Chapter 1 Introduction

1. List six different property classifications of materials that determine their applicability.
2. Define what is meant by a structural element of a material, and then cite two structural elements.
3. (a) Cite the four components that are involved in the design, production, and utilization of materials.
   (b) Now, briefly describe the interrelationships between these components.
4. Cite three criteria that are important in the materials selection process.
5. List the three primary classifications of solid materials, and then cite the distinctive chemical feature of each.

Chapter 2 Atomic Structure and Interatomic Bonding

1. Name the two atomic models cited, and note the differences between them.
2. Describe the important quantum-mechanical principle that relates to electron energies.
3. (a) Schematically plot attractive, repulsive, and net energies versus interatomic separation for two atoms or ions.
   (b) Note on this plot the equilibrium separation and the bonding energy.
4. (a) Briefly describe ionic, covalent, metallic, hydrogen, and van der Waals bonds.
   (b) Note what materials exhibit each of these bonding types.

Chapter 3 The Structure of Crystalline solids

1. Describe the difference in atomic/molecular structure between crystalline and noncrystalline materials.
2. Draw unit cells for face-centered cubic, bodycentered cubic, and hexagonal close-packed crystal structures.
3. Derive the relationships between unit cell edge length and atomic radius for face-centered cubic and body-centered cubic crystal structures.
4. Compute the densities for metals having facecentered cubic and body-centered cubic crystal structures given their unit cell dimensions.
5. Given three direction index integers, sketch the direction corresponding to these indices within a unit cell.
6. Specify the Miller indices for a plane that has been drawn within a unit cell.
7. Describe how face-centered cubic and hexagonal close-packed crystal structures may be generated by the stacking of close-packed planes of atoms.
8. Distinguish between single crystals and polycrystalline materials.
9. Define isotropy and anisotropy with respect to material properties.

Chapter 4 Imperfections in Solids

1. Describe and draw the defects in the material.
2. For an alloy, compute the weight and atomic percent of each element.
3. Define the terms microstructure & microscopy.
4. Given a photomicrograph of a polycrystalline material, as well as the magnification, determine the grain size using intercept and ASTM methods.

Chapter 5 Diffusion

1. Name and describe the two atomic mechanisms of diffusion.
2. Distinguish between steady-state and nonsteady-state diffusion.

Chapter 6 Mechanical Properties of Metals

1. Concepts of Stress and Strain
2. Stress-Strain Behavior 6.4 Anelasticity
3. Elastic Properties of Materials 6.6 Tensile Properties
4. True Stress and Strain
5. Elastic Recovery During Plastic Deformation
6. Compressive, Shear, and Torsional Deformation
7. Hardness
8. Variability of Material Properties
9. Design/Safety Factors

Chap 7 Dislocations and Strengthening Mechanisms

1. The characteristics of dislocations and their involvement in plastic deformation.
2. Several techniques are presented for strengthening single-phase metals, the mechanism of which are described in terms of dislocation.
3. The latter sections of this chapter are concerned with recovery and recrystallization —processes that occur in plastically deformation metals, normally at elevated temperatures.
4. Grain growth.

Chapter 8 Failure

1. Describe the mechanism of crack propagation for both ductile and brittle modes of fracture.
2. Explain why the strengths of brittle materials are much lower than predicted by theoretical calculations.
3. Define fracture toughness in terms of (a) a brief statement, and (b) an equation; define all

parameters in this equation.
4. Make distinctions between stress intensity factor, fracture toughness, and plane strain fracture toughness.
5. Name and describe the two impact fracture testing techniques.
6. Define fatigue and specify the conditions under which it occurs.
7. From a fatigue plot for some material, determine (a) the fatigue lifetime (at a specified stress level), and (b) the fatigue strength (at a specified number of cycles).
8. Define creep and specify the conditions under which it occurs.
9. Given a creep plot for some material, determine
(a) the steady state creep rate, and (b) the rupture lifetime.

Chapter 9 Phase Diagram

1. (a) Schematically sketch simple isomorphous and eutectic phase diagrams.
   (b) On these diagrams label the various phase regions.
   (c) Label liquidus, solidus, and solvus lines.
2. Given a binary phase diagram, the composition of an alloy, its temperature, and assuming that the alloy is at equilibrium,
   determine:(a) what phase(s) is (are) present;(b) the composition(s) of the phase(s); and (c) the mass fraction(s) of the phase(s).
3. For some given binary phase diagram, do the following:
(a) locate the temperatures and compositions of all eutectic, eutectoid, peritectic, and congruent phase transformations; and
(b) write reactions for all these transformations for either heating or cooling.
4. Given the composition of an iron – carbon alloy containing between 0.022 wt% C and 2.14 wt% C, be able to
(a) specify whether the alloy is hypoeutectoid or hypereutectoid; (b) name the proeutectoid phase; (c) compute the mass fractions of proeutectoid phase and pearlite; and(d) make a schematic diagram of the microstructure at a temperature just below the eutectoid.

Ch10. Gibbs Free Energy Composition and Phase Diagrams of Binary Systems

1.Introduction
2.Gibbs Free Energy and Thermodynamic Activity
3.The Gibbs Free Energy of Formation of Regular Solution
4.Criteria for Phase Stability in Regular Solution
5.Liquid and Solid Standard States
6.Phase Diagrams, Gibbs Free Energy, and Thermodynamic Activity