

## **Graduate Degrees in Materials Science and Engineering offered in the Department of Mechanical Engineering and Materials Science of the School of Engineering at the University of Pittsburgh**

The Department of Mechanical Engineering and Materials Science (MEMS) offers advanced degrees in Materials Science and Engineering (MSE), including Master of Science (MS) and Philosophical Doctor (PhD).

### **Doctor of Philosophy Program**

The doctor of philosophy (PhD) program in the Department of Mechanical Engineering and Materials Science is a research degree leading largely to careers in teaching and research in academia, government and industry. The program is designed for excellent students. Students develop an understanding at the highest level in their areas of specialization and their research must lead to an original contribution to the field in the PhD dissertation.

PhD studies are a demanding (and rewarding) experience that requires a strong interest in research in the selected area of specialization. The PhD program has been designed to optimize the fundamental education of students in materials science and engineering, at the same time providing much required advanced specialization. The program is designed to develop the student's ability to think about materials science and engineering at a high level in order to provide the foundation necessary to cross into other materials-related interdisciplinary areas, as required by future career developments.

Please view the [current graduate course listings](#).

### **Application Requirements**

A bachelor's or master's degree holder applying to the program must have a QPA equal to or higher than 3.3 (B+) or equivalent. Students who do not meet this requirement may be able to enter the program based on experience demonstrating their excellence, as evaluated by the Graduate Committee.

In some cases, depending on previous background and QPA, students may be admitted initially on a provisional basis. This usually requires students to secure grades of 3.3 (B+) or better in courses that are required to obtain a better background in materials science and engineering and/or other graduate-level courses as deemed necessary by the Graduate Admissions Committee.

## PhD Program Requirements

A minimum of 72 credits beyond the BS level is required for the PhD. No more than 30 credits may be accepted for a master's degree awarded by another institution to meet the minimum credit requirement. In recognition of graduate study beyond the master's degree successfully completed elsewhere, no more than 12 additional credits may be accepted at the time of admission to meet the minimum credit requirement. No more than 30 credits may be accepted for a previously earned PhD degree in recognition of master's degree work.

Fulfilling the minimum requirements of the PhD program in the Department of Mechanical Engineering and Materials Science involves

- a) Completion of course work,
- b) Passing the Qualifying Examination (can be attempted twice),
- c) Preparing a PhD Dissertation Proposal and Passing a Comprehensive Exam,
- d) Execution of PhD level Original Research,
- e) Preparation and Defense of the Doctoral Thesis.

## Residency Requirement

Students seeking the PhD degree are required to engage in a minimum of one term of full-time doctoral study, which excludes any other employment except as approved by their departments.

## Required Coursework

Of the total of 72 credits required for the PhD degree a minimum of 36 credits must be coursework beyond the Bachelor of Science (BS) degree. PhD students must maintain a minimum QPA of 3.3 (B+) in this coursework. The coursework consists of (I) a materials core (six required courses students must take in the first year of enrollment), (II) a group of courses tailored for each student's research and as required technical broadening beyond the MSE focus, (III) courses to address mathematical/numerical skills, and (IV) PhD Research and Dissertation credits. Information on and listings of Materials Science and Engineering graduate courses can be found [here](#). The student's advisor must approve the course sequence selection.

The 18 credits core course component must be taken within the first year of the program. Typically, PhD students will carry a **course load of three courses per term** until their coursework is completed. Not all of the advanced MSE courses can be offered each year. If a student's background is insufficient for a given graduate course, the student must prepare by attending appropriate undergraduate courses or through independent study. This should be arranged in consultation with the student's faculty advisor and the lecturing faculty of the relevant course(s).

(I) MSE Core Courses (18 credits)

As part of the MSE core a student must take the following six MSE courses (18 credits) within the first fall and spring term after admission:

- 1) MSE 2067: Elements of Materials Science and Engineering 1 (Fall),
- 2) MSE 2003: Structure of Materials (Fall),
- 3) MSE 2011: Thermodynamics of Materials/Energetics (Fall),
- 4) MSE 2013: Kinetics in Materials Science (Spring),
- 5) MSE 2015: Electromagnetic Properties of Materials (Spring), 6) MSE 2030: Mechanical Behavior of Materials (Spring).

