Procedures Manual, prior to submission of the final written thesis, a draft complete in all particulars is required for editorial comment and professional appraisals by the supervisor and reader. In planning a schedule, the student should realize that in excess of one month has customarily been required to complete the editorial comment, professional appraisal, required revisions and review.

To be submitted to the Academic Office:

- Two copies of the signed thesis document (except the Graduate Officer), printed on archival bond paper, and exactly meeting all MIT thesis specifications. Covers and clips are available in the Academic Office. Archival bond paper is available through CopyTech. http://libraries.mit.edu/archives/thesis-specs
- One electronic copy emailed to the Academic Office staff.
- Forward your confirmation of upload into DSpace to the Academic Office staff.
- The Proquest form for the libraries, with an extra copy of your abstract attached (does not have to be on archival bond paper).
- The NSE Graduation Checklist, signed by each person on the checklist after you have been cleared by their office.

Copies of the final thesis should also be distributed to your thesis committee, sponsor and/or fellowship donor, in whatever format they prefer.

Completion

Upon satisfactory completion of this program the student will ordinarily receive the degree of Doctor of Philosophy unless a specific request for the degree of Doctor of Science is made. The requirements for both degrees are the same.

All calculations and records, as well as any equipment or instrumentation developed during the thesis research, are the property of the Institute, at the discretion of the supervisor. Upon completion of the thesis, each student should make arrangements with the thesis supervisor for the transfer of records and equipment.

Publication of Materials from MIT Nuclear Science and Engineering Theses

The Department expects that all articles in all publications whose substance is extracted in whole or in part from a thesis in the Department shall be submitted to the MIT thesis supervisor for comments and proofing before they are submitted to the appropriate journal. This step is taken to ensure that all works of the Department which are submitted for publication are of high quality and meet the Department standards.

All articles whose substance is extracted in whole or in part from a thesis should indicate the departments of MIT with which all authors were associated at the time the research was conducted; present affiliations (if other than MIT) should be shown by a footnote to the authors' names.

The student and the thesis supervisor should agree on the basic contents of the articles which are to result from the thesis, methods of publication, appropriate journal, number of authors, and acknowledgements, prior to the student's termination of residence at MIT. In the case of a PhD thesis, this should be done before the final oral examination of the thesis. In the case of an SM thesis, it should be done at the time of submission of the thesis.

It is normal practice for the staff supervisor to be the coauthor of articles resulting from theses. When authorship of a publication is shared by a member of the staff and a student, and there is no sponsoring project, help in meeting publication costs will be given by the Department.

Doctoral Thesis in Absentia:

Doctoral thesis research is ordinarily done in residence at the Institute. However, on some occasions and in some fields, work such as the gathering of data away from the Institute may be essential or desirable. Approval for thesis research to be done in absentia is given in writing by the departmental graduate officer after establishing that there are compelling educational reasons to approve thesis research in absentia. A copy of that approval must be filed in the Office of the Dean for Graduate Education (ODGE). The following requirements must also be met:

1. The opportunity for the continuing intellectual growth of the student must be clearly evident.
2. The thesis must continue to be supervised by an Institute faculty member, or by a senior staff member, approved by the Department.
3. The student must be registered as a full-time resident during the final term.
4. A doctoral student must normally have completed the General Examination requirement for the degree and devote full-time to thesis research in absentia.
5. Major and Minor subjects are to be chosen from MIT subjects and approved by thesis and registration officer. With the concurrence of the registration officer, minor subjects may be satisfied by subjects taken from outside the Institute.