

MAE 20
Elements of Materials Science (4 units)

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

Course Coordinator(s): Joanna McKittrick

Textbooks/Materials:

1. William D. Callister, Materials Science and Engineering: An Introduction, John Wiley, 8th edition, (2007)

Catalog Description: The structure and control of materials: metals, ceramics, glasses, semiconductors and polymers to produce desired, useful properties. Atomic structures. Defects in materials, phase diagrams, micro structural control. Mechanical and electrical properties are discussed. Time temperature transformation diagrams. Diffusion.

Prerequisites: Phys. 2A or 4A, Chem. 6A, Math 20C. Priority given to engineering majors.

- Required Course
- Technical Elective Course
- Other: _____

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)

Objective 1: To teach students the concept of structure/processing/properties/performance correlation in engineering materials (1a, 3c, 10j)

Objective 2: To teach students the structure of engineering materials and its role on physical properties (1a).

Objective 3: To explain the various fundamental theories for materials synthesis and processing, with focus on materials intended for structural and electrical applications. (1a, 3c).

Objective 4: To teach students methods for determining the properties of materials, both physical and mechanical properties. (1a).

Objective 5: To teach students the methodology of materials selection for engineering applications (3c, 10j).

Course Topics:

1. Atomic Structure, Bonding, Properties
2. Crystal Structures and Crystalline Geometry
3. Atomic Diffusion in Solids
4. Solidification and Crystal Imperfections
5. Equilibrium Phase Diagrams
6. Binary Eutectics, Phase Transformations
7. Steel: Equilibrium and Non-Equilibrium Structures; Heat Treatment
8. Mechanical properties of materials, fracture, fatigue and creep
9. Polymerization/Thermoplastics/Thermosets
10. Electrical Properties

Prepared By: K. Vecchio, March 2000

Revised: Prab bandaru & Joanna McKittrick, April 2008, via Teaching Work Group Meeting

Reviewed and Revised: TWG, June 2010; June 2011

Reviewed: TWG, November 2012