MAE 20
Elements of Materials Science

Designation: Required Course for ME

Catalog Data:
MAE 20 Elements of Materials Science (4)

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, rheological, electrical, optical and magnetic properties are discussed. Time temperature transformation diagrams. Diffusion.

Prerequisites: Phys. 2A or 4A, Chem. 6A, Math 21C or Math 20D (or concurrent enrollment). Priority given to engineering majors.

Textbooks, Required Materials:
1. Donald R. Askeland and Pradeep Phule, Essentials of Materials for Science and Engineering Thompson Press, 2004.
2. William D. Callister, Materials Science and Engineering An Introduction, John Wiley, 8th edition, (2007)

Prerequisites by Topic: Inorganic chemistry and physics.

Class/Laboratory Schedule: 3 lecture hours and 1 discussion hour per week

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, Magnetic and Optical Properties

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, ME12)

Objective 2: To teach students the structure of engineering materials and its role on physical properties (1a, ME 12).

Objective 3: To explain the various fundamental theories for materials synthesis and processing, with focus on materials intended for structural, electrical, optical, and magnetic applications. (1a, 3c, ME12).

Objective 4: To teach students methods for determining the properties of materials, both physical and mechanical properties. (1a, ME 12).

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

Methods of Evaluation:

1. Homework will be regularly collected and graded.
2. Weekly quizzes to emphasize most important concepts.
3. Exams

Performance Criteria:

(Numbers in parentheses refer to the methods of evaluation used to assess student performance)

Objective 1

1.1 Students will demonstrate an understanding of optimum material selection for a variety of engineering applications. (1,2,3).

Objective 2

2.1 Students will demonstrate the ability to identify the structure of common engineering materials, and calculate crystal lattice parameters. (1,2,3).

2.2 Students will demonstrate an ability to qualitatively predict the physical properties of materials based on atomic bonding considerations. (1,2).

2.3 Students will demonstrate an ability to qualitatively predict the mechanical properties of materials based on atomic bonding and crystal structure considerations. (1,2,3).

Objective 3

3.1 Students will demonstrate an understanding of material synthesis and processing techniques. (1,2,3)

3.2 Students will demonstrate an understanding of the role of processing route on microstructure evolution during material synthesis (1,2,3).

3.3 Students will demonstrate an ability to select a processing route for material synthesis to achieve specific material performance (1, 2).

3.4 Students will demonstrate an understanding of semiconductor materials and their use in solid state devices. (1,2,3).

Objective 4

4.1 Students will demonstrate the ability to calculate the stress-strain behavior of a material from its load-displacement behavior.(1,2,3)

4.2 Students will demonstrate the ability to design a thermo-mechanical processing route to produce a desired microstructure for structural, electrical, optical or magnetic performance. (1, 2,3)

Contribution of Course to Professional Component:

Engineering Science

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