Advanced Materials Science & Engineering Center

Assessment Plan

Mission Statement

Our mission is to educate students in materials science, support interdisciplinary research, and enhance regional industry competitiveness and innovation.

Program Educational Objectives *(Longer-term goals for graduates of the program)*

1. To prepare students for successful careers or continued education in industry, government and academia in the field of materials science.
2. To provide students an understanding of and fluency in the fundamental and emerging concepts in materials science.
3. To develop critical thinking and practical problem solving skills for applications to interdisciplinary challenges in the field of materials science.

Assessment of Program Educational Outcomes

Educational outcomes are assessed in part through a required capstone project. The capstone project, taken as MSCI 491/492, may be either a research experience under the guidance of a faculty mentor, or an internship. If a research experience, students are required to submit a final report and are assessed by their faculty mentor. A public presentation (talk or poster) is sometimes required as well. If an internship, students are required to follow the AMSEC internship guidelines, which include a final report and assessments from the internship advisor (normally the AMSEC Director) and assigned company mentor.

Program Educational Outcomes *(Goals for students upon completion of the program)*

A. Students will have a solid foundation in the chemistry and physics of materials.
B. Students will have a fundamental and practical understanding of materials synthesis, processing, and characterization methods.
C. Students will demonstrate a fundamental understanding of inter-relationships between materials composition, processing, and properties, and their application to materials selection.
D. Students will demonstrate the ability to apply knowledge from chemistry, geology, physics or engineering technology to solve problems in materials science, both independently and collaboratively.
E. Students will have understanding and appreciation of emerging directions in materials science.
F. Students will demonstrate effective scientific and technical communication skills in materials science.

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Assessment of Program Educational Objectives

All graduating seniors undergo a formal exit interview, conducted by the Program Manager. The interview uses a survey tool to probe student satisfaction, ***

List of Appendices

1. Student educational learning outcomes (SLO's)
2. Course content and assessment guidelines for MSCI 220, 320, 330, 410
3. Exit interview survey tool

Appendix 1. Student educational learning outcomes

	Materials Science 201	**Applicable Program Outcomes**
1	Students will be able to select appropriate engineering materials for specific engineering applications based on their mechanical properties, safety factors and cost, as well as be able to apply ethical principles, engineering codes of ethics, and professional responsibilities in the selection of materials in engineering design.	**C, D**
2	Students will be able to conceptually explain the classification schemes that are used to categorize engineering materials and explain the differences in the mechanical behavior of engineering materials based upon bond type, structure, composition, and processing.	**A, B, C**
3	Students will be able to describe why each of the fundamental mechanical engineering properties of materials are important in engineering design, be able to distinguish between geometric and materials properties effects, and understand the effect of temperature and operating environment upon the structure, composition, and mechanical performance of materials.	**C, D**
4	Students will understand and be able to calculate the basic stress/strain behavior of materials, describe basic concepts of deformation mechanisms, and describe defects (point, line and interfacial) in materials, as well as understand how they affect engineering properties and limit their use in service.	**A, C, D**
5	Students will be able to describe the basic structures and repeat units for common thermoplastics and relate the distribution of molecular weights, degree of polymerization, percent crystallinity, and glass transition temperature to properties in service.	**A, B**
6	Students will understand how different types of composites are created to improve certain engineering properties and be able to calculate upper limits of mechanical properties based upon the rule of mixtures.	**C, D**
7	Students will demonstrate the ability to work in teams to research and communicate current applications of engineering materials in service using appropriate nomenclature and terminology, understand historical limitations, evaluate future trends, and understand long-term issues.	**F**
	Materials Science 320	**Applicable Program Outcomes**
1	Students will be able to describe the basic structure of materials at the molecular, microscopic, and macroscopic scales, and will be able to describe modern methods of characterizing materials at each of these length scales.	**A, B**
2	Students will be able to describe the categories of polymeric and ceramic materials and relate them to structure and resulting properties.	**A, C, D**
3	Students will have an understanding of the primary means by which polymeric, ceramic, and some composite materials are synthesized and processed.	**B**
4	Students will understand diffusion and electrochemical processes in materials.	**A, D**
5	Students will understand the ways in which materials properties change on the nanometer length scale, including the properties of nanomaterials as well as the behavior of materials at surfaces and interfaces.	**A, E**
6	Students will have an understanding of emerging topics in materials science and engineering and be able to read, analyze, and present recent peer reviewed literature on modern materials research topics.	**E, F**

