Department of Materials Science and Engineering

Julie M. Schoenung, Department Chair
916 Engineering Tower
949-824-5802
http://www.eng.uci.edu/dept/mse

Overview
The Department of Materials Science and Engineering offers the B.S. in Materials Science and Engineering, a minor in Materials Science and Engineering, and the M.S. and Ph.D. in Materials Science and Engineering.

Undergraduate Major in Materials Science and Engineering

Program Educational Objectives: Graduates of the Materials Science and Engineering program will (1) establish a productive Materials Science and Engineering career in industry, government or academia; (2) apply critical reasoning and the requisite analytical/quantitative skills in seeking solutions to materials science and engineering problems; (3) promote innovation in materials discovery, development and design through effective leadership, skilled communications, and multidisciplinary teamwork; (4) exhibit a commitment to engineering ethics, environmental stewardship, continued learning, and professional development.

(Program educational objectives are those aspects of engineering that help shape the curriculum; achievement of these objectives is a shared responsibility between the student and UCI.)

Since the beginning of history, materials have played a crucial role in the growth, prosperity, security, and quality of human life. In fact, materials have been so intimately related to the emergence of human culture and civilization that anthropologists and historians have identified early cultures by the name of the significant materials dominating those cultures. These include the stone, bronze, and iron ages of the past. At the present time, the scope of materials science and engineering has become very diverse; it is no longer confined to topics related to metals and alloys but includes those relevant to ceramics, composites, polymers, biomaterials, nanostructures, intelligent materials, and electronic devices. In addition, present activities in materials science and engineering cover not only areas whose utility can be identified today, but also areas whose utility may be unforeseen. The services of materials scientists and engineers are required in a variety of engineering operations dealing, for example, with emerging energy systems, design of semiconductor and optoelectronic and nano devices, development of new technologies based on composites and high-temperature superconductivity, biomedical products, performance (e.g., quality, reliability, safety, energy efficiency) in automobile and aircraft components, improvement in nondestructive testing techniques, corrosion behavior in refineries, radiation damage in nuclear power plants, and fabrication of advanced materials.

The undergraduate major in Material Science and Engineering (MSE) provides students with a thorough knowledge of basic engineering and scientific principles. The undergraduate curriculum in MSE includes (a) a core of Chemistry, Physics, and Mathematics; (b) basic Engineering courses; (c) Materials and Engineering core; and (d) technical courses in Materials Science, Engineering, and Sciences.

Because of the interdisciplinary nature of MSE and its intimate relations with other Engineering disciplines (Aerospace, Biomedical, Chemical, Civil, Computer, Electrical, Environmental, and Mechanical Engineering), qualified students will be able to satisfy in a straightforward manner the degree requirements of their Engineering major and the MSE major.

Admissions

High School Students: See School Admissions information.

Transfer Students: Preference will be given to junior-level applicants with the highest grades overall, and who have satisfactorily completed the following required courses: two years of approved calculus, one year of calculus-based physics with laboratories (mechanics, electricity and magnetism), completion of lower-division writing, one year of general chemistry (with laboratory), statics, an introductory Materials Science and Engineering course, and one course in introductory programming. For course equivalency specific to each college, visit assist.org.

Students are encouraged to complete as many of the lower-division degree requirements as possible prior to transfer. Students who enroll at UCI in need of completing lower-division coursework may find that it will take longer than two years to complete their degrees. For further information, contact The Henry Samueli School of Engineering at 949-824-4334.

Requirements for the B.S. in Materials Science and Engineering

All students must meet the University Requirements.
All students must meet the School Requirements.

Major Requirements

Mathematics and Basic Science Courses:

Core Courses:

ENGR 1A General Chemistry for Engineers
<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 1B-1C</td>
<td>General Chemistry</td>
</tr>
<tr>
<td>CHEM 1LC</td>
<td>General Chemistry Laboratory</td>
</tr>
<tr>
<td>MATH 2A-2B</td>
<td>Single-Variable Calculus and Single-Variable Calculus</td>
</tr>
<tr>
<td>MATH 2D</td>
<td>Multivariable Calculus</td>
</tr>
<tr>
<td>MATH 3A</td>
<td>Introduction to Linear Algebra</td>
</tr>
<tr>
<td>MATH 3D</td>
<td>Elementary Differential Equations</td>
</tr>
<tr>
<td>MATH 2E</td>
<td>Multivariable Calculus</td>
</tr>
<tr>
<td>PHYSICS 7C-7LC</td>
<td>Classical Physics and Classical Physics Laboratory</td>
</tr>
<tr>
<td>PHYSICS 7D-7E</td>
<td>Classical Physics and Classical Physics Laboratory</td>
</tr>
<tr>
<td>PHYSICS 7LD</td>
<td>Classical Physics Laboratory</td>
</tr>
<tr>
<td>Basic Engineering or Science Elective Courses:</td>
<td></td>
</tr>
<tr>
<td>Select four (4) units from the following:</td>
<td></td>
</tr>
<tr>
<td>BIO SCI 93</td>
<td>From DNA to Organisms</td>
</tr>
<tr>
<td>BME 50A</td>
<td>Cell and Molecular Engineering</td>
</tr>
<tr>
<td>CHEM 51A</td>
<td>Organic Chemistry</td>
</tr>
<tr>
<td>EECS 70B</td>
<td>Network Analysis II</td>
</tr>
<tr>
<td>ENGR 7A-7B</td>
<td>Introduction to Engineering I and Introduction to Engineering II 1</td>
</tr>
<tr>
<td>ENGRCEE 20</td>
<td>Introduction to Computational Problem Solving</td>
</tr>
<tr>
<td>ENGRMAE 52</td>
<td>Computer-Aided Design</td>
</tr>
<tr>
<td>ENGRMAE 80</td>
<td>Dynamics</td>
</tr>
<tr>
<td>or ENGRCEE 80</td>
<td>Dynamics</td>
</tr>
<tr>
<td>PHYSICS 51A</td>
<td>Modern Physics</td>
</tr>
<tr>
<td>STATS 7</td>
<td>Basic Statistics</td>
</tr>
<tr>
<td>Engineering Topics Courses:</td>
<td></td>
</tr>
<tr>
<td>Students must complete a minimum of 22 units of engineering design.</td>
<td></td>
</tr>
<tr>
<td>Core Courses:</td>
<td></td>
</tr>
<tr>
<td>ENGRMSE 65A</td>
<td>Thermodynamics of Materials</td>
</tr>
<tr>
<td>or ENGRMAE 91</td>
<td>Introduction to Thermodynamics</td>
</tr>
<tr>
<td>ENGRMSE 65B</td>
<td>Diffusion in Materials</td>
</tr>
<tr>
<td>or CBE 120B-CBE 120C</td>
<td></td>
</tr>
<tr>
<td>or ENGRMAE 120</td>
<td></td>
</tr>
<tr>
<td>ENGRMSE 154</td>
<td>Polymer Science and Engineering</td>
</tr>
<tr>
<td>ENGRMSE 155</td>
<td>Mechanical Behavior and Design Principles</td>
</tr>
<tr>
<td>ENGRMSE 155L</td>
<td>Mechanical Behavior Laboratory</td>
</tr>
<tr>
<td>ENGRMSE 160</td>
<td>Advanced Lab in Synthesis of Materials</td>
</tr>
<tr>
<td>ENGRMSE 164</td>
<td>X-ray Diffraction, Electron Microscopy, and Microanalysis</td>
</tr>
<tr>
<td>ENGRMSE 164L</td>
<td>X-ray Diffraction, Electron Microscopy, and Microanalysis Lab</td>
</tr>
<tr>
<td>ENGRMSE 165</td>
<td>Materials Kinetics and Phase Transformations</td>
</tr>
<tr>
<td>ENGRMSE 169</td>
<td>Electronic and Optical Properties in Materials</td>
</tr>
<tr>
<td>ENGRMSE 175</td>
<td>Design Failure Investigation</td>
</tr>
<tr>
<td>ENGRMSE 189A-189B-189C</td>
<td>Senior Design Project I and Senior Design Project II and Senior Design Project III</td>
</tr>
<tr>
<td>EECS 70A</td>
<td>Network Analysis I</td>
</tr>
<tr>
<td>or ENGRMAE 60</td>
<td>Electric Circuits</td>
</tr>
<tr>
<td>ENGR 54</td>
<td>Principles of Materials Science and Engineering</td>
</tr>
<tr>
<td>ENGR 150</td>
<td>Mechanics of Structures</td>
</tr>
</tbody>
</table>
ENGRMAE 10  Introduction to Engineering Computations
ENGRMAE 30  Statics
  or ENGR 30  Statics
  or ENGRCEE 30  Statics
ENGRMAE 150L  Mechanics of Structures Laboratory

