

INSTITUTE OF MATERIALS SCIENCE AND ENGINEERING

INTERDISCIPLINARY PH.D. PROGRAM IN MATERIALS SCIENCE AND ENGINEERING

Graduate Student Handbook

9/27/2018

List of acronyms used in this document (other than department names):

A&S: School (or Faculty) of Arts & Sciences

DGS: Director of Graduate Studies

IMSE: Institute of Materials Science and Engineering

MTE: Mentored Teaching Experience

SEAS: School of Engineering and Applied Science

EXPECTATIONS OF THE PH.D. PROGRAM IN MATERIALS SCIENCE AND ENGINEERING

(Approved by IMSE Graduate Faculty on October 6, 2017)

The IMSE Ph.D. program in Materials Science and Engineering consists of 72 total credits hours of academic and research work. To remain in good standing and complete the program, students must meet the following expectations:

- Successfully complete graded coursework requirements (minimum 36 academic credits), including:
 - 4 required core courses (12 credits)
 - Chem 465, *Solid State and Materials Chemistry* OR Phys 472, *Solid State Physics*
 - EECE 502, *Advanced Thermodynamics*
 - Phys 537, *Kinetics of Materials*
 - MEMS 5608, *Introduction to Polymer Science and Engineering*
 - 3 courses from a pre-approved list of Materials Science and Engineering electives (9 credits)
 - IMSE 500, *IMSE Research Rotation* (3 credits)
 - Reports must be submitted by the first day of final exams for the semester
 - A minimum of 12 credits of graduate-level technical elective courses in Mathematics or any science or engineering department, to reach a total of at least 36 academic credits.
 - A maximum of 3 credits of IMSE 502, *Independent Study*, will be permitted toward this requirement.
 - A maximum of 3 credits of IMSE 505, *Materials Science Journal Club*, will be permitted toward this requirement.
 - 400 level courses not included on the pre-approved list of Materials Science and Engineering electives must be approved by the Graduate Studies Committee.
 - A maximum of 12 credits of 400 level courses may be applied to the required 36 academic credits. Undergraduate-only courses (below the 400 level) are generally not permitted by the Graduate School, and may not be used to fulfill this requirement.
- Enroll in and satisfactorily complete IMSE 501, *IMSE Graduate Seminar* every semester
- Successfully complete 18-36 credits of IMSE 600, *Doctoral Research*.
- Complete research ethics training by the end of the 3rd semester.
- Maintain a GPA of at least 3.0 for all graded coursework
 - Have no more than one grade of B- or below in a core course or Materials Science and Engineering elective.
- Successfully complete teaching requirement
 - Attend 2+ Teaching Center Workshops
 - Have 15 units of teaching experience

- Pass the IMSE Qualifying Examination (oral + written)
- Identify an IMSE Graduate Faculty member willing and able to support their thesis research on a materials-related topic
- Maintain satisfactory research progress on a topic in materials science, as determined by the Thesis Advisor and Mentoring Committee
- Successfully complete the Thesis Proposal and Presentation, with approval from the Thesis Committee
- Successfully complete and defend a Ph.D. Dissertation, with final approval from Thesis Committee.

Additional requirements and expectations may be set by the IMSE Director of Graduate Studies (DGS). These will be given to the student in writing.

COURSE PLAN FOR IMSE PHD CANDIDATES ENTERING THE PROGRAM BEGINNING FALL 2017

The expected time to obtain a Ph.D. degree is 5 years from entrance into the program.

Year 1

Fall Semester (13 credits)

- *Solid-State and Materials Chemistry* (Chem 465) or Elective
- *Advanced Thermodynamics in EECE* (EECE 502)
- *Introduction to Polymer Science and Engineering* (MEMS 5608)
- Elective (optional)
- *IMSE Graduate Seminar* (IMSE 501)

Spring Semester (13 credits)

- *Solid State Physics* (Physics 472) or Elective
- *Kinetics of Materials* (Physics 537)
- Elective (optional)
- *IMSE Research Rotation* (IMSE 500)
- *IMSE Graduate Seminar* (IMSE 501)