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	Materials Science 330	**Applicable Program Outcomes**
1	Students will demonstrate an understanding of electrical conduction in materials, including insulators, semiconductors, and metals.	**A, B, D**
2	Students will understand doping in semiconductors and the operation of the primary types of devices based on a semiconductor pn junction.	**A, C, D**
3	Students will have an understanding of thermal and magnetic properties of materials.	**A, B, D**
4	Students will understand how electromagnetic radiation interacts with materials, and how these interactions lead to functionality of materials including lasers, luminescence and optoelectronic devices, and optical fibers.	**A, C, D**
5	Students will demonstrate knowledge of advanced materials including multifunctional materials and superconductors.	**E, F**
6	Students will have an understanding of emerging topics in materials science and engineering and be able to present both written and oral work according to the preferred style in academic research.	**E, F**
	Materials Science 410	**Applicable Program Outcomes**
1	Students will demonstrate an operational understanding of a wide range of methods for characterizing materials, including understanding the applicability and limits of applicability of each advanced analytical technique.	**A, B, D**
2	Students will have considerable hands-on experience synthesizing a range of important materials.	**B, D, E**
3	Students will be able to communicate concisely and effectively like professional scientists and engineers using industrial-style methods for reporting results.	**F**
4	Students will Be able to assess the quality of experimental data and to create experimental designs to investigate properties of materials.	**D, F**
5	Students will demonstrate the ability to collaborate with peers to develop ideas, to analyze complex phenomena and to communicate results.	**D, F**

Appendix 2a. MSCI 201

Major Topics

- Overview of major materials classifications and introduction to their properties
- Relationship of materials properties to engineering design criteria
- Mechanical properties of materials, defects
- Introduction to the properties of polymers and composites

Student Learning Outcomes

- Students will be able to select appropriate engineering materials for specific engineering applications based on their mechanical properties, safety factors and cost, as well as be able to apply ethical principles, engineering codes of ethics, and professional responsibilities in the selection of materials in engineering design.
- Students will be able to conceptually explain the classification schemes that are used to categorize engineering materials and explain the differences in the mechanical behavior of engineering materials based upon bond type, structure, composition, and processing.
- Students will be able to describe why each of the fundamental mechanical engineering properties of materials are important in engineering design, be able to distinguish between geometric and materials properties effects, and understand the effect of temperature and operating environment upon the structure, composition, and mechanical performance of materials.
- Students will understand and be able to calculate the basic stress/strain behavior of materials, describe basic concepts of deformation mechanisms, and describe defects (point, line and interfacial) in materials, as well as understand how they affect engineering properties and limit their use in service.
- Students will be able to describe the basic structures and repeat units for common thermoplastics and relate the distribution of molecular weights, degree of polymerization, percent crystallinity, and glass transition temperature to properties in service.
- Students will understand how different types of composites are created to improve certain engineering properties and be able to calculate upper limits of mechanical properties based upon the rule of mixtures.
- Students will demonstrate the ability to work in teams to research and communicate current applications of engineering materials in service using appropriate nomenclature and terminology, understand historical limitations, evaluate future trends, and understand long-term issues.

Appendix 2b. MSCI 320

Major Topics

- Polymers
- Ceramics
- Composites
- Thermally activated processes in materials
- Electrochemistry and corrosion
- Advanced materials
- Nanomaterials

Student Learning Outcomes

- Students will be able to describe the basic structure of materials at the molecular, microscopic, and macroscopic scales, and will be able to describe modern methods of characterizing materials at each of these length scales.
- Students will be able to describe the categories of polymeric and ceramic materials and relate them to structure and resulting properties.
- Students will have an understanding of the primary means by which polymeric, ceramic, and some composite materials are synthesized and processed.
- Students will understand diffusion and electrochemical processes in materials.
- Students will understand the ways in which materials properties change on the nanometer length scale, including the properties of nanomaterials as well as the behavior of materials at surfaces and interfaces.
- Students will have an understanding of emerging topics in materials science and engineering and be able to read, analyze, and present recent peer reviewed literature on modern materials research topics.

Appendix 2c. MSCI 330

Major Topics

- Electronic properties
- Thermal properties
- Magnetic properties
- Optical properties
- Multifunctional materials
- superconductors

Student Learning Outcomes

- Students will demonstrate an understanding of electrical conduction in materials, including insulators, semiconductors, and metals.
- Students will understand doping in semiconductors and the operation of the primary types of devices based on a semiconductor pn junction.
- Students will have an understanding of thermal and magnetic properties of materials.
- Students will understand how electromagnetic radiation interacts with materials, and how these interactions lead to functionality of materials including lasers, luminescence and optoelectronic devices, and optical fibers.
- Students will demonstrate knowledge of advanced materials including multifunctional materials and superconductors.
- Students will have an understanding of emerging topics in materials science and engineering and be able to present both written and oral work according to the preferred style in academic research.

Appendix 2d. MSCI 410

Major Topics

Theory and operation of major materials characterization instrumentation

Data interpretation, data quality, and experiment design

Student Learning Outcomes

- Students will demonstrate an operational understanding of a wide range of methods for characterizing materials, including understanding the applicability and limits of applicability of each advanced analytical technique.
- Students will have considerable hands-on experience synthesizing a range of important materials.
- Students will be able to communicate concisely and effectively like professional scientists and engineers using industrial-style methods for reporting results.
- Students will Be able to assess the quality of experimental data and to create experimental designs to investigate properties of materials.
- Students will demonstrate the ability to collaborate with peers to develop ideas, to analyze complex phenomena and to communicate results.