**Engineering Electives:**
Students must complete a minimum of five courses from:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BME 50A</td>
<td>Cell and Molecular Engineering</td>
</tr>
<tr>
<td>BME 110A-110B</td>
<td>Biomechanics I and Biomechanics II</td>
</tr>
<tr>
<td>BME 111</td>
<td>Design of Biomaterials</td>
</tr>
<tr>
<td>BME 120</td>
<td>Sensory Motor Systems</td>
</tr>
<tr>
<td>CBE 110</td>
<td>Reaction Kinetics and Reactor Design</td>
</tr>
<tr>
<td>CBE 130</td>
<td>Separation Processes</td>
</tr>
<tr>
<td>ENGRMSE 141</td>
<td>Nano-Scale Materials and Applications</td>
</tr>
<tr>
<td>ENGRMSE 158</td>
<td>Ceramic Materials for Sustainable Energy</td>
</tr>
<tr>
<td>ENGRMSE 163</td>
<td>Computer Techniques in Experimental Research</td>
</tr>
<tr>
<td>CBE 187</td>
<td>Semiconductor Device Packaging</td>
</tr>
<tr>
<td>ENGRMSE 176</td>
<td>Surface and Adhesion Science</td>
</tr>
<tr>
<td>ENGRMSE 191</td>
<td>Materials Outreach</td>
</tr>
<tr>
<td>ENGRMSE 199</td>
<td>Individual Study</td>
</tr>
<tr>
<td>EECS 70B</td>
<td>Network Analysis II</td>
</tr>
<tr>
<td>EECS 170LA</td>
<td>Electronics I Laboratory</td>
</tr>
<tr>
<td>EECS 170B</td>
<td>Electronics II</td>
</tr>
<tr>
<td>EECS 174</td>
<td>Semiconductor Devices</td>
</tr>
<tr>
<td>EECS 176</td>
<td>Fundamentals of Solid-State Electronics and Materials</td>
</tr>
<tr>
<td>EECS 180A</td>
<td>Engineering Electromagnetics I</td>
</tr>
<tr>
<td>ENGR 165</td>
<td>Advanced Manufacturing</td>
</tr>
<tr>
<td>ENGRMAE 106</td>
<td>Mechanical Systems Laboratory</td>
</tr>
<tr>
<td>ENGRMAE 145</td>
<td>Theory of Machines and Mechanisms</td>
</tr>
<tr>
<td>ENGRMAE 147</td>
<td>Vibrations</td>
</tr>
<tr>
<td>ENGRMAE 151</td>
<td>Mechanical Engineering Design</td>
</tr>
<tr>
<td>ENGRMAE 152</td>
<td>Introduction to Computer-Aided Engineering</td>
</tr>
<tr>
<td>ENGRMAE 155</td>
<td>Composite Materials and Structures</td>
</tr>
<tr>
<td>ENGRMAE 157</td>
<td>Lightweight Structures</td>
</tr>
<tr>
<td>ENGRMAE 170</td>
<td>Introduction to Control Systems</td>
</tr>
</tbody>
</table>

Students select, with the approval of a faculty advisor, any additional engineering topics courses needed to satisfy school and department requirements.

**Engineering Professional Topics Course:**
ENGR 190W  Communications in the Professional World

(The nominal Materials Science and Engineering program will require 184 units of courses to satisfy all university and major requirements. Because each student comes to UCI with a different level of preparation, the actual number of units will vary. Dual engineering majors are reminded that they are required to satisfy all requirements of both majors individually. Students should not assume that courses for one, such as senior design, will satisfy the requirements of the other, without prior approval.)

1 ENGR 7A-ENGR 7B is available only to lower-division students. Both ENGR 7A-ENGR 7B must be taken to be counted as a Basic Engineering or Science Elective course.

Students majoring in MSE may elect, with approval of their faculty advisor, to use available engineering electives to complete one of the following specializations.

