BAKER COLLEGE
STUDENT LEARNING OUTCOMES

ME2110A Materials Science
4 Semester Hours

Student Learning Outcomes & Enabling Objectives

1. Introduce Material Science
    a. Develop Learning Objectives & Historical Perspectives
    b. Classify Materials
    c. Appraise Advanced Materials
    d. Decide upon Modern Materials
    e. Contrast Processing/Structure/Properties of Materials

2. Explain how Atomic Structure & Interatomic Bonding affects Material Science
    a. Demonstrate Fundamental Concepts of Atoms
    b. Make use of Atomic Structure and the Periodic Table
    c. Compare Bonding Forces (Primary, Secondary)
    d. Explain Criteria of Molecular Structure
    e. Determine Bonding Type-Material Classifications

3. Explain the Structure of Crystalline Solids
    a. Apply the Fundamental Concepts
    b. Construct Unit Cells (FCC, BCC, etc.)
    c. Create of Metallic Crystal Structures
    d. Make use of Density Computations
    e. Compare Polymorphism and Allotropy
    f. Assess Crystal Systems
    g. Determine Point Coordinates
    h. Evaluate Crystallographic Directions & Planes
    i. Justify Linear and Planar Densities
    j. Establish relationships of Close-Packed Crystal Structures
    k. Model Crystalline and non-crystalline materials
    l. Compare Single Crystals & Polycrystalline Materials
    m. Determine Anisotropy
    n. Dissect X-Ray Diffraction: Determination of Crystal Structures
    o. Explain Non-crystalline Solids

4. Explain Imperfections in Solids
    a. Identify Vacancies and Self-Interstitials
    b. Interpret Importance of Impurities in Solids
    c. Appraise Specification of Composition
    d. Identify Linear Defects

e. Compare Linear and Interfacial Defects
f. Determine Materials of Importance – Crystals
g. Calculate measurements regarding Bulk / Volume Defects
h. Determine Atomic Vibrations
i. Estimate Basic Concepts of Microscopy
j. Explain the Importance of Microscopy Techniques
k. Explain Grain-size Determination

5. Define Diffusion
    a. Discuss organization of Diffusion Mechanisms
    b. Categorize Fick's First Law
    c. Examine Fick's Second Law
    d. Inspect Factors that Influence Diffusion
    e. Discuss simplification of Diffusion in Semi-conducting Materials
    f. Discuss functions of Other Diffusion Paths

6. Define Mechanical Properties of Metals
    a. Discuss Concepts of Stress & Strain
    b. Identify Stress-strain Behavior
    c. Examine Anelasticity
    d. Discuss the Importance of Elastic Properties of Materials
    e. Measure Tensile Properties
    f. Compare True Stress and True Strain
    g. Prioritize Elastic Recovery After Plastic Deformation
    h. Compare Compressive, Shear and Torsional Deformation
    i. Appraise Hardness
    j. Determine Variability of Material Properties
    k. Distinguish both Design and Safety Factors

7. Explain Dislocations and Strengthening Mechanisms
    a. Discover Characteristics of Dislocations
    b. Examine Slip Stems
    c. Discuss Function of Slip in Single Crystals
    d. Discuss relationships regarding Plastic Deformation of Polycrystalline Materials
    e. Discuss Deformation by Twinning
    f. Justify of Strengthen by Grain Size Reduction
    g. Measure of Solid-Solution Strengthening
    h. Discuss Analysis of Strain Hardening
    i. Use of Recovery, Recrystallization and Grain Growth

8. Explain How Failure is Specifically Defined
    a. Apply Fundamentals of Fracture
    b. Examine Ductile Fracture
    c. Classify of Brittle Fracture
    d. Discuss Function of Principles of Fracture Mechanics
    e. Distinguish specific Fracture Toughness Testing
    f. Discuss Assessment of Cyclic Stresses

g. Discuss Importance of the S-N curve and Fatigue
h. Discuss Simplification of Crack Initiation and Propagation
i. Categorize of Factors that Affect Fatigue Life
j. Discover Environmental Effects of Failure Mechanisms
k. Discover of Generalized Creep Behavior
l. Distinguish Stress and Temperature Effects
m. Compare of Data Extrapolation Methods
n. Discuss Assessment of Alloys for High-Temperature Use

9. Define Phase Diagrams
    a. Discuss Solubility Limits and Phases
    b. Construct of Microstructure
    c. Develop of Phase Equilibria
    d. Experiment with One Component Phase Diagrams
    e. Develop Microstructure in Isomorphous Alloys
    f. Appraise of Mechanical Properties for Isomorphous Alloys
    g. Estimate Binary Eutectic Systems
    h. Discuss Importance of Development of Microstructure Eutectic Alloys
    i. Discuss Equilibrium Diagrams Having Intermediate Phase or Compounds
    j. Rate Eutectoid and Peritectic Reactions
    k. Measure Congruent Phase Transformations
    l. Appraise Ceramic and Ternary Phase Diagrams
    m. Define The Gibbs Phase Rule
    n. Discuss The Iron-Iron Carbide Phase Diagram
    o. Discuss Marking of the Development of Microstructure in Iron-Carbon Alloys
    p. Prioritize The Influence of Other Alloying Elements

10. Label Phase Transformation: Development of Microstructure and Alteration of Mechanical Properties
    a. Discover Basic Concepts of Phase Transformation
    b. Examine The Kinetics of Phase Transformations
    c. Compare of Metastable Versus Equilibrium States
    d. Discuss Relationships of Isothermal Transformation Diagrams
    e. Discuss Importance of Continuous Cooling Transformation Diagrams
    f. Interpret Mechanical Behavior of Iron-Carbon Alloys
    g. Experiment with Tempered Martensite

11. Define of Applications and Processing of Metal Alloys
    a. Develop of Ferrous Alloys
    b. Compare to Nonferrous Alloys
    c. Dissect Forming Operations
    d. Discuss Casting
    e. Inspect the Annealing Process
    f. Examine of Heat Treatment of Steels
    g. Define of Precipitation Hardening

12. Relate Polymer Structures to Material Structures
    a. Examine Hydrocarbon Molecules
    b. Develop Polymer Molecules
    c. Evaluate The Chemistry of Polymer Molecules
    d. Compare Molecular Weight, Shape, Structure and Configurations of Polymers
    e. Contrast Thermoplastic and Thermosetting Polymers
    f. Categorize Copolymers
    g. Examine Polymer Crystallinity
    h. Evaluate Defects of Polymers
    i. Measure Diffusion in Polymeric Materials

13. Define Characteristics, Applications and Processing of Polymers
    a. Determine Stress-Strain Behavior
    b. Examine of Macroscopic Deformation
    c. Examine of Viscoelastic Deformation
    d. Compare Fracture of Polymers
    e. Evaluate Misc. mechanical Characteristics
    f. Discuss the importance of Deformation of Semi crystalline Polymers
    g. Justify Deformation of Elastomers
    h. Inspect of Crystallization Process and Melting Process
    j. Categorize the Glass Transition Phenomenon
    k. Discuss Melting and Glass Transition Temperatures
    l. Discuss Criteria regarding Factors that Influence Melting and Glass Transition Temperatures
    m. Measure Polymerization & Polymer Additives
    n. Discuss Importance of Forming Techniques for Plastics
    o. Categorize Fabrication of Elastomers, Fibers and Films

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These SLOs are not approved for experiential credit.

Effective: Summer 2020