Students must score at least a B (3.0) in each of these six classes. If a student does not get at least a letter grade of B, the class must be taken a second time. These classes must be successfully completed before the student can apply for admission to PhD Candidacy.

(II) Advanced and Technical Elective Courses ( $\geq 12$  credits)

A student must take advanced courses and technical electives. These are comprised of at least two courses (6 credits) selected by the student and his or her advisor as the best advanced preparation for research in the area of the dissertation, and two courses, as a broadening experience, to complement the student's PhD specialization and contribute significantly to career preparation.

(III) Mathematical/Numerical Courses

The student is required to take two mathematics/numerical courses for six (6) credits beyond those required for the materials science and engineering Bachelor of Science degree. They can be satisfied by many courses. This requirement may be waived if it was met in a previous program.

(IV) PhD Research and Dissertation Credits

Each student must also have:

- At least six (6) credits of MSE 3997 (PhD Research);
- At least 12 credits of MSE 3999 (PhD Dissertation);

Please note that registration for MSE 3999 is allowed only after the student has passed the Comprehensive Examination and defended the PhD Proposal, which qualifies the student for the status of PhD Candidacy.

A total of up to twelve (12) credits may be taken in relevant science, math, engineering disciplines outside of the MSE designation of graduate level courses and in different departments than MEMS.

The selection of courses, in general, must be acceptable to the student's advisor. The course requirements described in these guidelines are a minimum requirement. The minimum requirement of 72 credits of graduate work must be satisfied by combinations of research, course work and transfer credits for the award of a PhD degree. Students are allowed to take additional courses with the agreement of their advisors. In some cases, these courses may be suggested by the PhD Committee for better preparation for a given research area. Note that completion of the PhD degree and admission PhD candidacy require a GPA of B+ or better ( $\geq 3.3$ )

## Qualifying Examination

The qualifying examination is a multi-component examination to assess the student's academic foundations, the ability to synthesize and analyze basic materials science and engineering concepts, and the student's aptitude for the successful execution of PhD level original research.

To advance towards preparation for the PhD dissertation proposal and the Comprehensive exam the student has to

- (i) Achieve academic excellence in the six (6) MSE core course sequence (grades of letter grade of B (3.0) or better in each of them, see above)

and

- (ii) Pass the PhD qualifying examination.

### Format of the PhD Qualifying Examination:

The PhD qualifying examination is based on a literature review combined with a related mini-proposal in a general topic area suited to each student's anticipated research project. The student will write a paper and then present the paper orally (30 minute presentation) to the examining committee and then be examined orally on the topic area and related core course material.

Topic: The topic for the paper should be in the same general field as the student's research but not exactly the same as their specific research topic. Appropriate

topic descriptions should be developed by the advisor and submitted to the Qualifying Exam committee for review in advance.

Written document: The written document must be submitted two (2) weeks prior to the oral presentation. The written document should be no more than 10 pages long (1-inch margins, single spaced, including any necessary figures and tables but excluding references). It should include a Motivational section describing why the topic is of general importance, a Background/Introduction section that summarizes what is known ("state-of-the-art"), a Remaining Questions section that describes the major issues that still need to be addressed, and a Research Plan that describes experiments and methods of interpretation that can be used to address these open questions. An appropriate list of References should be included at the end.

Oral exam: The examining committee consists of 3 faculty, 1 of whom is the coordinator for the entire qualifier process for that year – this person sits on all the committees. The other two members are independent faculty (not to include the advisor).

Timing: The qualifier will be given once per year at the end of the spring term – all new PhD degree students must take the exam in the first year. Special students (less prepared) may delay until the second year if the advisor petitions the graduation committee.

Second attempts: If the student does not pass the exam, a retake is allowed if the advisor petitions the graduate committee and commits to continuing to support the student for the 2<sup>nd</sup> year. The second attempt can occur the following spring semester or earlier in the fall, if the advisor and student can arrange for 3 committee members (which includes the previous year's examining committee chair) to be present and administer the exam. However, this will only be done in the fall for retakes. First time exams will not be given in the fall.

## **Comprehensive Examination**

The dissertation proposal conference is the comprehensive examination in the research area of the dissertation. This is an oral examination, and the PhD Dissertation Committee administers it. To be eligible for this, a student must have:

- i) Passed the preliminary (qualifying) examination.
- ii) Met with the Dissertation Committee at least six months earlier.
- iii) Completed or be close to completion of the coursework of the common core, the advanced courses, and the math courses with a minimum QPA of 3.3 (B+).

