

Materials Science and Engineering Graduate Curriculum

Adopted by the MS&E Graduate Governance Committee 1/26/16.

Revised:

- 1. 9/12/16: Add permanent course numbers of graduate courses taught within MS&E.*
- 2. 12/16/16 and 5/23/17: Correct permanent MS&E course numbers in elective course list.*
- 3. 5/23/17: Add statement that list of existing qualifying exam topics will be circulated.*
- 4. 7/12/17: Add Assistant Dean for Graduate Affairs as the grievance policy contact. Add Parental Leave Policy for Graduate Student Assistants*
- 5. 5/1/18: Change qualifying exam regulations*
- 6. 11/8/18: Revised curriculum for terminal Master's degree and Ph.D. minor.*

This document describes the courses, exams, and other activities required for graduate students to earn a Master's degree or Ph.D. from the Materials Science and Engineering Department. It is organized into 4 sections:

1. Requirements for students starting from a bachelor's degree and enrolling directly in the Ph.D. program
2. Requirements for students starting from a master's degree and enrolling directly in the PhD program
3. Requirements for the terminal master's degree
4. Requirements for a Ph.D. minor in Materials Science and Engineering
5. Grievance procedure

1. Requirements for students starting from a bachelor's degree and enrolling directly in the Ph.D. program

These requirements apply to students entering graduate school with the intent to pursue a Ph.D. with a bachelor's degree and no further advanced degree. These students will earn a Master's in Materials Science and Engineering on their way to the Ph.D. Requirements for students entering with a Master's degree in materials or a related field are given in Section 2. Students who have earned a Master's degree in an unrelated field may elect to follow the requirements in this section and earn a second Master's in Materials Science and Engineering.

Courses

Students are required to take the introductory seminar MSE 900 for their first two semesters of enrollment.

Students are required to complete 24 credits (~8 courses) of lecture or laboratory (not research) coursework, not counting the introductory seminar.

Within those twenty four credits, students must take:

- Three materials core courses, chosen from:
 - MSE 530: Thermodynamics of Solids
 - MSE 551: Structure of Materials

- MSE 521: Advanced Polymer Materials
- Graduate level math course (choose from NEEP 547, CBE 660, Math 703, Math 704, Physics 721)
- MSE 752: Advanced Materials Science: Phase Transformations
- Two materials electives courses, chosen from the list below.
- The student's research advisor must sign a form available from the department graduate secretary approving the five courses taken to fulfill the materials core and materials electives requirements.
- A Ph.D. minor selected from one of the following options:
 - Option A: disciplinary minor from a department or program outside MSE. Requirements are set by that department or program.
 - Option B: Distributed minor. Select a topic or theme and three courses around that theme. At least one course must be graduate level. There are no other restrictions on the course department or topic.

The same course may not satisfy more than one requirement. For example, if MSE 530 is taken as a materials core course, it could not be used as a materials elective course or as part of an Option B minor. In addition, only one mathematics course may be counted as a materials core or materials elective course.

Before registering for the second semester of courses, students must submit to the department graduate secretary a plan for all 24 credits, including the core courses, elective courses, and the minor, signed by the student and the advisor. Students are not required to follow this course plan in detail, since future course offerings cannot be predicted with certainty. Students and advisors are encouraged to update the course plan once a semester, but updated versions do not need to be submitted.

Before the student undertakes the thesis proposal exam, the student's research advisor must sign the form available from the department graduate secretary approving the five courses taken to fulfill the materials core and materials electives requirements.

The Graduate School requires that a Ph.D. student earn at least 51 total credits, at least half of which must be at the graduate level. Thus, MS&E graduate students are required to take at least 25 additional credits of research study (51 credits - 24 course credits - 2 credits for MSE 900) beyond the required lecture or laboratory courses. These credits may be research credits, additional courses, or a combination of both. For research credits, students should register for the following courses:

1. Before earning the Master's degree, students should register for MSE 790.
2. After earning the Master's degree, they should register for MSE 890.
3. Once they have achieved dissertator status, they should register for MSE 990.

All course requirements are subject to modification or substitution to better serve the research needs of the student. To request a change, submit a letter to the department graduate secretary signed by the student and advisor proposing a change and explaining how the change will better

suit the student's needs, especially as it pertains to their research. Course substitutions and other curriculum variances are decided by the department Director of Graduate Studies, subject to appeal to the department Graduate Governance Committee and the grievance procedure in Section 5.