**Specialization in Biomaterials:**
Requires a minimum of 14 units from:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BME 50A</td>
<td>Cell and Molecular Engineering</td>
</tr>
</tbody>
</table>

*UCI General Catalogue 2019-2020  3*
### Specialization in Electronics Processing and Materials:
Requires a minimum of 14 units from:

- CBE 187: Semiconductor Device Packaging
- ENGRMSE 199: Individual Study (up to 3 units)
- or ENGR H199 (up to 3 units)
- EECS 70B: Network Analysis II
- EECS 170LA: Electronics I Laboratory
- EECS 174: Semiconductor Devices
- ENGR 165: Advanced Manufacturing

### Specialization in Materials and Mechanical Design:
Requires a minimum of 14 units from:

- ENGRMSE 199: Individual Study (up to 3 units)
- or ENGR H199 (up to 3 units)
- ENGRMAE 106: Mechanical Systems Laboratory
- ENGRMAE 145: Theory of Machines and Mechanisms
- ENGRMAE 147: Vibrations
- ENGRMAE 151: Mechanical Engineering Design
- ENGRMAE 152: Introduction to Computer-Aided Engineering
- ENGRMAE 155: Composite Materials and Structures
- ENGRMAE 157: Lightweight Structures
- ENGRMAE 170: Introduction to Control Systems

### Planning a Program of Study

A sample program of study chart for the major in Materials Science and Engineering is available in the Undergraduate Student Affairs Office. Students should keep in mind that this program is based upon a sequence of prerequisites, beginning with adequate preparation in high school mathematics, physics, and chemistry. Students who are not adequately prepared, or who wish to make changes in the sequence for other reasons, must have their program approved by their faculty advisor. Materials Science and Engineering majors are encouraged to consult with academic counselors as needed, and students who are academically at risk are mandated to see a counselor as frequently as deemed necessary by the advising staff.

### Sample Program of Study — Materials Science and Engineering

#### Freshman

<table>
<thead>
<tr>
<th>Fall</th>
<th>Winter</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 2A</td>
<td>MATH 2B</td>
<td>MATH 2D</td>
</tr>
<tr>
<td>ENGR 1A</td>
<td>CHEM 1B</td>
<td>CHEM 1C</td>
</tr>
<tr>
<td>ENGRMAE 10</td>
<td>PHYSICS 7C</td>
<td>PHYSICS 7D</td>
</tr>
<tr>
<td>General Education</td>
<td>PHYSICS 7LC</td>
<td>PHYSICS 7LD</td>
</tr>
</tbody>
</table>

#### Sophomore

<table>
<thead>
<tr>
<th>Fall</th>
<th>Winter</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 3A</td>
<td>MATH 3D</td>
<td>MATH 2E</td>
</tr>
<tr>
<td>ENGR 30</td>
<td>ENGRMSE 65A</td>
<td>EECS 70A</td>
</tr>
<tr>
<td>ENGR 54</td>
<td>General Education</td>
<td>ENGRMSE 65B</td>
</tr>
<tr>
<td>PHYSICS 7E</td>
<td>General Education</td>
<td>Basic Engineering/Science Elective</td>
</tr>
</tbody>
</table>

#### Junior

<table>
<thead>
<tr>
<th>Fall</th>
<th>Winter</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGRMSE 165</td>
<td>ENGRMSE 155</td>
<td>ENGRMSE 175</td>
</tr>
<tr>
<td>ENGR 150</td>
<td>ENGRMSE 155L</td>
<td>Engineering Elective</td>
</tr>
<tr>
<td>ENGRMAE 150L</td>
<td>ENGRMSE 164</td>
<td>Engineering Elective</td>
</tr>
<tr>
<td>Engineering Elective</td>
<td>ENGRMSE 164L</td>
<td>General Education</td>
</tr>
<tr>
<td>General Education</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The interdisciplinary field of materials science and engineering has become critical to many emerging areas of advanced technology and their applications. As a result, there are needs and opportunities for engineers and scientists with education and training in materials science and engineering. The goal of the minor in Materials Science and Engineering (MSE) is to provide students at UCI with such education and training that will enable them, upon graduation, to not only participate in projects or programs of an interdisciplinary nature but also address challenging societal needs and complex technological advances.

Admission
Admission in the MSE minor requires a minimum 2.5 overall UCI GPA. Students are required to complete all prerequisites for required courses and selected electives. In particular, students need to complete the following courses before applying:

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 1A</td>
<td>General Chemistry</td>
</tr>
<tr>
<td>CHEM 1LE</td>
<td>Accelerated General Chemistry Lab</td>
</tr>
<tr>
<td>MATH 2D</td>
<td>Multivariable Calculus</td>
</tr>
<tr>
<td>MATH 2E</td>
<td>Multivariable Calculus</td>
</tr>
<tr>
<td>MATH 3A</td>
<td>Introduction to Linear Algebra</td>
</tr>
<tr>
<td>MATH 3D</td>
<td>Elementary Differential Equations</td>
</tr>
<tr>
<td>PHYSICS 7C</td>
<td>Classical Physics</td>
</tr>
<tr>
<td>PHYSICS 7LC</td>
<td>Classical Physics Laboratory</td>
</tr>
<tr>
<td>PHYSICS 7D</td>
<td>Classical Physics</td>
</tr>
<tr>
<td>PHYSICS 7LD</td>
<td>Classical Physics Laboratory</td>
</tr>
</tbody>
</table>

Requirements for the Minor in Materials Science and Engineering
The minor in Materials Science and Engineering requires a total of seven courses—five required courses and two electives:

Required courses:

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGRMSE 155</td>
<td>Mechanical Behavior and Design Principles</td>
</tr>
<tr>
<td>ENGR 54</td>
<td>Principles of Materials Science and Engineering</td>
</tr>
</tbody>
</table>

Select three of the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGRMSE 165</td>
<td>Materials Kinetics and Phase Transformations</td>
</tr>
<tr>
<td>ENGRMSE 169</td>
<td>Electronic and Optical Properties in Materials</td>
</tr>
<tr>
<td>ENGRMSE 175</td>
<td>Design Failure Investigation</td>
</tr>
<tr>
<td>ENGRMSE 199</td>
<td>Individual Study</td>
</tr>
</tbody>
</table>

Electives:

