

MAE 20  
Elements of Materials Science (4 units)

**Class/Laboratory Schedule:** four hours of lecture, eight hours of outside preparation.  
12 hours/week total

**Course Coordinator(s):** Joanna McKittrick, Prabhakar Bandaru

**Textbooks/Materials:**

1. William D. Callister, Materials Science and Engineering: An Introduction, John Wiley (10<sup>th</sup> Edition)

**Catalog Description:** The structure and properties of materials (metals, ceramics, glasses, polymers, composites and semiconductors) are discussed. The focus is on atomic structures, defects in materials, diffusion, stress-strain curves, phase diagrams and microstructural control. Mechanical and electrical properties are discussed.

**Prerequisites:** Phys. 2A or 4A, Chem. 6A, Math 20C. Priority given to Engineering Majors.

**Course Type:** Required

**Performance Criteria:**

Objective 1

1.1 Students will demonstrate an understanding of optimum material selection for a variety of engineering applications.

Objective 2

2.1 Students will demonstrate the ability to identify the structure of common engineering materials, and calculate crystal lattice parameters.

2.2 Students will demonstrate an ability to qualitatively predict the physical properties of materials based on atomic bonding considerations.

2.3 Students will demonstrate an ability to qualitatively predict the mechanical properties of materials based on atomic bonding and crystal structure considerations.

Objective 3

3.1 Students will demonstrate an understanding of the role of processing route on microstructure evolution during material synthesis.

3.2 Students will demonstrate an ability to select a processing route for material synthesis to achieve specific material performance.

#### Objective 4

4.1 Students will demonstrate the ability to calculate the stress-strain behavior of a material from its load-displacement behavior.

4.2 Students will demonstrate the ability to design a thermo-mechanical processing route to produce a desired microstructure for structural and electrical performance.

#### **Course Objectives:**

**(Numbers in parentheses refer to MAE Program Outcomes)**

1. To teach students the concept of structure/processing/properties/performance correlation in engineering materials. (1, 2, 4, ME10, ME11)
2. To teach students the structure of engineering materials and its role on physical properties. (1, ME10)
3. To explain the various fundamental theories for materials synthesis and processing, with focus on materials intended for structural and electrical applications. (1, 2, ME10, ME11)
4. To teach students methods for determining the properties of materials, both physical and mechanical properties. (1, ME10)
5. To teach students the methodology of materials selection for engineering applications. (2, 4, ME11)

#### **Course Topics:**

1. Atomic Structure, Bonding, Properties
2. Crystal Structures
3. Imperfections in Materials
4. Atomic Diffusion in Solids
5. Mechanical Properties of Metals, Dislocations, Strengthening Mechanisms
6. Equilibrium Phase Diagrams
7. Applications and Processing of Metals
8. Structure and Properties of Ceramics
9. Polymer Structures, Applications, Processing
10. Composite Structures and Applications
11. Electrical Properties

Last Updated: 10th June 2019