Summer

- Begin thesis research
- Prepare for Qualifying Exam (August)
 - Written document and oral presentation on research rotation
 - Oral exam on fundamentals from core courses

Years 2 and Beyond

- Complete sufficient Materials Science and Engineering and technical electives to total at least 36 credits of graded coursework at the graduate level (discuss selections with thesis adviser)
- *IMSE Graduate Seminar* (IMSE 501)
- 18-36 credits *IMSE PhD Research* (IMSE 600), until 72 total credits is reached, or *Full-Time Graduate Study* (LGS GSAS 9000/9001) to maintain full-time status beyond 72 credits.
- Research ethics training (3rd semester)
- Teaching Requirement
 - Attend 2+ Teaching Center Workshops
 - 15 units of Mentored Teaching Experience (MTE)
- Annual (or more frequent) meetings with Mentoring Committee
- Thesis proposal and presentation (5th semester)
- Dissertation and oral defense

GRADUATE ADVISOR, COURSE REGISTRATION, AND DROPPING COURSES

In the first year, students are assigned a graduate advisor by the IMSE DGS. Starting in their second year, students will be advised by their thesis research advisor.

Each semester, before registering for courses, the students should meet with their advisor to discuss the courses that they plan to take. The student may register for these courses only after the advisor has given their approval. Students must obtain permission from their advisors before dropping any course.

RESEARCH ROTATIONS

During their first year, students are required to register for and complete one research rotation (IMSE 500) with an IMSE Graduate Faculty mentor. They have the *option* of pursuing additional research opportunities as Independent Study (IMSE 502). A presentation and report on the research rotation will be an integral component of the qualifying exam. The rotations are chosen in consultation with the DGS and must be mutually agreeable to both the student and the mentor. At the completion of the rotation, the student must submit to the DGS a written report approved by the mentor.

TEACHING REQUIREMENTS

The Graduate School requires all Ph.D. students at Washington University to gain teaching experience. Students in the Ph.D. program will receive formal pedagogical training by attending a minimum of two Teaching Workshops offered by the Washington University Teaching Center, and will be expected to fulfill a total of at least 15 units of teaching experience. A unit of teaching is broadly defined as an hour spent communicating with a group of students or scholars. The teaching requirements must be completed before the student submits their doctoral dissertation to the graduate school. There are two paths that an IMSE student could follow to meet the 15 units of teaching requirement:

"Traditional" Mentored Teaching Experience (MTE)

For students pursuing a "traditional" MTE path, the required 15 units could be completed by assisting with 1-2 courses. IMSE students who choose to follow this MTE path will be assigned to assist with courses where they will engage with the students in recitation/discussion sections, small groups, or laboratory settings. They may also be asked to prepare and present guest lectures. The course instructor will be expected to provide the appropriate mentoring during the MTE, and will provide a summary of the teaching activities and expectations required successful completion of the MTE, prior to the IMSE student being assigned to the course. The mentor will also indicate the total number of teaching units (hours) completed and provide feedback to the student and IMSE DGS at the end of the course.

"Outreach" Mentored Teaching Experience

IMSE students who choose to follow an "outreach" focused MTE path will gain experience working on K-12 or public outreach activities focusing on science, technology, engineering, or math (STEM) and organized by their research advisor, the IMSE, or other campus organizations. Credit will be given for time spent preparing and presenting these activities. Again, the student's advisor or a representative from the lead organization will be expected to provide the appropriate mentoring during the MTE, and will provide a summary of the teaching activities and expectations required successful completion of the MTE. The mentor will also indicate the total number of teaching units (hours) completed and provide feedback to the student and IMSE Graduate Studies Director at the end of the experience.

Additional Teaching Opportunities

In addition to the above opportunities, IMSE students may use the following activities to complete up to 5 units of the teaching requirement:

- Leading a journal club session
- Presenting their research in the IMSE or other departmental seminar attended by students and faculty (max 2 units)

- Presenting their research as a speaker at a professional society or similar national or international meeting (max 2 units)

Other activities similar to those listed here will be considered for inclusion by the IMSE DGS on a case-by-case basis.

