

## MIT Department of Nuclear Science and Engineering

### Doctoral Degree Requirements

#### Summary of Requirements

##### Coursework

- Core subjects (24 units)
- Field of Specialization (36 units)
- Advanced Subjects (24 units)
- NSE Breadth Requirement (12 units)
- Unrestricted Elective (12 units)

##### Academic Research (register each term)

- 22.ThG Thesis Research (variable units/term; hours/week not including RA work hours)
- 22.911 Doctoral Seminar (3 units/term), starting Fall term of the third year

##### Registration

- Minimum registration is 24-36 units per term to maintain full time student status.
- Typical expected registration is 36 units: 24 units of coursework + 12 units of research.

##### Milestones (required to progress in the doctoral program)

Criteria to continue in the doctoral program:

Deadline	Milestone	Criteria
End of 4 <sup>th</sup> term	Complete Core Subjects + 2 of 3 Field of Specialization Subjects (Written Qualifying Exam)	B or higher average grade
End of 4 <sup>th</sup> term	Oral Qualifying Exam	Pass (maximum 2 tries)
End of 5 <sup>th</sup> term	Thesis Prospectus and Defense with Full Research Committee	Submit approved prospectus and pass defense (maximum 2 tries)

Criteria to complete the doctoral program:

- Pass/complete all criteria above
- Complete 3<sup>rd</sup> Field of Specialization subject
- Complete Advanced Subjects, NSE Breadth Requirement and Unrestricted Elective
- Thesis Defense
- Final thesis submission with approvals

## Coursework Requirements

### Core Subjects (24 units)

- 22.101 Applied Nuclear Physics, 12 units
- 22.102 Applications of Nuclear Science and Engineering, 3 units
- 22.103 Nuclear Technology and Society, 9 units

### 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 and one of: 22.72, 22.73, 22.74, 22.76, 3.21
- Fusion - Plasma Physics: 22.611, 22.62, and one of 22.63, 22.612, 22.615 or 22.67
- Fusion Engineering: 22.611, 22.62 and one of 22.211 (neutronics), 22.71 or 22.74 (materials) or 22.312 (engineering)
- Quantum Science and Engineering: 22.51, 8.511 and one of 22.52, 8.333, or 8.421
- Nuclear Security and Policy: 6.3702 (formerly 6.431), 22.90, + one subject by petition

### Advanced Subjects (24 units)

- Closely related to the student's doctoral thesis topic, but not necessarily in NSE
- Must complete with an average grade of B (GPA $\geq$ 4.0) or better
- Must not overlap with other degree requirements
- Must be approved as part of the doctoral thesis prospectus

### NSE Breadth Requirement (12 units)

- One or more subjects offered within the NSE Department.
- Must be outside of the Field of Specialization and area of thesis research.
- The following undergraduate subjects are permitted for this requirement:  
22.05 Neutron Science and Reactor Physics, 22.06 Engineering of Nuclear Systems,  
22.061 Fusion energy, 22.071 Analog Electronics and Analog Instrumentation

### Unrestricted Elective (12 units)

- One or more subjects, in any department.
- May be graduate or undergraduate level

## Academic Research

### 22.ThG Doctoral Thesis

Register each term, for units equivalent to hours/week of effort, not including employment (RA) hours. (A full RA is 20 hours/week.)

### 22.911 Doctoral Seminar

- Students must register for 22.911 each term, starting in Fall of the third year.
- Students should not register for 22.911 during the semester that they defend their thesis.

## **Milestones to continue in the doctoral program (First 5 terms)**

### **I. Qualifying Exams (Core, FoS, Oral Exam)**

#### ***Written Qualifying Exam***

##### *1) Complete Core Coursework – Part of Written Qualifying Exam*

- All Core subjects are included in the Written Qualifying Exam GPA calculation.
- All must be completed by the end of the 4<sup>th</sup> term (not including IAP or Summer).
- If a subject is retaken, the most recent grade will be used for the written qualifying exam.

