MATERIALS SCIENCE & ENGINEERING (MSE)

MSE 5000 Master's Thesis
Prerequisites: Graduate standing and permission of instructor.
Description: Students will be performing thesis research under the guidance of a thesis advisor. This will involve performing literature search, writing proposal for the research and conducting research in the laboratories. At the end of the course students will present the findings of research to the committee and prepare a thesis for approval by the thesis committee. Offered for variable credit, 1-6 credit hours, maximum of 6 credit hours.
Credit hours: 1-6
Contact hours: Lab: 2
Levels: Graduate
Schedule types: Lab
Department/School: Materials Sci. & Eng

MSE 5010 Materials Science and Engineering Seminar for Masters Students
Prerequisites: Graduate standing or consent of instructor.
Description: Advanced Research and Development Topics. Maximum 3 credit hours. Graded on pass/fail basis. Offered for variable credit, 1-3 credit hours, maximum of 3 credit hours.
Credit hours: 0
Contact hours: Other: 0
Levels: Graduate
Schedule types: Discussion
Department/School: Materials Sci. & Eng

MSE 5013 Advanced Thermodynamics of Materials
Prerequisites: Graduate standing and permission of instructor.
Description: Thermodynamics of materials is important for materials synthesis, stability and performance. The course will cover basic laws of thermodynamics, solution theory, phase equilibrium diagrams and thermodynamics of electrochemical systems.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Materials Sci. & Eng

MSE 5023 Diffusion and Kinetics
Prerequisites: Graduate standing and permission of instructor.
Description: Diffusion and kinetics are important for materials processing, stability, microstructure evolution and performance. The course will cover basic concepts underlying diffusion and kinetics as they relate to materials behavior. Topics on diffusion, nucleation and growth, spinodal decomposition, reactions involving solid with solids, gases and liquids, and phase transformation will be covered.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Materials Sci. & Eng

MSE 5030 Independent Study in Materials Science and Engineering
Prerequisites: Graduate standing and permission of instructor.
Description: Currently, there is no course number specifically related to the creative component (2 hour credit) that needs to be registered for by an M.S. creative component. Further, independent study courses could be offered by individual faculty in specific areas related to a student's graduate study.
Credit hours: 1-3
Contact hours: Lecture: 1
Levels: Graduate
Schedule types: Lecture
Department/School: Materials Sci. & Eng

MSE 5033 Composite Materials
Prerequisites: Graduate standing and permission of instructor.
Description: Composites are important for advanced performance and reliability of existing and new products for aerospace, electronics, and medical systems. This course is to introduce fundamental concepts for the design, fabrication and mechanical property evaluation of composites. This includes methods of fabricating fibers, matrices and composites, toughening mechanisms in composites, mechanical properties, and role of interfaces. The focus will be for composites useful at high temperatures.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Materials Sci. & Eng

MSE 5043 Advanced Materials Characterization
Prerequisites: Graduate standing and permission of instructor.
Description: Advances in materials require availability, training, and proficiency in advanced instrumentation to characterize materials at length scales from macro- to nanometer-scale. This course is to introduce fundamental concepts forming the basis of different equipments, their operation and capability for developing advanced materials. This includes instruments such as SES, TEM, x-ray diffraction, FTIR, AFM, and Nanoindentation. The lectures will be complemented with hands-on experience to students in labs housing these equipments.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Materials Sci. & Eng

MSE 5053 Smart Materials
Prerequisites: Graduate standing and permission of instructor.
Description: Advances in new technologies rely on the availability of "smart" materials that adapt to environment. Examples include sun-sensor glasses that become dark in sunlight and clear-out when indoors, and shape-memory materials used as stents in human body. In this course, the definition of a smart material and to understand principles of using electrical and other functional properties of materials to create smart systems is covered. Students are also taught to search literature on a suitable topic and work as a group to write a term paper and make a presentation to the class.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Materials Sci. & Eng