The student should present the proposal for the thesis research as a public seminar shortly after approval by the dissertation committee has been obtained.

## **DISSERTATION COMMITTEE**

As soon as possible after passing successfully the Qualifying Exam a request to appoint a Dissertation Committee must be submitted by the student's major advisor and within about six months a first meeting of the committee is to be held to guide the student in his or her final specialization. This meeting is not an examination. Only a broad definition of the PhD dissertation and the area of specialization are necessary in order to appoint the Dissertation Committee and hold the first meeting. The Dissertation Committee administers the PhD dissertation proposal conference and is required to meet with the student at least once a year after the dissertation proposal to monitor the student's progress.

A Dissertation Committee consists of four or more persons, including at least one from another department in the University of Pittsburgh or from an appropriate graduate program at another academic institution. At least three members or the majority of the committee, including the major advisor, must be full or adjunct members of the Graduate Faculty in the Department of MEMS. Qualified individuals with non-academic affiliations, e.g. in industry or government research laboratories, may be committee members in addition to the minimum required four academic members. This committee must review and approve the proposed research project before the student may be admitted to candidacy. A published [Graduate Faculty Membership Roster](#) is updated three times a year.

This doctoral committee has the responsibility to advise the student during the progress of the candidate's research and has the authority to require high-quality research and/or the rewriting of any portion of the dissertation. It conducts the final oral examination and determines whether the dissertation meets accepted standards.

Membership of the doctoral committee may be changed whenever it is appropriate or necessary, subject to the approval of the department chair and the dean.

## **Comprehensive Examination**

In the comprehensive examination, the student must demonstrate excellent knowledge and understanding of the literature and the fundamentals of the selected subject area of the dissertation. In a well-designed course of study the coursework provides much of this foundation. In the dissertation proposal, the student presents a plan of research that develops logically and leads to the anticipated original contributions, which must be clearly stated. A clear presentation of professional quality not exceeding reasonable limits of time ( $\approx 45$  minutes) is expected in the dissertation proposal. The student must submit a written dissertation outline to the members of the Dissertation Committee at least a week before the examination.

This comprehensive examination is designed to ascertain whether the student is prepared satisfactorily for the dissertation and to perform research in the selected

area of specialization. From a broader perspective, it promotes skills necessary for oral presentations and demonstrates the ability of the student to "think on his or her feet". The student will be asked questions on the proposed research designed to gauge originality and feasibility of the proposed plan of work, and the student's command of the relevant literature. Questions typically relate to the fundamentals of the proposed research and the advanced courses taken by the student. As a result of their first meeting with the student, the Dissertation Committee may have defined additional areas of responsibility in preparation for this Comprehensive Examination not listed here in these general guidelines.

### **Public Seminar**

Shortly (typically two to six weeks) after completing successfully the closed-door, private presentation of the PhD proposal to the Dissertation Committee, the student will present his or her dissertation proposal to the department and the community in a public seminar. The student will have included the retained suggestions made during the private, closed-door dissertation proposal. This seminar must emphasize the plans for the proposed study and their justification, methods selected, anticipated difficulties, sources of error, etc. Preliminary results should be used only to illustrate and support the pertinent points of the proposal. The audience is encouraged to ask questions and make suggestions. The Dissertation Committee will review the presentation and the answers to the questions as the final step of the Comprehensive Examination. The final decision is made by a unanimous decision of the committee. The PhD proposal examination can be attempted only twice. **Successful completion of the Comprehensive Examination and PhD Dissertation Proposal entitles the student to transition to the status of PhD Candidacy.** The Dissertation Committee must complete the Application for Admission to Candidacy for Doctoral Degree and the student's faculty advisor must complete the relevant sections of a new Graduate Engineering Action Form.

### **Time Limit**

Only considering Fall and Spring terms, it is expected that all previous requirements, which lead to the status of **Candidacy for the Doctoral Degree will be attained within four to five academic terms** after initial enrollment for students with an MSE background and within six or fewer terms for students with a non-MSE background. Students who do not meet this time limit must petition the Graduate Committee and Chair of the Department for a time extension. If the petition is rejected, the student will lose his or her financial support.