##### *2) Field of Specialization – Part of Written Qualifying Exam*

- 2 of 3 Field of Specialization Subjects are included in the Written Qualifying Exam gpa calculation. If 3 subjects are completed, the two highest grades will be used.
- 2 FoS Subjects must be completed by the end of the 4<sup>th</sup> term (not including IAP/Summer)
- If a subject is retaken, the most recent grade will be used for the written qualifying exam.
- The third Field of Specialization must be completed before graduation.

#### ***Oral Qualifying Exam***

##### Eligibility Requirements

- 4.0 or higher cumulative GPA
- Completed 2 of 3 Field of Specialization subjects
- Complete all core subjects
- Student must have secured a research project with an approved advisor

The purpose of the oral exam 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 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.

### Oral Exam Logistics

- The Oral Exam will be offered twice annually.
- Oral Exam Committee will consist of at least three NSE faculty members or senior research scientists (SRS).
- The Oral Exam Chair must be a member of the NSE faculty other than the student's research advisor.
- The Committee will assign a grade of pass or fail.
- The Oral Exam Chair will provide feedback to the student shortly after the oral examination. If the student receives a grade of *fail*, at least one other member of the committee will also provide feedback.
- Two tries are permitted.
- Must be completed (passed) by the end of the 4<sup>th</sup> term (not including IAP/Summer).

## II. Thesis Prospectus and Defense

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.

- The final, approved prospectus document must be submitted by the end of the 5th term (not including IAP or Summer)
- The thesis prospectus must be approved by the research advisor and reader, or two co-advisors.

This prospectus should contain:

- a descriptive title of thesis
- a general description of the problem; its significance; and background information relating to the problem
- approach and methods as well as the significance of potential outcomes of the project
- a list of the subjects to be taken to satisfy the coursework requirements: field of specialization, advanced subjects and minor subjects
- approvals from the research advisor(s) and reader (required for the final copy submitted to the Academic Office)

Format requirements:

- 5-10 pages not including list of courses, title page and references
- Use one of the following typefaces identified below:  
Arial, Courier New, or Palatino Linotype at a font size of 10 points or larger; Times New Roman at a font size of 11 points or larger; or Computer Modern family of fonts at a font size of 11 points or larger.
- No more than six lines of text within a vertical space of one inch.
- Margins, in all directions, must be at least an inch.

### ***Thesis Prospectus Defense***

- Defense must be passed by the end of the 5th term (not including IAP/ Summer) in order to progress in the doctoral degree program.
- Two tries are permitted.
- Defense must include the full research committee (3 members required, see Doctoral Research Committee Regulations).
- The Defense must include a member of the NSE faculty who is not the research advisor.
- The research advisor is expected to review and provide feedback ahead of the defense.
- The draft Thesis Prospectus must be sent to the committee a minimum of 2 weeks ahead of the defense.

### **Doctoral Research Committee Regulations**

Must be composed of at least 3 members, including

1. Research advisor(s)
2. Reader
3. Additional committee members

Either the research advisor or reader must be an NSE faculty member. If a student has two research co-advisors, and at least one is an NSE faculty member, a reader is not required.

A minimum of two (2) members must be MIT affiliates, and other members must be approved by the research advisor.

Research Advisors and Readers are required to approve the final thesis submission.

### ***Eligibility for Research Advising***

The following categories are eligible to be research advisors:

- NSE faculty (including emeritus and professor of the practice)
- MIT faculty outside NSE
- Senior and Principal Research Scientists in affiliated labs (PSFC, NRL)
- Supervisors from affiliated labs approved by the NSE Department Head
- By petition, with approval from the Graduate Committee: Visiting Professors, Senior and Principal Research Scientists outside affiliated labs, and Research Scientists with PI status (who are not Senior or Principal).

While the rules for a research committee only require one NSE faculty member, students should be aware that for the final thesis defense committee, 3 MIT faculty are required (see Thesis Defense section below).

