

NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY
FACULTY OF INDUSTRIAL TECHNOLOGY
DEPARTMENT OF INDUSTRIAL AND MANUFACTURING ENGINEERING
BEng Degree in Civil and Water Engineering
PART II SECOND SEMESTER EXAMINATION MAY 2011
MATERIALS SCIENCE – TCW 1202

INSTRUCTIONS

Answer any four Questions

Total Marks 100

Time 2 hour

Question 1

Discuss the various ways which can be used to protect mild steel pipelines laid underground or in contact with the ground from corrosion. Include the oxidation and reduction reactions occurring during corrosion of steel, and illustrations where appropriate. **[25 marks]**

Question 2

- a. Explain why concrete is attractive as a construction material? **[6 marks]**
- b. How can the properties of concrete be enhanced? **[9 marks]**
- c. Outline the procedure used in determining relative phase amounts from a binary phase diagram. **[7 marks]**
- d. What is the significance of a eutectic point on a binary eutectic phase diagram? **[3 marks]**

Question 3

- a. Define the following material properties
- i. Thermal conductivity [3 marks]
 - ii. Rigidity [3 marks]
 - iii. Hardness [3 marks]
 - iv. Creep resistance [3 marks]
- b. Describe how a tensile test is conducted and give the mechanical properties that are determined from the test. [13 marks]

Question 4

- a. Using the Bohr atomic model describe the basic structure of an atom, giving the symbols associated with the subatomic particles, their relative masses and charges. [10 marks]
- b. Briefly explain the difference between ionic, metallic, and covalent bonding. [6 marks]
- c. Sketch the FCC unit cell and state two metals which display that structure. [4 marks]
- d. Show that the atomic packing factor for the FCC structure is 0.74. [5 marks]

Question 5

- a. Why are alloys preferred to pure metals for structural applications? [5 marks]
- b. Explain with suitable examples the meaning of 'structural applications'. [6 marks]
- c. Apart from metals and their alloys, which other classes of materials can be used in construction and why? [6 marks]
- d. Discuss the uses of polymers. [8 marks]

Question 6

- a. One way to strengthen metals is by annealing. Describe how annealing is conducted. **[6 marks]**
- b. Discuss the mechanical and structural changes that occur in a metal on annealing. **[9 marks]**
- c. For a brass alloy, yielding begins at 346 MPa, and the stiffness is 105 GPa.
- i. Determine the maximum load that may be applied to a specimen with a cross sectional area of 130 mm² without plastic deformation. **[5 marks]**
 - ii. If the original specimen length is 75 mm, what is the maximum length to which it may be stretched without causing plastic deformation? **[5 marks]**

End of exam