MSE 5063 Methods in Materials Science
Prerequisites: Graduate standing and permission of instructor.
Description: Methods in materials science and engineering are the fundamental basis for conducting research. This course covers the principles and practical aspects of using microscopy and characterization techniques in materials research. Students will learn how to design experiments, analyze data, and present results accurately. This course is essential for all materials science and engineering students.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Materials Sci. & Eng

MSE 5073 Materials for Bioengineering
Prerequisites: Graduate standing and permission of instructor.
Description: Materials for bioengineering are designed to interact with biological systems in a specific and controlled manner. This course covers the fundamentals of materials science with a focus on applications in biomedical engineering. Students will explore topics such as biomaterials, biocompatibility, and tissue engineering.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Materials Sci. & Eng

MSE 5083 Advanced Materials Processing
Prerequisites: Graduate standing and permission of instructor.
Description: Advanced materials processing is crucial for developing materials with specific properties and performance. This course covers various processing techniques and their impacts on material properties. Students will learn how to optimize processing parameters to achieve desired material characteristics.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Materials Sci. & Eng

MSE 5093 Research on Smart Materials
Prerequisites: Graduate standing and permission of instructor.
Description: Research on smart materials involves exploring new materials and technologies to create adaptable and responsive materials. This course focuses on conducting independent research projects related to smart materials. Students will develop research proposals, perform experiments, and analyze data to contribute to the field of smart materials.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Materials Sci. & Eng

MSE 5103 Finite Element Analysis
Prerequisites: Graduate standing and permission of instructor.
Description: Finite element analysis is a powerful tool for simulating the behavior of materials under various conditions. This course covers the fundamentals of finite element analysis and its applications in materials science. Students will learn how to use finite element software to model and analyze material behavior.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Materials Sci. & Eng

MSE 5113 Manufacturing Processes
Prerequisites: Graduate standing and permission of instructor.
Description: Manufacturing processes are essential for producing materials with the desired properties. This course covers a range of manufacturing processes and their applications in materials science. Students will learn how to select and optimize manufacturing processes for different materials.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Materials Sci. & Eng

MSE 5123 Electronic Materials and Devices
Prerequisites: Graduate standing and permission of instructor.
Description: Electronic materials and devices are critical components of modern electronics and energy systems. This course covers the fundamentals of electronic materials and their applications in device fabrication. Students will explore topics such as semiconductors, nanostructures, and energy storage devices.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Materials Sci. & Eng

MSE 5133 Modeling and Simulation of Materials Behavior
Prerequisites: Graduate standing and permission of instructor.
Description: Modeling and simulation of materials behavior are essential for predicting material performance under different conditions. This course covers various modeling techniques and their applications in materials science. Students will learn how to develop and analyze models for material behavior.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Materials Sci. & Eng

MSE 5143 Nanomaterials and Nanotechnology
Prerequisites: Graduate standing and permission of instructor.
Description: Nanomaterials and nanotechnology have revolutionized the field of materials science. This course covers the fundamentals of nanomaterials and their applications in various technologies. Students will learn about the unique properties of nanomaterials and how they can be used to develop new technologies.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Materials Sci. & Eng

MSE 5153 Materials in Energy Systems
Prerequisites: Graduate standing and permission of instructor.
Description: Materials in energy systems are crucial for developing sustainable and efficient energy solutions. This course covers the role of materials in various energy systems, such as solar, wind, and energy storage. Students will learn about the properties and selection criteria for materials used in energy systems.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Materials Sci. & Eng