## **Post-Qualifying Requirements**

### **Milestones to complete the doctoral program**

- Complete/pass all pre-qualification milestones and coursework
- Complete post-qualification coursework:
  - final Field of Specialization subject
  - Advanced Subjects
  - NSE Breadth requirement
  - unrestricted elective
  - satisfactory performance in 22.911
- Satisfactory research progress until thesis defense and submission
- Thesis Defense
- Final thesis submission and approvals

### **Research Committee Meetings**

The research committee will meet regularly, following these guidelines:

- One primary meeting per year must be a full committee meeting with all members attending in person or online.
- The student or committee may request that a second meeting take place within 6 months of the primary meeting. This additional meeting can be a series of individual meetings with each member of the committee, or a series of discussions with subsets of the committee members, and should be organized by the student.
- Acknowledgement of the meeting(s) should be submitted to the NSE Academic Office, using the Research Committee Form or an email equivalent.

The meetings with the Research Committee are to be organized by the student. The purpose is to ensure that the research advisor, reader, and student are all in agreement with respect to the scope and quality of the thesis work.

### **Research Progress**

In addition to the required annual research committee meeting, 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 warning 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 to the Academic Office:

- the draft thesis document
- the executive summary document
- draft notice of the thesis defense, including the list the names of the committee members, date, time, and place of the scheduled defense
- approval from the research advisor for both of the above documents

The student may not advertise the thesis defense until informed by the Academic Office that all materials have been received and approved.

### **Thesis Defense**

- The candidate will be examined on the content of the thesis and related topics
- The candidate shall arrange the date and time for the defense such that all members of the thesis defense examining committee can attend
- The examining committee shall include at least three members of the MIT faculty (of whom the research advisor(s) and reader may be two)
- The chair of the committee must be an NSE faculty member who is not a member of the research committee
- Thesis defense examinations are open to the public
- A notice of thesis defense should be emailed to all NSE faculty, staff and students at least one week prior to presentation
- The chair of the thesis defense committee will inform the NSE academic office of the result of the defense.

### **Final Thesis Document**

Prior to submission of the final written thesis, a draft complete in all particulars is required for editorial comment and professional appraisals by the research advisor 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.

#### *Use of Publications in the Thesis Document*

Students who wish to incorporate prior publications into their thesis can include publications as appendices in the thesis (with permission from the publisher), and can cite them extensively. However, it is necessary to maintain a consistent voice and single authorship in the PhD thesis. Most papers are multi-authored, including the student's research advisor. It is hard to separate who wrote what. PhD thesis must be single-authored by the student. So, unless the publications are truly single-authored by the student alone, they cannot form the main chapters. It is also necessary for a thesis to have a "grand theme" and a consistent notation. Just putting together papers of disparate topics together without the linkages is not acceptable. It is important to ensure there are enough technical details in the thesis - because of page limitations, most papers are more concise than thesis. NSE expects a thesis that is detailed enough. Students are in no way obligated to include prior publications in the thesis.

## **Additional Rules and Requirements**

### **Petitions**

Students must submit a petition to the Graduate Chair in order to:

- request a departure from the subjects outlined in the field of specializations
- pursue a unique field of specialization
- make changes to the advanced subject plan submitted in the thesis prospectus
- request an extension or other exception to the doctoral degree requirements due to extenuating circumstances

When submitting a petition for a change to the Field of Specialization (FoS), please be sure to include:

1. whether you are requesting a substitution of a single course in an existing FoS or proposing a unique FoS. A unique FoS might entail different oral examination questions, while a substitution will not;
2. all subjects that will be in your Field of Specialization (number, name) with a brief description of the courses if they are not already included in any existing FoS;
3. the justification for the change, including any potential external circumstances that prevent taking a regular FoS and how each proposed subject supports your research area and/or FoS topic; if requesting a unique FoS, define the proposed FoS and the rationale for why a unique FoS is needed (as opposed to a departure from an existing FoS).

### **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 research advisor 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 research advisor 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 research advisor 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.

## **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.

Students must provide all data files, code, etc. relating to the thesis research to the advisor. All equipment and instrumentation purchased by MIT funds must be returned.

Please review the NSE Graduation Checklist to ensure that you submit all required materials, including your final thesis document and all required forms and surveys. Questions can be directed to the Academic Office.

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