EXAMINATIONS AND MENTORING COMMITTEES

Qualifying Exam

A qualifying exam will be given late in the summer following the first year of graduate study. The examining committee will consist of three members of the IMSE Graduate Faculty, excluding the student's intended Ph.D. mentor (thesis advisor). Of the members, at least one must have their primary appointment in A&S, and one must have their primary appointment in SEAS. The IMSE DGS will select the committee by the beginning of the summer following the first year of graduate school, in consultation with the student and their advisor. Once the student has been notified of their committee, it will be the student's responsibility to contact their committee members to arrange a time and a place for the exam.

The qualifying exam consists of three parts:

1. 10-15 page written report describing the background, methods, and results obtained from one research rotation experience. This document may be based on the student's previously submitted rotation report;
2. 20 minute oral presentation on this research rotation;
3. 100 minute oral examination covering the presented work as well as the student's knowledge of the fundamental areas of Materials Science and Engineering, particularly those covered in the IMSE Ph.D. core courses. The examiners may ask fundamental scientific questions outside of these courses as they relate to the research the student presents in their report or oral presentation.

The written and oral portions of the exam will be evaluated separately. Students must pass all parts of the exam (oral and written, research and fundamentals) to complete this requirement.

Both the research report and presentation should be prepared by the student, and should discuss the student's specific research. That is, while they may seek advice from their research advisor and group members, the work should be presented in their own words, and should focus on their personal contributions. The student may include an appropriate review of prior work as it relates to their research. Sources for work that is not the student's should be properly cited in both the report and presentation.

If the student fails the qualifying exam the first time, the student will be allowed to take the

qualifying exam again in the *third* semester, before November 1. Any extensions to this timeline must be approved by the DGS. Prior to the second exam, the DGS will provide the student with written warning that failing the exam a second time will result in dismissal from the Ph.D. program. If the student passes the qualifying exam on the second try and has obtained the required grades in the graded courses, they are admitted to Ph.D. candidacy without prejudice.

If the student fails the qualifying exam twice but has maintained an average grade of B (GPA 3.0) for all courses taken, with no more than one grade below a B-, they may opt to fulfill the requirements necessary to obtain an A.M. by the end of their second year. They will, however, not receive stipend support while they complete the requirements for the A.M.

Thesis Advisor

By the start of the second year of study, the student must identify a faculty member willing and able to support their thesis research as the Ph.D. thesis advisor. Both the thesis advisor and the advisor's department chair must agree to this responsibility. The thesis advisor must be a member of the IMSE Graduate Faculty with the title of Professor, Associate Professor, or Assistant Professor. The student must inform the DGS (via the Administrative Assistant) of the name of the thesis advisor.

Mentoring Committee

After admission to candidacy, the student chooses a faculty Mentoring Committee, consisting of at least three IMSE Graduate Faculty members, including the thesis advisor, who are well-qualified to evaluate and help the student in their thesis research. The members of this committee will also be part of the Thesis Committee. It is recommended that the Mentoring Committee be drawn from more than one department (see description of the Thesis Committee.)

The student should meet with their Mentoring Committee at least once per semester until the completion of the Ph.D. to review their progress in thesis research. More frequent meetings may be appropriate in some cases. Both the student and the thesis advisor are empowered to call meetings of the Mentoring Committee, and both are obligated to attend these meetings when called. Every December, or more often in the case of unsatisfactory progress, the committee will send a report on the student's progress to the IMSE DGS (via the Administrative Assistant).

The Mentoring Committee meeting should begin **without** the advisor present, giving the student the opportunity to meet with the other members alone. The advisor would then be invited to joint for the remainder of the meeting and discussion of the research. At the conclusion of that discussion, the student will be excused so the committee members, including the advisor, can discuss their report.

If a student's progress is deemed unsatisfactory by the Mentoring Committee, it may meet more frequently and require continuing progress reports, to be shared with the DGS. The committee

will work with the student to develop and implement an improvement plan, which for example may include recommended coursework and/or additional training in research techniques or strategies, as well as a timeline for improvements and consequences. If the student does not meet the expectations of the committee within the specified time frame, the committee may recommend that the student be put on probation or dismissed from the Ph.D. program in accordance with Graduate School guidelines. Under these circumstances, the DGS will provide the student with written notice of probation or dismissal. If the student has satisfactorily completed all of the requirements of the A.M., they will be awarded that degree upon termination from the Ph.D. degree program.

