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): Prabhakar Bandaru

Textbooks/Materials:

1. William D. Callister, Materials Science and Engineering: An Introduction, John Wiley (10^{th} Edition)

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

Prerequisites: PHYS 2A or 4A, CHEM 6A or CHEM 6AH, and MATH 20C.

Course Type: Required

Course Objectives:

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, with emphasis on ferrous and non-ferrous alloys .

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 characteristics.

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 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

Last Updated: March 22, 2025