Material's Elective Courses

Materials elective courses must be selected from the following list. These courses are not taught every semester, and many of them are not taught every year. Check the course timetable for offerings in each semester, and consult the department graduate secretary for information on typical course offering schedules.

Students or faculty may request that a course be added to the list by submitting a letter to the department graduate secretary including the course syllabus and explaining why the course is a materials-centric course. The course catalog description is not a sufficient replacement for a syllabus.

MSE 401 Special Topics (any three credit special topics course)
MSE 421 Polymer Materials
MSE 423 Nuclear Materials
MSE 433 Corrosion
MSE 434 Thin Film Deposition
MSE 435 Joining of Materials
MSE 441 Deformation of Solids
MSE 445 Multicomponent Phase Equilibria
MSE 448 Crystallography and X-ray Diffraction
MSE 451 Ceramic Materials
MSE 456 Electronic Optical and Magnetic Properties of Materials
MSE 461 Advanced Metal Casting
MSE 462 Welding Metallurgy
MSE 463 Materials for Elevated Temperature Service
MSE 465 Fundamentals of Heat Treatment
MSE 521 Advanced Polymer Materials
MSE 530 Thermodynamics
MSE 541 Heterogeneous and Multiphase Materials
MSE 551 Structure of Materials
MSE 553 Nanomaterials and Nanotechnology
MSE 560 Fundamental of Atomistic Modeling
MSE 570 Properties of Solid Surfaces
MSE 748 Structural Analysis of Materials
MSE 750 Imperfections and Mechanical Properties
MSE 752 Advanced Materials Science: Phase Transformations
MSE 756 Structures and Properties of Advanced Electronic Properties

MSE 760 Molecular Dynamics and Monte Carlo Simulations in Materials Science
MSE 770 Methods of Surface and Interface Characterization
MSE 803 Advanced Scattering for Materials Analysis
MSE 803/801 Special Topics (any three credit special topics course)
BME 430 Biomaterials
BME 615 Tissue Mechanics
BIOCHEM 704 Chemical Biology
CBE 540 Polymer Materials
CBE 747 Advanced Colloid and Interface Science
Chem 652 Chemistry of Inorganic Materials
Chem 653 Chemistry of Nanoscale Materials
Chem 621 Instrumental Analysis
Chem 654 Materials Chemistry of Polymers
Chem 664 Introduction to Macromolecular Chemistry
ECE 745 Solid State Electronics
Geoscience 765: Crystal Chemistry
PHYS 415 Thermal Physics
PHYS 551 Solid State Physics
PHYS 715 Statistical Mechanics
PHYS 751 Advanced Solid State Physics

Qualifying Exam

Purpose: The qualifying exam is an assessment of whether students have sufficient background in the areas of materials science and engineering relevant to their research to undertake graduate research. As such, it is intended to test knowledge of undergraduate-level materials science and engineering. However, one way to solidify basic knowledge of a topic is to study it at a more advanced level, so graduate-level coursework will help prepare students to take the qualifying exam. The qualifying exam will also assess students' ability to explain concepts and to synthesize knowledge that is taught in separate classes at the undergraduate level.

Format: The qualifying exam consists of an oral examination covering two subjects, each with a committee of two faculty members. The student and the student's advisor choose the two subjects from the five core subjects. For each subject, the list contains a list of topics within that subject; resources for studying such as courses, textbooks, monographs, or online resources; at least three sample questions; and at least two faculty members qualified as examiners on that topic. For each academic year, once all the students select the subjects, the department graduate study secretary will assign groups of two faculty members as the examination committee for each core subject.

Examiners must also prepare for the exam. One week before the exam, examiner must submit at least one exam questions covering their subject to the other committee members and the department Associate Chair of Graduate Studies. This will allow the examiners to consider synergies between the subjects in a given exam. The question will also be placed in a library of questions for each subject to ensure uniformity across various exams, guide new examiners as

to the appropriate level of the questions, and to update the example question lists for each subject. The exam of each subject will take up to 45 minutes. The updated question list of each subject will be distributed to the examiners of the same subject before the exam. The examiners will start with their prepared questions, but may ask any other questions in addition (may from the library).

Assessment: After all the students complete the exam of each subject, the committee will determine whether or not each student has passed that subject. Should the student not pass a subject, the examiners for that subject will document in writing the reason the student did not pass the subject. If this is a first attempt, the examiners will recommend in writing resources for the student to prepare for a retest.