Thesis Proposal and Examination Committee

The Thesis Committee will consist of at least five members, including the members of the Mentoring Committee. At least three members must be IMSE Graduate Faculty. Of the IMSE Graduate Faculty members, no more than three members may have their primary faculty appointment in the same department. At least one committee member must be chosen from outside the IMSE Graduate Faculty, and must be a tenured or tenure-track faculty member at Washington University. The committee will be chaired by the thesis advisor.

In the fifth semester of study, the student will prepare and present a Thesis Proposal on their proposed Ph.D. project, with the necessary background to support it, to the Thesis Committee. Any extensions to this timeline must be approved by the DGS. The Thesis Proposal should outline the research background, proposed procedures, preliminary results, and plans for completion, including a proposed timeline. The document will be typically between fifteen and thirty pages in length and must contain a comprehensive bibliography. The Thesis Proposal should be provided to the Thesis Committee at least two weeks prior to the oral presentation and examination. Should a member of the Thesis Committee be unable to participate in the examination, the DGS, in consultation with the Ph.D. mentor, will choose a replacement. The thesis advisor will report the results of the Thesis Proposal and examination to the DGS, including any committee recommendations. The DGS will notify the student of the results and recommendations.

If the student fails the Thesis Proposal and examination, they will be placed on probation according to Graduate School guidelines, and will be allowed to attempt the proposal and examination again in the *sixth* semester. If the student fails the second time, they will be dismissed from the Ph.D. program. If the student has satisfactorily completed all of the requirements of the A.M., they will be awarded that degree upon termination from the Ph.D. degree program.

Dissertation and Defense

The student will prepare a written dissertation for examination by the Thesis Committee and will defend the dissertation before this committee. Should a member of this committee be unable to participate, the DGS, in consultation with the Ph.D. mentor, will choose a replacement. The thesis

and oral defense requirements are set by the Graduate School and can be found at <https://graduateschool.wustl.edu/degree-requirements-0> . If the committee members feel that the dissertation has deficiencies, they may recommend that the candidate address them and send the revised dissertation to the committee members for approval. The committee may also recommend that the candidate present another oral defense of the modified work. The Thesis Committee will inform the DGS of their recommendation, and the DGS will warn the student in writing that they must submit a revised dissertation and pass the oral defense (if recommended) in order to complete the Ph.D. program. If, after revision and reexamination, the Thesis Committee still finds deficiencies and cannot reach unanimous agreement to approve the dissertation, the Graduate School's Policy on Dissenting Votes (found in the Graduate School Bulletin, which can be obtained at http://bulletin.wustl.edu/grad/Bulletin_2018-19_graduate_school.pdf will apply

PROCESS AND TIMELINE FOR DISMISSAL FROM PH.D. PROGRAM

The progress of students through the IMSE Ph.D. program will be closely monitored by the DGS (prior to candidacy) or the student's thesis advisor (post candidacy). These primary points of contact will be advised by feedback from the Qualifying Examination Committee, Mentoring Committee, and Thesis Committee described above. Failure to meet the following milestones will result in written warnings from the DGS of possible dismissal from the Ph.D. program:

Course Grades: The student will receive written warning of possible termination if their cumulative GPA falls below a 3.0, or after they receive their first grade of B- or below in a required course. The performance of the student will be reviewed at the end of the following semester for possible termination at that time. If significant improvement was exhibited, but still has not achieved the satisfactory level, the student may be given a second semester of probation. The student will be terminated if their GPA continues to decrease the following semester, or if they receive a second grade of B- or below.

Qualifying Exam: The student will receive written warning of possible termination if they fail the qualifying exam for the first time during the summer after their first year in the program. The student will be given a second opportunity to pass the exam during their third semester. If the student passes the second exam and meets the other program requirements (e.g. grades), they may continue the program without prejudice. If the student fails the exam a second time, they will be terminated from the Ph.D. program but may complete the A.M. degree if they meet other requirements (e.g. course grades).