MSE 5163 Materials for the Environment
Prerequisites: Graduate standing and permission of instructor.
Description: Materials for the environment are designed to address environmental challenges, such as pollution and resource depletion. This course covers the fundamentals of materials science with a focus on environmental applications. Students will explore topics such as sustainable materials and remediation technologies.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Materials Sci. & Eng
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Prerequisites</th>
<th>Description</th>
<th>Credit hours</th>
<th>Contact hours</th>
<th>Levels</th>
<th>Schedule types</th>
<th>Department/School</th>
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<tbody>
<tr>
<td>MSE 5063</td>
<td>Biomedical Materials</td>
<td>Graduate standing and permission of instructor.</td>
<td>The objective of this course is to introduce fundamental concepts for energy storage using batteries and supercapacitors. The course will include fundamentals of electrochemical systems/batteries and supercapacitors. Efficiency of storage based on thermodynamics will be described. In addition, role of important materials required in selected battery systems and capacitors will be included. The role of batteries and supercapacitors in the current and future energy storage devices will be described.</td>
<td>3</td>
<td>Lecture: 3</td>
<td>Graduate</td>
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<td>MSE 5123</td>
<td>Advanced Composites Manufacturing: Materials, Methods and Applications</td>
<td>Graduate standing and permission of instructor.</td>
<td>Covers important topics such as basic concepts and definitions of composite materials, fabrication, structure, properties, and applications of fibrous materials, structure and properties of polymer matrix, metal matrix and ceramic matrix materials, constituent materials, fabrication and repair methods, properties and applications of polymer matrix composites, metal matrix composites, ceramic matrix composites and carbon/carbon composites and markets.</td>
<td>3</td>
<td>Lecture: 3</td>
<td>Graduate</td>
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<td>MSE 5133</td>
<td>Solid Oxide Fuel Cells</td>
<td>Graduate standing and permission of instructor.</td>
<td>The objective of this course is to introduce fundamental concepts for energy production using solid oxide fuel cells. The course will include fundamentals of solid oxide fuel cells. Efficiency based on thermodynamics will be described. In addition, roles of important materials as electrolyte for oxygen transport, anode and cathodes as electronic conductors, and high temperature seals required for solid oxide fuel cells will be covered. The role of fuel cells in the current and future energy systems will also be described.</td>
<td>3</td>
<td>Lecture: 3</td>
<td>Graduate</td>
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<td>MSE 5073</td>
<td>Tissue Engineering</td>
<td>Graduate standing or consent of instructor.</td>
<td>Tissue engineering (TE) and the material strategy for different tissue constructs in bone TE, liver TE, neural TE, intestine TE, etc. will be discussed in this course. Same course as CHE 5073.</td>
<td>3</td>
<td>Lecture: 3</td>
<td>Graduate</td>
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<tr>
<td>MSE 5093</td>
<td>Fundamentals of Materials Science</td>
<td>Instructor approval.</td>
<td>MSE 5093 is a first-year graduate course that covers basic concepts in materials science. The course is designed for both materials science and engineering graduates and graduates with other engineering or science backgrounds (physics, chemistry, mechanical engineering, chemical engineering, electrical engineering, etc.).</td>
<td>3</td>
<td>Lecture: 3</td>
<td>Graduate</td>
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<td>MSE 5103</td>
<td>Electrical and Optical Properties of Ceramics</td>
<td>Graduate standing and permission of instructor.</td>
<td>Inorganic ceramic materials are useful in many applications because of their electrical, optical, dielectric, and magnetic properties. These are important for advancing performance and reliability of existing and new products for aerospace, electronics and medical systems. This course is to introduce fundamental concepts for the understanding of principles of electrical and optical behaviors of ceramic materials including atomic structure, conduction mechanisms, processing and electrical-optical properties.</td>
<td>3</td>
<td>Lecture: 3</td>
<td>Graduate</td>
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<td>MSE 5113</td>
<td>Diffraction in Materials</td>
<td>Graduate standing and consent of instructor.</td>
<td>Introduction to crystallography and diffraction with an emphasis on X-ray diffraction, some exposure to Neutron diffraction, radiography, and tomography. Applications will focus on mechanical properties measurements. New methods will be surveyed with an emphasis on current research. Same course as MAE 5113.</td>
<td>3</td>
<td>Lecture: 3</td>
<td>Graduate</td>
<td>Lecture</td>
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MSE 5153 Crystal Physics and Materials Properties
Prerequisites: Graduate standing or consent of instructor.
Description: This course is about crystal physics and crystal chemistry, and their applications to engineering problems. It is designed as an introduction to the relationships between symmetry and the directional physical properties of crystals. Emphasis will be on the fundamental understanding of symmetry arguments as criteria in the material selection process for technological applications.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Materials Sci. & Eng