Select two of the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BME 110A-110B</td>
<td>Biomechanics I and Biomechanics II</td>
</tr>
<tr>
<td>BME 111</td>
<td>Design of Biomaterials</td>
</tr>
<tr>
<td>BME 120</td>
<td>Sensory Motor Systems</td>
</tr>
<tr>
<td>ENGRMSE 141</td>
<td>Nano-Scale Materials and Applications</td>
</tr>
<tr>
<td>ENGRMSE 154</td>
<td>Polymer Science and Engineering</td>
</tr>
<tr>
<td>ENGRMSE 158</td>
<td>Ceramic Materials for Sustainable Energy</td>
</tr>
<tr>
<td>ENGRMSE 163</td>
<td>Computer Techniques in Experimental Research</td>
</tr>
<tr>
<td>CBE 187</td>
<td>Semiconductor Device Packaging</td>
</tr>
<tr>
<td>ENGRMSE 191</td>
<td>Materials Outreach</td>
</tr>
<tr>
<td>CHEM 225</td>
<td>Polymer Chemistry: Synthesis and Characterization of Polymers</td>
</tr>
<tr>
<td>EECS 170A-170B</td>
<td>Electronics I and Electronics II</td>
</tr>
</tbody>
</table>
Graduate Study in Materials Science and Engineering

Materials Science and Engineering focuses on the discovery of new materials, the tailoring of materials systems for optimum performance in a given technological application, and the design of novel materials solutions for emerging technologies. MSE is an interdisciplinary field incorporating elements of chemistry, physics, biology and/or engineering to derive and control the connections between structure (at length scales ranging from sub-atomic to macroscale), the processing necessary to achieve that structure, the fundamental properties (electrical, optical, thermal, mechanical, etc.), and their performance. These correlations are investigated using advanced materials characterization techniques and theoretical/computational analysis. Many of the most pressing scientific and technological challenges faced by humanity are constrained by the limits of currently available materials. The discovery, design and development of enabling materials is at the core of solving current and future scientific and engineering grand challenges, and benefit industries involved in electronics, advanced sensors, communications, human health, transportation, manufacturing recreation, energy conversion and storage, and environmental sustainability.

Current research programs include nanomaterials, nanostructures, nanoelectronics, nanodevices, nanocharacterization, device/system packaging materials, materials for fuel cells and related alternative energy systems, biocompatible materials, soft materials such as biological materials and polymeric materials, electronic and photonic materials, hybrid materials, interfacial engineering of materials, and multifunctional materials. Faculty with relevant research are affiliated with the Integrated Nanofabrication Research Facility (INRF), the National Fuel Cell Research Center (NFCRC), the California Institute for Telecommunications and Information Technology (Calit2), the Advanced Power and Energy Program (APEP), the Laboratory for Electron and X-ray Instrumentation (LEXI), and the Irvine Materials Research Institute (IMRI), among others.

The MSE graduate degree program is hosted by the Department of Materials Science and Engineering (MSE). Faculty who may serve as advisors are listed as affiliated with the MSE Department and include faculty with strong materials science and engineering research programs from other departments. The formal degree that is awarded upon successful completion of the program is either the M.S. or Ph.D. in Materials Science and Engineering.

Recommended Background

Given the nature of Materials Science and Engineering as a cross-disciplinary program, students having a background and suitable training, in Materials, Engineering (Mechanical, Electrical, Civil, Chemical, Aerospace), and the Physical Sciences (Physics, Chemistry, Geology) are encouraged to participate. A student with an insufficient background may be required to take remedial undergraduate courses. Recommended background courses include an introduction to materials, thermodynamics, mechanical behavior, and electrical/optical/magnetic behavior.

Specific Fields of Emphasis

The Materials faculty at UCI have special interest and expertise in all areas of modern materials and technologies, including biomaterials, energy materials, advanced ceramics, polymers and nanocomposite materials, structural and nanostructured metallic materials, micro/nano-device materials, device/system packaging materials, and multifunctional materials.

Required Courses

Students are required to take one course from each area for the M.S. and as a basis for the Ph.D. preliminary examination.

Crystal Structure and Defects:
ENGRMSE 200 Crystalline Solids: Structure, Imperfections, and Properties

Electrical and Optical Behavior:
ENGRMSE 205 Materials Physics

Mechanical Behavior:
ENGRMSE 256A Mechanical Behavior of Engineering Materials

Thermodynamics and Kinetics:
ENGRMSE 265 Phase Transformations

For students who plan to pursue a graduate degree in MSE, it is highly recommended that they take ENGRMSE 165 in addition to two of the following courses: ENGRMSE 169, ENGRMSE 175, or ENGRMSE 199.
Electives
Faculty advisors should be consulted on the selection of elective courses. All graduate courses offered in ENGRMSE are potential electives. Graduate-level courses offered in other Engineering departments and relevant graduate courses from other schools may also be taken as electives.

Master of Science Degree
The M.S. reflects achievement of an advanced level of competence for professional practice of materials science and engineering. Two options are available: a thesis option and a comprehensive examination option.

Plan I: Thesis Option
For the M.S. thesis option, students are required to complete a research study of great depth and originality and obtain approval for a complete program of study. A committee of three full-time faculty members is appointed to guide development of the thesis. A minimum of 36 units is required for the M.S.

For the thesis option, the following are required: four required core courses; three quarters of ENGRMSE 298 (Department Seminar); five additional graduate elective courses numbered 200–289 (or 200-295 if offered by other departments) for 3 or more units each, related to their field of graduate studies, and approved by the graduate advisor. One of these elective courses may be substituted by an upper-division undergraduate elective course if the course is not a part of the required MSE undergraduate core curriculum and is approved by the MSE graduate advisor.

Full-time graduate students must enroll in the departmental seminar each quarter during their first year unless exempt by petition.

Plan II: Comprehensive Examination Option
For the comprehensive examination option, students are required to complete 36 units of study and a comprehensive examination.

The following are required: four required core courses; three quarters of ENGRMSE 298 (Department Seminar); and a minimum of five additional graduate elective courses for 3 or more units numbered 200–289 (or 200-295 if offered by other departments), related to their field of graduate studies, and approved by the graduate advisor. One of these elective courses may be substituted by an upper-division undergraduate elective course if the course is not a part of the required MSE undergraduate core curriculum and is approved by the MSE graduate advisor.