Students must attempt the qualifying exam within 12 months of the start of their first semester enrolled (Summer sessions do not count for this rule.) The qualifying exam will be offered within one month when the semester starts. A student who fails one or more subjects on a first attempt must retake the exam within four months of the first attempt. The student may retake the failed subjects, or may switch to a different subject or subjects. Example schedules for students who matriculate at different times of year are shown in the table below.

Matriculation semester	1st exam attempt	2nd exam attempt
September 2018	August/September 2019	January 2020
January 2019	January 2020	May 2020

Students who fail one or more qualifying exams in the second attempt may not continue to Ph.D.-level study in Materials Science and Engineering. They may elect to complete a terminal Master's degree in Materials Science and Engineering or they may leave the Materials Science and Engineering graduate program without a degree. Students who face these outcomes may elect to pursue a complaint through the Materials Science and Engineering graduate student grievance procedure in Section 5. The student's advisor can if they choose submit a document to the committee with his/her opinions that they may want to share with the committee at this stage.

Because the oral exam format may be unfamiliar to students, the required introductory seminar course, MSE 900, will incorporate preparation for this type of exam in the spring semester. That preparation will include training and practice in interactively solving problems in a real-time discussion environment, including relevant skills in verbal and visual presentation, framing problems and formulating responses in real time, working with partial information, listening effectively, answering effectively, and reaching an audience. These are essential skills for modern, team-based science and engineering practice.

The five core subjects are:

- Thermodynamics
- Structure of Materials

- Electronic, Optical and Magnetic Materials
- Soft Materials
- Metallic and Ceramic Materials

Thesis Proposal Exam

Students must complete a thesis proposal exam, typically by the end of their fourth semester. The exam consists of a written document, a presentation, and an oral defense with the student's thesis committee. This exam must be completed by the end of the fifth semester enrolled. Enrollment for the sixth semester will be blocked for students who have not passed the thesis proposal exam.

The written document is a forward-looking proposal for a plan of research that merits awarding of a Ph.D. It should:

1. Identify a problem, question, or hypothesis in science or engineering and identify its potential impact on society.
2. Summarize the state of the relevant literature.
3. Summarize the student's research to date. (If the thesis proposal represents a shift in topic, the summary of research to date can be presented as an appendix to the main text.)
4. Propose a program of research designed to solve the problem, answer the question, or test the hypothesis. Include analysis of potential critical path elements, decision points, and anticipated obstacles. Summarize the anticipated impact, both technical and societal, if the research is successful.

The document should be no more than 30 double-spaced pages including figures but not including references or title page. Margins, character size, and reference formats should follow typical guidelines for a research proposal to a federal agency such as NSF, DOE, or NIH. The report must be circulated to the committee no less than two weeks before the examination date.

The presentation should mimic the report, focusing on proposing new research and summarizing research to date. The planned presentation should be no more than 30 minutes to leave time for oral examination by the committee.

The committee consists of five faculty. It must include the student's advisor, at least three members from MS&E (including affiliate faculty) and members with tenure homes in at least two different departments. Up to one member may be from any of the following categories, as approved by the department Director of Graduate Studies: academic staff (including emeritus faculty), visiting faculty, faculty from other institutions, scientists, research associates, and other individuals deemed qualified by the Director of Graduate Studies. All members of the committee must be physically or virtually present for the exam, unless an exception is granted by the department Director of Graduate Studies.

The goal of the thesis proposal exam is to assess the student's research performance to date, research plan, and presentation, and to provide feedback from the committee, especially on the future research plan. If the committee feels the proposal or presentation are inadequate, they can request revisions to the document or require the student to retake the thesis proposal exam.

The retake must occur within three months of the first exam. In the rare case that a student fails the thesis proposal exam twice, the student may not continue Ph.D. study. The student may elect to fulfill the requirements and earn a terminal Master's degree in Materials Science and Engineering, or the student may leave the Materials Science and Engineering graduate program without a degree. Students who face these outcomes may elect to pursue a complaint through the Materials Science and Engineering graduate student grievance procedure in Section 5.

Upon passing the thesis proposal exam, students continuing onward to the Ph.D. have fulfilled the requirements for a Masters degree in Materials Science and Engineering. Also upon passing the thesis proposal exam, students earn dissertator status.

Thesis defense

The thesis defense consists of preparation and deposition of a thesis, a public seminar on the thesis research, and an oral defense before the thesis committee. The composition of the thesis committee follows the same rules as the thesis proposal exam committee and is usually the same individuals.

The student must prepare a thesis presenting their original research following the rules and guidelines set forth by the UW Graduate School, currently described at http://www.grad.wisc.edu/education/completedegree/Dissertation_options.html. The thesis must be circulated to the committee no less than two weeks before the defense date.