Failure to progress: The student will receive written warning of possible termination if their faculty Mentoring Committee reports that the student's research or academic progress is unsatisfactory at any time. The Mentoring Committee will formulate an improvement plan with the student that will

include a timeline for improvements as well as consequences if the student does not meet expectations within the specified time frame. The normal probationary period to demonstrate improvement will be three months (90 calendar days). If the Mentoring Committee reports that the student's progress does not improve according to this improvement plan, the student may be terminated from the program but may complete the A.M. degree if they meet other requirements (e.g. grades).

Thesis proposal: The student will receive written warning if they fail their Thesis Proposal in the fifth semester. The student will be given a second opportunity to pass the exam during their sixth semester. If the student passes the second exam and meets the other program requirements (e.g. grades), they may continue the program without prejudice. If the student fails the exam a second time, they will be terminated from the Ph.D. program but may complete the A.M. degree if they meet other requirements (e.g. grades).

Dissertation: If a majority of the student's Thesis Examination Committee members feel that the student's dissertation has deficiencies and requires revision and a second oral defense, the student will receive written warning that successful completion of the second defense is necessary to complete the Ph.D. program.

REQUIREMENTS FOR THE TERMINAL A.M. IN MATERIALS SCIENCE AND ENGINEERING

All graduate students in IMSE will be accepted for graduate work towards the Ph.D. However, in some cases students may not be able to complete the requirements for the Ph.D. degree. In those cases, some may wish to pursue a terminal Master of Arts (A.M.) degree in Materials Science and Engineering. However, they typically will not receive financial support from the IMSE or the Graduate School while they complete the A.M. requirements. To qualify for the A.M. without thesis, the student must:

- have been a full time student for one calendar year,
- have completed 36 academic credits as described in the Program Expectations while maintaining an overall grade average of B (GPA 3.0) or better,
- have completed two research rotations,
- submit a 15-20 page report on their research rotation that synthesizes the information learned from these experiences in light of their coursework and demonstrates their competence in Materials Science and Engineering.

COMPENSATION AND OTHER HUMAN RESOURCES ISSUES

Graduate Student Support

Each IMSE graduate student will receive a one-year (12 months), university-funded, fellowship during their first year of study. This will support them during their first year of courses as well as their first summer, so that they can establish themselves with a research group. After the first 12 months, in order to remain in good standing, the student is responsible for identifying a thesis advisor willing and able to provide continued support for the duration of their degree program.

Time Off

Graduate students receiving financial support are expected to commit themselves fully to their studies and research. Intersession periods listed in the University Academic Calendar denote times when classes are not in session, and graduate students are expected to devote themselves full times to their research during these periods.

Students on full support are permitted to take off a maximum of two weeks during the calendar year for holidays, interview trips, etc. Additional time off can be arranged in discussion with the research advisor, but it may result in a reduction of the student's stipend. During the first year in the program when students do not have a permanent advisor, they should consult the DGS to schedule any time off. Absence of a research assistant must be scheduled so as not to impede the progress of an ongoing research project and should be approved by the research advisor.

Outside Employment

Holders of fellowships, traineeships and assistantships are required to devote full-time effort to graduate studies. They are not permitted to engage in any outside employment without permission of their advisor and the DGS.

Tax Liability

The taxability of the various types of awards is determined by current policy of the U.S. Internal Revenue Service (IRS). It is prudent to assume that all stipends are fully taxable and that the tax will be withheld. Questions concerning any individual's tax liability must be referred to the IRS.

RESOURCES FOR STUDENTS WITH CONCERNS

If a graduate student has any problems, such as:

- being unsure if they are on track to meet the program requirements,
- feeling that they are not being treated properly or fairly by someone,
- feeling that things are not going well; anxiety; depression,
- any other issues that are worrying them,

please speak with someone. It could be one of the graduate student mentors or one of the staff or faculty responsible for grad students:

- the Administrative Assistant
- the Graduate Student Advisors for first-year students
- the Director of Graduate Studies
- the Director of IMSE
- any other faculty member with whom you feel comfortable
- the Graduate Student Ombuds <https://staffombuds.wustl.edu/>

Counseling is also available from Student Health Services (<https://shs.wustl.edu/Pages/default.aspx>).