Research units (ENGRMSE 296/ENGRMSE 299) do not count towards the degree requirements of the Comprehensive Exam Option. Full-time graduate students must enroll in the departmental seminar each quarter during their first year unless exempt by petition.

In addition to fulfilling the course requirements outlined above, it is a University requirement for the Master of Science degree that students fulfill a minimum of 36 units of study.

Doctor of Philosophy Degree
The Ph.D. in Materials Science and Engineering requires a commitment on the part of the student to dedicated study and collaboration with the faculty. Ph.D. students are selected on the basis of outstanding demonstrated potential and scholarship. Applicants must hold the appropriate prerequisite degrees from recognized institutions of high standing. After substantial preparation, Ph.D. candidates work under the supervision of faculty advisors. The process involves extended immersion in a research atmosphere and culminates in the production of original research results presented in a dissertation. Milestones to be passed in the Ph.D. program in order to remain in good standing include the following: acceptance into a research group by the faculty advisor at the end of the student’s first year of study; successful completion of the Ph.D. preliminary examination by the end of the second year; preparation for pursuing research and the development of a research proposal culminating in passing the Qualifying Examination by the end of the third year of the Ph.D. program. The Qualifying Examination includes faculty evaluation of a written research dossier and an oral presentation. Students must advance to candidacy in their third year (second year for students who entered with a master’s degree).

The core course requirements for the Ph.D. are listed under “Required Courses” above. Students must also enroll in ENGRMSE 298 (Department Seminar) each quarter during their first year unless exempt by petition. Ph.D. students must take two additional elective courses each for 3-4 units or a combination approved by the graduate advisor beyond the M.S. requirements. These courses are to be taken after the first year of graduate work, should be relevant to the Ph.D. dissertation topic, and must be selected in consultation with the research advisor and approved by the MSE graduate advisor. The preliminary examination is based on the four required core courses for the M.S. Students who have completed an MSE M.S. elsewhere must have a written approval by the graduate advisor to waive required MSE core courses, if they have taken the equivalent courses elsewhere.

Final examination involves the oral presentation and defense of an acceptable dissertation in a seminar attended by students and faculty. The Ph.D. is granted upon the recommendation of the Doctoral Committee and the Dean of the Graduate Division. The normative time for completion of the Ph.D. is five years (four years for students who entered with a master’s degree). The maximum time permitted is seven years.

Expectations for the Ph.D. Dissertation
The Ph.D. dissertation is written documentation of original research that has impact on the field of study for the Ph.D. Impact in the field is measured by accepted or published peer-reviewed journal articles, peer-reviewed conference proceedings, patents, or analogous original documented adoption of innovative technology. Faculty research advisors are to provide in writing their specific expectations consistent with the above criteria.
Relationship of M.S. and Ph.D. Programs

Students applying with the objective of a Ph.D. are admitted to the M.S./Ph.D. program only if they are likely to successfully complete a Ph.D. program. These students do not formally re-apply to the Ph.D. program after completing the M.S. Students who apply to the M.S.-only program must petition for the Ph.D. program if they desire to continue on for a Ph.D. Financial support is usually reserved for those students who plan to complete the Ph.D. The normative time to complete M.S. and Ph.D. degrees is two and five years, respectively.

Faculty

William Bowman, Ph.D. Arizona State University, Assistant Professor of Materials Science and Engineering (materials for energy conversion and storage, advanced transmission electron microscopy and spectroscopy, correlating multiscale properties, electrical properties of ceramics, electrochemistry and defect chemistry, interfaces, grain boundaries and surfaces, electron energy-loss spectroscopy, ceramic processing and thin-film growth)

James Earthman, Ph.D. Stanford University, Professor of Materials Science and Engineering; Biomedical Engineering (biomaterials, compositionally complex materials, nanocrystalline alloys, quantitative percussion diagnostics, deformation and damage processes)

Allon I. Hochbaum, Ph.D. University of California, Berkeley, Assistant Professor of Materials Science and Engineering; Chemical and Biomolecular Engineering; Chemistry (nanoscale materials and hybrid bio-inorganic devices for applications in clean energy)

Enrique Lavernia, Ph.D. Massachusetts Institute of Technology, UCI Provost and Executive Vice Chancellor and Distinguished Professor of Materials Science and Engineering (nanostructured materials, additive manufacturing, powder metallurgy, mechanical behavior)

Martha L. Mecartney, Ph.D. Stanford University, Professor of Materials Science and Engineering; Chemical and Biomolecular Engineering (ceramics for energy applications and for use in extreme environments, flash sintering, interfacial design of thermal conductivity, transmission electron microscopy)

Farghalli A. Mohamed, Ph.D. University of California, Berkeley, Professor Emeritus of Materials Science and Engineering (mechanical behavior of engineering materials such as metals, composites and ceramics, the correlation between behavior and microstructure, creep and superplasticity, mechanisms responsible for strengthening and fracture)

Daniel Mumm, Ph.D. Northwestern University, Associate Professor of Materials Science and Engineering (development of materials for power generation systems, propulsion, integrated sensing, advanced vehicle concepts and platform protection)

Xiaojing Pan, Ph.D. Saarlandes University, Henry Samueli Endowed Chair and Director of Irvine Materials Research Institute and Professor of Materials Science and Engineering; Physics and Astronomy (atomic-scale structure, properties and dynamic behaviors of advanced materials including thin films and nanostructures for memories, catalysts, and energy conversion and storage devices)

Regina Ragan, Ph.D. California Institute of Technology, Professor of Materials Science and Engineering; Chemical and Biomolecular Engineering (exploration and development of novel material systems for nanoscale electronic and optoelectronic devices)

Timothy Rupert, Ph.D. Massachusetts Institute of Technology, Associate Professor of Materials Science and Engineering; Chemical and Biomolecular Engineering; Mechanical and Aerospace Engineering (mechanical behavior, nanomaterials, structure property relationships, microstructural stability, grain boundaries and interfaces, materials characterization)

Julie Schoenung, Ph.D. Massachusetts Institute of Technology, Department Chair and Professor of Materials Science and Engineering (materials selection, green engineering, materials processing and characterization, nanostructured materials, structure-property relationships)

Lorenzo Valdevit, Ph.D. Princeton University, Director of Institute for Design and Manufacturing Innovation (IDMI) and Associate Professor of Materials Science and Engineering; Mechanical and Aerospace Engineering (architected materials, mechanical metamaterials, additive manufacturing, optimal design)