The defense consists of an open, public seminar, then a closed session with the committee for the oral examination. The seminar describes the student's research resulting in significant new contributions to human knowledge in both a technical (science and engineering) and a broader societal context. It should be modeled after the hour-long departmental research seminars. In the closed session, the committee will question the student about the student's research, both as presented in the seminar and in the thesis, including topics such as technical details about past work, implications for the field and society as a whole, and possible future directions.

The committee may pass the student, require revisions to the thesis, or fail the student on the exam. A student who fails the thesis defense may not continue Ph.D. study or earn a Ph.D. in the Materials Science and Engineering graduate program. The student may elect to fulfill the requirements and earn a terminal Master's degree in Materials Science and Engineering if they have not already done so, or the student may leave the Materials Science and Engineering graduate program without a degree. Students who face these outcomes may elect to pursue a complaint through the Materials Science and Engineering graduate student grievance procedure in Section 5.

2. Requirements for students starting from a master's degree and enrolling directly in the PhD program

These requirements cover students who (1) have already earned a Master's degree in MS&E or a related field and (2) do not wish to earn a MS&E Master's from UW.

Courses

Students must enroll in the introductory seminar, MSE 900, for their first two semesters of enrollment.

Students must satisfy all of the course requirements for the Ph.D. given in the preceding section. However, they may request that courses taken as part of a previous Master's degree at another institution serve to satisfy a portion of the requirements. Students will have one month after matriculation to identify that they wish to follow this track to their Ph.D. and to submit all their course substitution requests. Course substitutions will not be considered later in the student's Ph.D. studies.

To make such a request, the student should submit a request to the department graduate secretary describing (1) the course from a previous institution; (2) the UW course equivalent; (3) the MS&E course requirement that will be satisfied. The request must include sufficient information to determine if the courses are equivalent. Typically, a syllabus listing the course textbook and lecture topics is sufficient. A course catalog description is typically insufficient. Courses taken while enrolled as an undergraduate student at another institution will not be considered for substitution. This includes courses at the graduate level taken while the student is enrolled as an undergraduate.

If a request is not approved, the student must fulfill the corresponding requirement at the University of Wisconsin-Madison.

If one or more course substitutions are accepted, the student will not earn a Master's degree in Materials Science and Engineering from UW-Madison as part of their Ph.D. studies.

Qualifying Exam, Thesis Proposal Exam, and Thesis Defense

Students on this track must pass the qualifying exam, thesis proposal exam, and thesis defense as described above, on the same schedule with respect to their matriculation date. Students who fail one of these exams will have the opportunity to earn a terminal Master's degree in MS&E, even if they have been granted a course substitution.

3. Requirements for the Terminal Master's Degree

The MS&E department offers a terminal master's degree with thesis. A non-thesis, coursework-only Master's is not offered.

Courses:

Students are required to take the introductory seminar MSE 900 for their first two semesters of enrollment.

Students are required to complete 15 credits (~5 courses) of lecture or laboratory (not research) coursework, not counting introductory seminar.

Within those fifteen credits, students must take:

- Three materials core courses, chosen from:
 - MSE 530: Thermodynamics of Solids
 - MSE 551: Structure of Materials
 - MSE 521: Advanced Polymer Materials
 - Graduate level math course (choose from NEEP 547, CBE 660, Math 703, Math 704, Physics 721)
 - MSE 752: Advanced Materials Science: Phase Transformations
- Two materials electives courses, chosen from the list in Section 1.

The same course may not satisfy more than one requirement. For example, if MSE 530 is taken as a materials core course, it could not be used as a materials elective course. In addition, only one mathematics course may be counted as a materials core or materials elective course. The list of approved materials elective courses and the procedure to request that a course be added to the list is given in Section 1.

Before registering for the second semester of courses, students must submit to the department graduate secretary a plan for all 15 credits. Students are not required to follow this course plan in detail, since future course offerings cannot be predicted with certainty. Students and advisors are encouraged to update the course plan once a semester, but updated versions do not need to be submitted. Before the student can defend a thesis, the student's research advisor must sign a form available from the department graduate secretary approving the five courses taken to fulfill the materials core and materials electives requirements.

The Graduate School requires that a Master's student earn at least 30 total credits. Thus, MS&E graduate students are required to take at least 13 credits of research study (30 total credits - 15 course credits - 2 credits of MSE 900). Master's degree students should register for research credits in MSE 790.