MSE 5173 Organic Electronic Materials and Devices
Prerequisites: Graduate standing and permission of instructor.
Description: This course will serve as an introduction to organic materials with applications to active electronic and optoelectronic devices.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Materials Sci. & Eng

MSE 5174 Fundamentals of Photovoltaics
Prerequisites: Graduate standing and permission of instructor.
Description: This course will serve as in introduction to photovoltaic materials and devices. This course will cover commercial and emerging photovoltaic technologies.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Materials Sci. & Eng

MSE 5200 Applied Innovation I
Prerequisites: Graduate standing or consent of graduate program coordinator.
Description: Theory and practice of commercialization of new technologies, business plan development and formation of project teams to commercialize technologies and new products. Same course as EEE 5200.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Materials Sci. & Eng

MSE 5223 Additive Manufacturing: Materials, Methods and Applications
Prerequisites: Graduate standing or consent of instructor.
Description: Theory and practice of additive manufacturing, materials and their applications in various fields. Discuss their applications in product development, data visualization, rapid prototyping, and specialized manufacturing, with special emphasis on direct digital manufacturing.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Materials Sci. & Eng

MSE 5583 Corrosion Engineering
Prerequisites: ENSC 3313 or equivalent.
Description: Modern theory of corrosion and its applications in preventing or controlling corrosion damage economically and safely in service. Same course as MAE 5583.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Materials Sci. & Eng

MSE 5683 Thermodynamics and Thermostatistics of Materials
Prerequisites: ENSC 3313 or equivalent.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Materials Sci. & Eng

MSE 5693 Phase Transformations in Materials
Prerequisites: Graduate standing or consent of instructor.
Description: Principles of phase transformations in material. Structure of materials, phase diagrams, diffusion, solidification, and diffusional and diffusionless transformations will be covered. Recent developments in materials research relevant to phase transformations. Same course as MAE 5593.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Materials Sci. & Eng

MSE 6000 PhD Thesis
Prerequisites: Graduate standing and permission of instructor.
Description: Students will be performing thesis research under the guidance of a thesis advisor. This will involve performing literature search, writing proposal for the research, and conducting research in the laboratories. At the end of the course, students will present the findings of the research to the committee and prepare a thesis for approval by the thesis committee. Offered for variable credit, 1-10 credit hours, maximum of 60.
Credit hours: 1-10
Contact hours: Other: 1
Levels: Graduate
Schedule types: Independent Study
Department/School: Materials Sci. & Eng
MSE 6010 Materials Science and Engineering Seminar for PhD Students

**Prerequisites:** Graduate standing and consent of graduate program coordinator.

**Description:** Graduate students need to learn about the advances in materials and their processing, training and proficiency at length scales from macro to nanometer. This seminar course will allow students to interact with the experts and other students in the field and introduce descriptions of projects, as well as the concepts of structure-property co-relationships of advanced materials. This will allow the students to become better researchers and form the basis of future ideas and concepts. Guest speakers from different areas, industry and other universities will be invited from time to time. Graduate students will be allowed an opportunity to present their work and obtain feedback from other students for improving their research projects. Maximum of three credit hours. Graded on pass/fail basis.

**Credit hours:** 0

**Contact hours:** Other: 0

**Levels:** Graduate

**Schedule types:** Discussion

**Department/School:** Materials Sci. & Eng