Affiliate Faculty

Shane Ardo, Ph.D. Johns Hopkins University, Assistant Professor of Chemistry; Chemical and Biomolecular Engineering; Materials Science and Engineering (inorganic and organometallic, physical chemistry and chemical physics, polymer, materials, nanoscience)

Plamen Atanassov, Ph.D. Bulgarian Academy of Sciences, UCI Chancellor's Professor of Chemical and Biomolecular Engineering; Chemistry; Materials Science and Engineering (electrocatalysis and electrocatalysts for energy conversion processes; bio-electrocatalysis and energy harvesting systems)

Elliot L. Botvinick, Ph.D. University of California, San Diego, Professor of Surgery; Biomedical Engineering; Materials Science and Engineering

Peter J. Burke, Ph.D. Yale University, Professor of Electrical Engineering and Computer Science; Biomedical Engineering; Materials Science and Engineering (nano-electronics, bio-nanotechnology)

Alon A. Gorodetsky, Ph.D. California Institute of Technology, Associate Professor of Chemical and Biomolecular Engineering; Chemistry; Materials Science and Engineering (cephalopods, adaptive materials, camouflage, bioelectronics)
Courses

ENGRMSE 50L. Principles of Materials Science and Engineering. 2 Units.
Introduction to the experimental techniques to characterize the properties of engineering materials. Emphasis on understanding the influence of microstructure on elastic, plastic, and fracture behavior. Topics include microstructure characterization, heat treatment, grain size effect, precipitation hardening, and impact loading. Materials fee.
Corequisite: ENGR 54

ENGRMSE 65A. Thermodynamics of Materials. 4 Units.
Treatment of the laws of thermodynamics and their application in understanding properties and equilibrium states of engineering materials. Develops relationships pertaining to multiphase equilibrium and presents graphical constructions for interpretation of phase diagrams. Statistical thermodynamics in relation to materials phenomena.
Prerequisite: (ENGR 1A or CHEM 1A or CHEM H2A) and PHYSICS 7C
Overlaps with ENGRMAE 91, CBE 40C.
Restriction: Materials Science Engineering Majors have first consideration for enrollment.
ENGRMSE 65B. Diffusion in Materials. 4 Units.
Prerequisite: ENGRMSE 65A. ENGRMSE 65A with a grade of C- or better
Restriction: Materials Science Engineering Majors have first consideration for enrollment.

ENGRMSE 141. Nano-Scale Materials and Applications. 4 Units.
Overview of the chemistry, physics, and applications of nanometer-scale materials. Explore the effects of composition, bonding, and confinement on physical properties of nanomaterials, their chemical syntheses, and their device physics in electronic, optoelectronic, and energy technologies.
Prerequisite: (ENGR 1A or CHEM 1A or CHEM H2A) and ENGR 54 and ENGRMSE 169
Restriction: Biomedical Engineering Majors have first consideration for enrollment. Chemical Engineering Majors have first consideration for enrollment. Materials Science Engineering Majors have first consideration for enrollment.
Concurrent with ENGRMSE 241.

ENGRMSE 154. Polymer Science and Engineering. 4 Units.
An introduction to physical aspects of polymers, including configuration and conformation of polymer chains and characterization techniques; crystallinity, viscoelasticity, mechanical properties, polymer alloys, processing, and application.
Prerequisite: ENGR 54 and (CBE 110 or ENGRMSE 165)
Same as CBE 181.
Restriction: Chemical Engineering Majors have first consideration for enrollment. Materials Science Engineering Majors have first consideration for enrollment.
Concurrent with ENGRMSE 254 and CBE 281.

ENGRMSE 155. Mechanical Behavior and Design Principles. 4 Units.
Principles governing structure and mechanical behavior of materials, relationship relating microstructure and mechanical response with application to elasticity, plasticity, yielding, necking, creep, and fracture of materials. Introduction to experimental techniques to characterize the properties of materials. Design parameters.
Prerequisite: ENGR 54
Same as ENGRMAE 156.
Restriction: Mechanical Engineering Majors have first consideration for enrollment. Chemical Engineering Majors have first consideration for enrollment. Materials Science Engineering Majors have first consideration for enrollment.

ENGRMSE 155L. Mechanical Behavior Laboratory. 1 Unit.
Introduction to experimental techniques to characterize mechanical properties of materials. Emphasis on correlations between property and microstructure. Experiments include: plastic stability in tension, effect of grain size on flow stress, microstructural engineering. Materials fee.
Corequisite: ENGRMSE 155
Prerequisite: ENGR 54
Restriction: Materials Science Engineering Majors have first consideration for enrollment.

ENGRMSE 158. Ceramic Materials for Sustainable Energy. 3 Units.
A technical elective for students interested in materials. Topics covered include structure and properties of ceramic materials, and design for sustainable energy applications.
Prerequisite: ENGR 54
Restriction: Chemical Engineering Majors have first consideration for enrollment. Materials Science Engineering Majors have first consideration for enrollment.
ENGRMSE 160. Advanced Lab in Synthesis of Materials. 4 Units.
Synthesis and characterization of organic and inorganic materials including polymers and oxides. Techniques include electron and scanning probe microscopy, gel permeation chromatography, X-ray diffraction, porosimetry, and thermal analysis. Materials fee.

Prerequisite: ENGR 54
Restriction: Materials Science Engineering Majors have first consideration for enrollment.

ENGRMSE 163. Computer Techniques in Experimental Research. 4 Units.
Principles and practical guidelines of automated materials testing. Computer fundamentals, programming languages, data acquisition and control hardware, interfacing techniques, programming strategies, data analysis, data storage, safeguard procedures.

Restriction: Chemical Engineering Majors have first consideration for enrollment. Materials Science Engineering Majors have first consideration for enrollment.

ENGRMSE 164. X-ray Diffraction, Electron Microscopy, and Microanalysis. 3 Units.
Material characterization using X-ray diffraction and scanning electron microscopy (SEM). Topics include X-ray diffraction and analysis; SEM imaging and microanalysis. Materials fee.

Corequisite: ENGRMSE 164L
Prerequisite: ENGR 54
Restriction: Materials Science Engineering Majors have first consideration for enrollment.