### **Role of the PhD Advisor**

Every graduate student working toward a PhD must have a PhD advisor. In some cases, the graduate student coordinator could serve as the student's advisor for an initial period of one semester. This arrangement would be for an interim time period only, and the student must find a regular advisor for his or her PhD program before

commencing the second semester of his or her program of study. The student's advisor plays a central role in planning with the student an appropriate course work selection that may be more specific than these guidelines. Registration for appropriate courses must be done in consultation with the advisor. If the student desires to follow a coursework program that does not fit within these guidelines, the approval of the MSE graduate faculty must be obtained. The advisor also plays an important role in guiding the PhD dissertation research and is responsible for organizing and conducting as chair the comprehensive examination and dissertation proposal conference and the dissertation defense.

## **Defending a PhD Dissertation**

### **PhD Dissertation Preparation**

The PhD dissertation reports and discusses original contributions to the field of specialization and should contain results that are suitable for publication in appropriate archival journals. The PhD dissertation generally involves extensive research (experimental or theoretical) that is usually carried out on campus. In all cases, the research work must be unclassified and available for publication. The PhD dissertation must be based on the research performed personally and independently by the student and must constitute an original contribution to the field. It is the responsibility of the student to keep his or her advisor informed of the progress of the dissertation research and thesis preparation on a regular basis. It is also recommended that the student updates the PhD-Dissertation Committee on progress but somewhat less frequently than for the more closely involved faculty advisor. Assessing the originality of the PhD candidate's research is a particular focus of the faculty advisor and committee members.

### **PhD Dissertation Private Presentation**

In order to produce research of the highest caliber, it is necessary that adequate time be given for the review to a dissertation before it is accepted. After a first review of the dissertation by at least the MSE members of the PhD-Dissertation Committee the oral dissertation defense is held in public.

Once it has been determined by the dissertation advisor that the student may begin to write up his or her dissertation in the form of a PhD thesis document, he or she writes a rough draft. The rough draft must contain all parts of the dissertation, including figures and graphs, bibliography, etc., in legible form. The School of Engineering through the Office of Administration strictly enforces the format requirements for the written PhD thesis document. Hence, it is strongly recommended and proven best practice to prepare even the rough draft to conform as much as possible to these requirements. This facilitates a more efficient preparation of the final copy of the dissertation document, which must be filed both in hardcopy and electronically. [Read guidelines on preparing a dissertation.](#) A *Style*

*and Form Manual* for a thesis is available in the [Engineering Office of Administration](#).

A copy of the rough draft of the dissertation must be available to the Dissertation Committee at least two weeks before the closed-door meeting of the Dissertation Committee to conduct the private part of the PhD defense. In the closed-door meeting the student answers any questions deemed pertinent by the members of the committee in order to assess the suitability of the dissertation for fulfillment of the relevant requirements of the PhD degree.

### **PhD Dissertation: Public Presentation**

After a closed-door review of the dissertation by the committee the dissertation is defended publicly in the presence of the full Dissertation Committee.

With the guidance of his or her advisor, the student modifies the dissertation draft to satisfy the committee. After the dissertation has been reviewed in this manner, it will be prepared in its final form. The student must supply at least three print copies of the PhD dissertation, one each for the advisor, the MEMS department, and the library. One copy is to be made available in the department office for consultation by any member of the industrial or academic community for two weeks prior to the public presentation and final defense.

An announcement of the oral presentation of the dissertation defense is posted and distributed in the same way as departmental seminar presentations are announced at least two weeks prior to the date of the seminar. Best effort should be made to place an announcement in the University Times newspaper. Ideally, this oral PhD presentation and defense seminar will be held during the day and time (usually Thursday at 3 p.m.) allocated for the Departmental MSE Graduate Seminar series. The graduate seminar coordinator must be contacted well ahead of time to ensure availability of such a seminar date.

After a seminar-type presentation of the PhD dissertation the student answers any questions from the audience and the Doctoral Committee.

### **Exam Decision**

The final decision on the examination is made by the Dissertation Committee considering the performance of the student in all parts of the examination. If the vote of the committee is not unanimous, it will be referred to the Department Chair.

Following the PhD public presentation, the advisor must complete any change-of-grade forms, as needed, and also complete the appropriate sections of a new Graduate Engineering Action Form. The final thesis document must be submitted and satisfy the [New guidelines](#) of the School of Engineering.