Thesis Defense

The student must prepare and defend a master's thesis covering appropriate independent science or engineering research undertaken by the student. The format and procedures must conform to the Graduate School rules for a Master's thesis, currently found at <http://grad.wisc.edu/currentstudents/mastersthesis>. The Master's thesis should represent significant science or engineering research work and progress, but does not need to report a substantial new contribution to human knowledge. The thesis must be circulated to the committee at least two weeks before the defense.

The student must present the thesis project to a committee of faculty, then defend the thesis in an oral examination. The committee consists of three faculty. It must include the student's advisor, at least three members from MS&E (including affiliate faculty) and members with tenure home in at least two different departments. All members of the committee must be physically or virtually present for the exam. The committee may pass the student, require revisions to the

thesis, or fail the student on the exam. Students who fail the thesis defense will not earn a Master's degree in Materials Science and Engineering and will leave the program without a degree. Students who face these outcomes may elect to pursue a complaint through the Materials Science and Engineering graduate student grievance procedure in Section 5.

4. Ph.D. Minor in Materials Science and Engineering

The MS&E department offers a minor in Materials Science and Engineering for students studying towards a Ph.D. in other disciplines. The doctoral minor consists of at least 9 credits (typically 3 courses) of MS&E courses. Within those nine credits, 6 must be at the 400 level or above, and 3 must be at the 700 level or above. Students must earn a B or higher in every course. Transfer credits cannot be used to fulfill the minor requirements.

5. Grievance Procedure

Students who feel they have been unfairly treated or otherwise have a grievance related to the policies and procedures for graduate study in the Materials Science and Engineering Department may choose to submit a formal grievance to the department. Before taking this step, however, students are encouraged to discuss their grievance directly with the person or persons involved. Respectful, professional, direct communication can often reach a more satisfactory resolution to an issue more quickly than a formal grievance procedure.

To pursue a formal grievance, the student should submit a letter describing the issue in detail to the department Director of Graduate Studies within 60 days of the precipitating incident. (Should the grievance involve the Director of Graduate Studies, the letter should be submitted to the department Chair.) The Director (or Chair) will convene a committee of not fewer than three department faculty. The committee will obtain a written response from the person or persons who are the subject of the complaint. The committee will then decide a course of action in response to the grievance. The response from the subject of the complaint and the committee course of action will be communicated in writing to the student within 15 working days of submission of the grievance. The course of action will be implemented no later than 10 working days of the communication.

If the departmental procedure does not resolve the grievance, the student may appeal to the College of Engineering or the Graduate School. The College grievance procedures are currently available at <http://www.engr.wisc.edu/current/current-students-how-to-file-a-grievance.html>, and the Graduate School procedures are available at <http://grad.wisc.edu/acadpolicy/>.

The Assistant Dean for Graduate Affairs (engr-dean-graduateaffairs@engr.wisc.edu) provides overall leadership for graduate education in the College of Engineering (CoE), and is a point of contact for graduate students who have concerns about education, mentoring, research, or other difficulties.

6. Parental Leave Policy for Graduate Student Assistants

The College of Engineering (CoE) is fully committed to providing a climate of support for women and their partners who choose to have children during their graduate studies. The goal of this CoE parental leave policy is to reduce academic and financial hardships for a) female graduate students during the late stages of their pregnancy, childbirth, and postpartum periods, and b) any graduate student who is a new parent providing care for his/her infant.

All CoE graduate students with current research, teaching, or project assistantships are eligible to request a parental leave under this policy. Upon request, expectant mothers will be provided with 12 weeks of paid accommodation time for childbirth. Other new parents (father, adoptive mother, adoptive father) will, upon request, be provided with 6 weeks of paid accommodation time. There will be no research or teaching expectations of the student during the leave.

Students should ideally notify their department (through the Department Administrator or Department Chair) six months prior to the expected birth to request the leave. Students should alert their research advisor or TA coordinator at that time as well to ensure that the ongoing research and teaching environment is safe for the expectant mother. It is recognized that each case will be unique in terms of the timing of the pregnancy or adoption relative to the academic calendar, and that creative and supportive solutions will be required on the part of advisors, chairs, TA coordinators, etc.

The leave will ordinarily begin at the time of birth, but other proposals will be considered. Departments – both advisors and chairs – are expected to provide flexibility in working out the details of the leave and to adjust the timeline of the leave as needed to accommodate any unexpected medical issues that arise during pregnancy (e.g. doctor-ordered bed rest).

All academic requirement deadlines (e.g., qualifying exams) will be extended for the student requesting the leave, consistent with department academic timelines.