ENGRMSE 164L. X-ray Diffraction, Electron Microscopy, and Microanalysis Lab. 2 Units.
Material characterization using X-ray diffraction and scanning electron microscopy (SEM). Topics include X-ray diffraction and analysis; SEM imaging and microanalysis.

Corequisite: ENGRMSE 164
Prerequisite: ENGR 54
Restriction: Materials Science Engineering Majors have first consideration for enrollment.

ENGRMSE 165. Materials Kinetics and Phase Transformations. 3 Units.
Treatment of the kinetics of solid-state reactions and reactions at interfaces. Thermodynamics and kinetics of phase transformations, including solidification processes, diffusional and diffusionless phase transformations.

Prerequisite: ENGR 54 and ENGRMSE 65B. ENGRMSE 65B with a grade of C- or better
Restriction: Materials Science Engineering Majors have first consideration for enrollment.

ENGRMSE 169. Electronic and Optical Properties in Materials. 4 Units.
Covers the electronic, optical, and dielectric properties of crystalline and amorphous materials to provide a foundation of the underlying physical principles governing the properties of existing and emerging electronic and photonic materials.

Prerequisite: PHYSICS 7D and PHYSICS 7E and (MATH 3A or I&C SCI 6N) and MATH 3D
Restriction: Materials Science Engineering Majors have first consideration for enrollment.

ENGRMSE 171. Green Engineering: Theory and Practice. 4 Units.
Methods and impacts of selecting alternative technologies, processes, materials, chemicals, to reduce pollution, waste, and use of toxic substances, thereby creating “green," environmentally responsible, sustainable solutions. Topics include environmental regulations, recycling, life-cycle assessment, economic analysis, design, green chemistry, and toxicology.

Restriction: Seniors only. Materials Science Engineering Majors have first consideration for enrollment.

ENGRMSE 174. Composite Materials Design. 3 Units.

Prerequisite: ENGR 54 and ENGR 150
ENGRMSE 175. Design Failure Investigation. 4 Units.
Survey of mechanisms by which devices fail, including overload, fatigue, corrosion, and wear. Use of fractography and other evidence to interpret failure modes and specify design/manufacturing changes. Students redesign failed parts or structures based on actual parts and/or case histories.
Prerequisite: ENGR 54
Restriction: Chemical Engineering Majors have first consideration for enrollment. Materials Science Engineering Majors have first consideration for enrollment.

ENGRMSE 176. Surface and Adhesion Science. 4 Units.
Structure, thermodynamics of, kinetics, and reactions on surfaces. Surface electronic and mechanical properties and characterization of all classes of materials including metals, semiconductors, ceramics, polymers, and soft materials. Adhesion between different materials is also addressed.
Prerequisite: (CBE 110 or ENGRMSE 165) and (ENGRMSE 141 or ENGRMSE 169)
Same as CBE 183.
Restriction: Chemical Engineering Majors have first consideration for enrollment. Materials Science Engineering Majors have first consideration for enrollment.
Concurrent with ENGRMSE 276 and CBE 283.

ENGRMSE 189A. Senior Design Project I. 3 Units.
Group supervised senior design projects that deal with materials selection in engineering design and that involve case studies in ethics, safety, design, failure modes, new products, and patents. Activities conclude with a presentation of the projects. Materials fee.
Grading Option: In Progress (Letter Grade with P/NP).
Restriction: Seniors only. Materials Science Engineering Majors only. MSE 189A, MSE 189B, and MSE 189C must be taken in the same academic year.

ENGRMSE 189B. Senior Design Project II. 3 Units.
Group supervised senior design projects that deal with materials selection in engineering design and that involve case studies in ethics, safety, design, failure modes, new products, and patents. Activities conclude with a presentation of the projects. Materials fee.
Prerequisite: ENGRMSE 189A
Grading Option: In Progress (Letter Grade with P/NP).
Restriction: Seniors only. Materials Science Engineering Majors only. MSE 189A, MSE 189B, and MSE 189C must be taken in the same academic year.

ENGRMSE 189C. Senior Design Project III. 3 Units.
Group supervised senior design projects that deal with materials selection in engineering design and that involve case studies in ethics, safety, design, failure modes, new products, and patents. Activities conclude with a presentation of the projects. Materials fee.
Prerequisite: ENGRMSE 189B
Restriction: Seniors only. Materials Science Engineering Majors only. MSE 189A, MSE 189B, and MSE 189C must be taken in the same academic year.

ENGRMSE 190. Materials Selection and Design. 4 Units.
Meaning and phases of design; design considerations; properties of engineering materials; materials property charts; materials selection; process selection; multi-constraint and multi-objective design. Selection of shape in mechanical components. Designing with hybrid materials: challenges and opportunities. Environmental considerations; case studies.
Restriction: Materials Science Engineering Majors have first consideration for enrollment.

ENGRMSE 191. Materials Outreach. 3 Units.
Demonstrates major concepts in Materials Science and Engineering. Concepts of materials engineering covered include deformation in crystalline solids, effects of heat treatment on mechanical properties, thermal barrier materials, composites design, mechanical behavior of polymers, superconductivity in ceramics.
Prerequisite: ENGR 54
Repeatability: May be taken for credit 4 times.
Restriction: Materials Science Engineering Majors have first consideration for enrollment.
ENGRMSE 195. Special Topics in Materials Science and Engineering. 1-4 Units.
Studies in selected areas of Materials Science and Engineering. Topics addressed vary each quarter.
Prerequisite: Prerequisites vary.
Repeatability: Unlimited as topics vary.

ENGRMSE 198. Group Study. 1-4 Units.
Group study of selected topics in engineering.
Repeatability: May be repeated for credit unlimited times.
Restriction: Upper-division students only.

ENGRMSE 199. Individual Study. 1-4 Units.
Supervised independent reading, research, or design for undergraduate Engineering majors. Students taking individual study for design credit are to submit a written paper to the instructor and to the Undergraduate Student Affairs Office in the School of Engineering.
Repeatability: May be taken for credit for 8 units.
Restriction: Materials Science Engineering Majors only.

ENGRMSE 199P. Individual Study. 1-4 Units.
Supervised independent reading, research, or design for undergraduate Engineering majors. Students taking individual study for design credit are to submit a written paper to the instructor and to the Undergraduate Student Affairs Office in the School of Engineering.
Grading Option: Pass/no pass only.
Repeatability: May be repeated for credit unlimited times.

