THE OPEN UNIVERSITY OF SRI LANKA
FACULTY OF ENGINEERING TECHNOLOGY
DIPLOMA IN TECHNOLOGY – LEVEL 4
FINAL EXAMINATION 2005/2006
MEX 4233/MED 2204 – MATERIALS ENGINEERING – PART B
DATE : 22ND MARCH 2006
TIME : 1015-1230 HRS
DURATION : 2 HOURS AND 15 MINUTES

ANSWER FIVE QUESTIONS ONLY. ALL QUESTIONS CARRY EQUAL MARKS.

PART B

1. (a) Define the following terms.
   (i) Crystal structure
   (ii) Unit cell
   (iii) Atomic Packing factor

(b)Gold belongs to the cubic crystal system with an atomic mass of 196.97 g/mol. The lattice constant of gold is 4.0788×10^{-10} m and its density is 19.3 g/cm^3.

   (i) Determine the number of atoms per unit cell of gold, and identify the type of the unit cell. Take the Avogadro's number as 6.023×10^{23} mol^{-1}.
   (ii) Determine the atomic radius of gold.

2. (a)Explain the meaning of "toughness" with particular reference to mechanical properties of materials.

   Distinguish clearly between notch-impact toughness and fracture toughness.

(b)Discuss the effect of strain rate and temperature on the toughness of engineering materials.

(c)Describe how the ductile-brittle transition temperature of a given material is experimentally determined.

3. (a) Derive the lever rule for a Binary system.

(b) Consider 1 kg of plain carbon steel containing 1.1 wt% of C, heated to 1000°C, held for a long period, and then slowly cooled to a temperature below 650° C. Using Fig. (3) answer the following.

   (i) What are the equilibrium phase or phases at 1000°C and their compositions?
   (ii) At what temperature does the pro eutectoid phase start to form?
   What is the name and the composition of this pro eutectoid phase?
   (iii) At 650°C, how many kilograms each of total ferrite and cementite form?

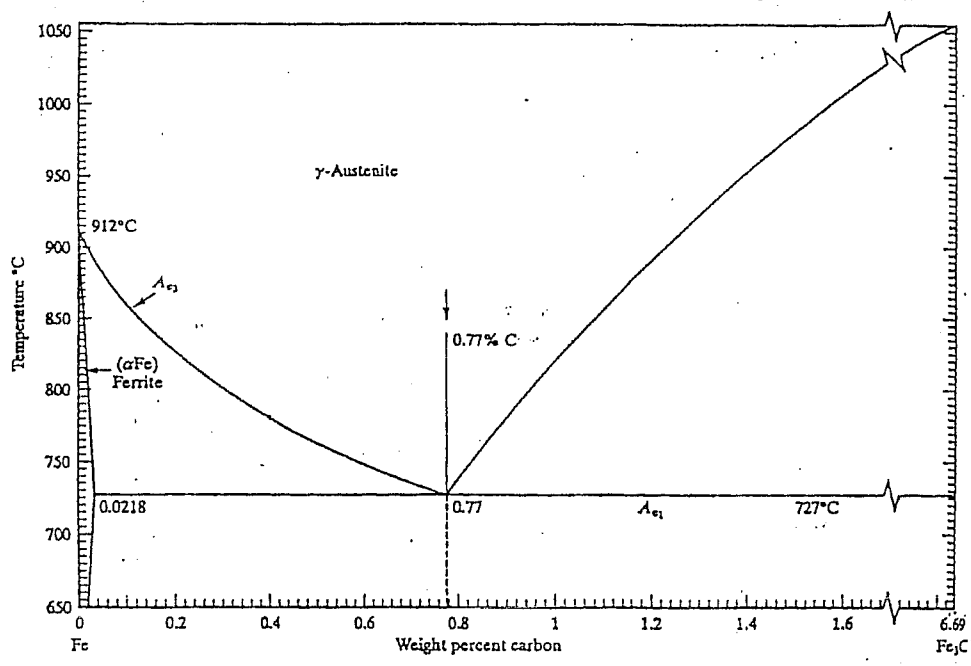

Fig.3

4. (a) State Flick's first and second laws of Diffusion.

(b) During a carburizing experiment diffusivity at the temperature of 850°C was found to be 7.4×10^{-8} cm^2/sec. The depth of the carburized layer when the specimen was held for 4 hours at 850°C was found to be the same when it was held for 1 hour at 950°C. In the second case the surface of the specimen had a carbon content of 1.2%, whereas in the first case it was 0.2%.

(i) Calculate the diffusivity at 950°C.

(ii) Find the carburizing time to achieve a carbon content of 0.4% at a depth of 1 mm at 950°C. The error function values are given in the table below.

Z	erfZ
0.2	0.2227
0.4	0.4284
0.6	0.6039
0.8	0.7421
1.0	0.8427

(iii) Compute the activation energy for the process.
(Assume k – Boltzmann's constant = 8.6×10^{-5} eV K^{-1})

5. Discuss and analyze the significance of any **two** of the following from an engineering point of view.

(i) TTT curves
(ii) Plastics
(iii) Fatigue limit or the endurance limit
(iv) Mechanical properties of materials

6. (a) Describe the following three major polymer categories with the aid of diagrams showing their general structure.
(i) Thermoplastics
(ii) Thermosets
(iii) Elastomers

(b) Molecular weight data for a Polytetra-Fluoroethylene (PTFE) material are tabulated below. Compute the following.
(i) The number average molecular weight
(ii) The weight average molecular weight
(iii) The number average degree of polymerization
(Atomic weight of C =12.01, F = 19)

Molecular weight range (g/mole)	X_i	W_i
10,000-20,000	0.03	0.01
20,000-30,000	0.09	0.04
30,000-40,000	0.15	0.11
40,000-50,000	0.25	0.23
50,000-60,000	0.22	0.24
60,000-70,000	0.14	0.18
70,000-80,000	0.08	0.12
80,000-90,000	0.04	0.07

7.(a) Discuss the advantages of using composite materials in engineering applications giving at least two examples.

(b) Identify and describe the types of bonds present in ceramic materials.

(c) Explain how chain silicate structure and sheet silicate structure are produced by the basic tetrahedron silicate structure.

8.(a) Draw a typical creep curve for a metal under a constant load and at a relatively high temperature. Briefly explain all three stages of creep.

(b) Two Aluminium samples were tested for creep at 200°C with one sample subjected to a stress of 60 MPa and the other 35 MPa. The following observations were made.

Time (Hr)	Strain at 60 MPa (mm/mm)	Strain at 35 MPa (mm/mm)
0	0.320	0.108
20	0.532	0.215
60	0.815	0.332
90	1.000	0.400
120	1.200	0.477
140	1.320	0.532
170	1.477	0.610
220	1.800	0.723

(i) Plot strain-time characteristic curves and evaluate the steady state creep rates for each stress.

(ii) Calculate the value of stress that would give rise to a minimum creep rate of 4.8×10^{-3} hr^{-1}. Assume that the material follows the Norton equation, $d\varepsilon/dt = C\,\sigma^n$, where C and n are material constants.

9. (a) Describe and differentiate crevice corrosion and stress corrosion cracking.

(b) Explain the methods of prevention of stress corrosion cracking.

(c) What is Pilling – Bed Worth ratio?

(d) Explain, how the oxidation resistance of a metal can be increased by alloying.