Principles and concepts underlying the study of advanced materials including alloys, composites, ceramics, semiconductors, polymers, ferroelectrics, and magnetics. Crystal structure and defects, surface and interface properties, thermodynamics and kinetics of phase transformations, and material processing, related to fundamental material properties.
Restriction: Graduate students only.

ENGRMSE 205. Materials Physics. 4 Units.
Covers the electronic, optical, and dielectric properties of crystalline materials to provide a foundation of the underlying physical principles of governing the properties of existing and emerging electronic and photonic materials.
Restriction: Graduate students only.

ENGRMSE 241. Nano-Scale Materials and Applications. 4 Units.
Overview of the chemistry, physics, and applications of nanometer-scale materials. Explore the effects of composition, bonding, and confinement on physical properties of nanomaterials, their chemical syntheses, and their device physics in electronic, optoelectronic, and energy technologies.
Prerequisite: ENGRMSE 200 and ENGRMSE 205
Restriction: Graduate students only.
Concurrent with ENGRMSE 141.

ENGRMSE 249. Special Topics in Materials Science and Engineering. 1-4 Units.
Studies in selected areas of Materials Science and Engineering. Topics addressed vary each quarter.
Prerequisite: Prerequisites vary.
Repeatability: Unlimited as topics vary.
Restriction: Graduate students only.
ENGRMSE 254. Polymer Science and Engineering. 4 Units.
An introduction to physical aspects of polymers, including configuration and conformation of polymer chains and characterization techniques; crystallinity visoelasticity, rheology, and processing.

Same as CBE 281.

Restriction: Graduate students only.

Concurrent with CBE 181 and ENGRMSE 154.

ENGRMSE 255A. Design with Ceramic Materials. 4 Units.

Prerequisite: ENGR 54

Restriction: Graduate students only.

ENGRMSE 256A. Mechanical Behavior of Engineering Materials. 4 Units.
Principles governing structure and mechanical behavior of materials, relationship relating microstructure and mechanical response with application to elasticity, plasticity, creep, and fatigue, study of rate-controlling mechanisms and failure modes, fracture of materials.

Restriction: Graduate students only.

ENGRMSE 259. Transmission Electron Microscopy. 4 Units.
The theory and operation of the transmission electron microscope (TEM), including the basic construction, electron optics, electron diffraction and reciprocal space, formation of image and electron diffraction information, microanalysis, and specimen preparation.

Prerequisite: ENGRMSE 200

Restriction: Graduate students only.

ENGRMSE 261. High Temperature Deformation of Engineering Materials. 4 Units.
Theoretical and practical aspects of creep and superplasticity in metallic and non-metallic systems are presented. Topics include: creep testing methods, diffusional creep, deformation mechanism maps, and superplasticity in non-metals.

Restriction: Graduate students only.

ENGRMSE 264. Scanning Electron Microscopy. 4 Units.
The theory and operation of the scanning electron microscope (SEM) and X-ray microanalysis. Topics covered include the basic design and electron optics, electron beam - specimen interactions, image formation and interpretation, X-ray spectrometry, and other related topics and techniques.

Prerequisite: ENGRMSE 200

Restriction: Graduate students only.

ENGRMSE 265. Phase Transformations. 4 Units.
Advanced thermodynamics and kinetics of phase transformations and phase transitions.

Prerequisite: CBEMS 240

Restriction: Graduate students only.

ENGRMSE 267. Seminar in Systems Microbiology Research. 1 Unit.
A research and journal club seminar that covers topics on bacteria and phage using approaches and principles from biology, engineering, and physics.

Grading Option: Satisfactory/unsatisfactory only.

Repeatability: May be repeated for credit unlimited times.

Same as MOL BIO 268, PHYSICS 268.

Restriction: Upper-division students only. Graduate students only.
ENGRMSE 271. Green Engineering: Theory and Practice. 4 Units.
Methods and impacts of selecting alternative technologies, processes, materials, chemicals, to reduce pollution, waste, and use of toxic substances, thereby creating “green,” environmentally responsible, sustainable solutions. Topics include environmental regulations, recycling, life-cycle assessment, economic analysis, design, green chemistry, and toxicology.

Restriction: Graduate students only.

ENGRMSE 273. Electroceramics & Solid State Electrochemical Systems. 4 Units.
Theory, underlying principles, experimental techniques, and applications of electroceramics and solid-state electrochemical systems. Links solid state physics, atomic structure, thermodynamics, defect chemistry, and transport processes to electrical properties of ceramics - spanning from insulators to fast-ion conductors and HT superconductors.

Prerequisite: ENGRMSE 200

ENGRMSE 276. Surface and Adhesion Science. 4 Units.
Structure, thermodynamics of, kinetics, and reactions on surfaces. Surface electronic and mechanical properties and characterization of all classes of materials including metals, semiconductors, ceramics, polymers, and soft materials. Adhesion between different materials is also addressed.

Same as CBE 283.

Restriction: Graduate students only.

Concurrent with ENGRMSE 176 and CBE 183.

ENGRMSE 295. Seminar in Engineering. 1-4 Units.
Seminars by individual faculty in major fields of interest.

Grading Option: Satisfactory/unsatisfactory only.

Repeatability: Unlimited as topics vary.

Restriction: Graduate students only.

ENGRMSE 296. Master of Science Thesis Research. 1-16 Units.
Individual research or investigation conducted in preparation for the thesis required for the M.S. degree in Engineering.

Repeatability: May be repeated for credit unlimited times.

Restriction: Graduate students only.

ENGRMSE 297. Doctor of Philosophy Dissertation Research. 1-16 Units.
Individual research or investigation conducted in preparation for the dissertation required for the Ph.D. degree in Engineering.

Repeatability: May be repeated for credit unlimited times.

Restriction: Graduate students only.

ENGRMSE 298. Seminars in Materials Science Engineering. 2 Units.
Presentation of advanced topics and reports of current research efforts in Materials Science Engineering.

Grading Option: Satisfactory/unsatisfactory only.

Repeatability: May be repeated for credit unlimited times.

Restriction: Graduate students only.

ENGRMSE 299. Individual Research. 1-16 Units.
Individual research or investigation under the direction of an individual faculty member.

Grading Option: Satisfactory/unsatisfactory only.

Repeatability: May be repeated for credit unlimited times.

Restriction: Graduate students only.