

INTI

INTERNATIONAL COLLEGE PENANG (507232-U)
LAUREATE INTERNATIONAL UNIVERSITIES

FINAL
Examination Paper
(COVER PAGE)

 INTI LIBRARY
INTI INTERNATIONAL COLLEGE PENANG

Session : August 2012

Programme : Diploma in Electrical and Electronic Engineering Programme

Course : EGM1182 : Structures and Properties of Materials

Date of Examination : 14 December 2012

Time : 11 a.m. – 1p.m Reading Time : Nil

Duration : 2 Hours

Special Instructions :

This paper consists of **SIX (6)** questions. Answer any **FOUR (4)** questions in the answer booklet provided. All questions carry equal marks.

Materials permitted : Nil

Materials provided : Periodic Table

Examiner(s) : Phua Chin Lai

Moderator : Hemalatha Murugiah

This paper consists of 7 printed pages, including the cover page.

INTI INTERNATIONAL COLLEGE PENANG

DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING PROGRAMME (DEEI)
 EGM 1182: STRUCTURES AND PROPERTIES OF MATERIAL
 FINAL EXAMINATION: AUGUST 2012 SESSION

Instructions: This paper consists of SIX (6) questions. Attempt any FOUR (4) questions in the answer booklet provided. All questions carry equal marks.

Question 1

(a) Give the electron configurations for the Fe^{3+} and S^{2-} ions. (4 marks)

(b) Do noncrystalline materials display the phenomenon of allotropy (or polymorphism)? Explain why? (3 marks)

(c) Of those materials listed in Table 1,

Material	Yield Strength (MPa)	Tensile Strength (MPa)	Strain at Fracture	Fracture Strength (MPa)	Elastic Modulus (GPa)
A	310	340	0.23	265	210
B	100	120	0.40	105	150
C	415	550	0.15	500	310
D	700	850	0.14	720	210
E	Fractures before yielding			650	350

Table 1

- (i) Which material will experience the greatest percent reduction in area? Why?
 (ii) Which material is the strongest? Why?
 (iii) Which material is the stiffest? Why? (9 marks)
- (d) Briefly explain the main differences between ionic, covalent, and metallic bonding. (9 marks)

Question 2

(a) A copper-nickel alloy of composition 70 wt% Ni-30 wt% Cu is slowly heated from a temperature of 1300°C. Refer to Figure 2a.

- (i) At what temperature does the first liquid phase form?
 (ii) What is the composition of this liquid phase?
 (iii) At what temperature does complete melting of the alloy occur?
 (iv) What is the composition of the last solid remaining prior to complete melting? (4 marks)

INTI LIBRARY
INTI INTERNATIONAL COLLEGE PENANG

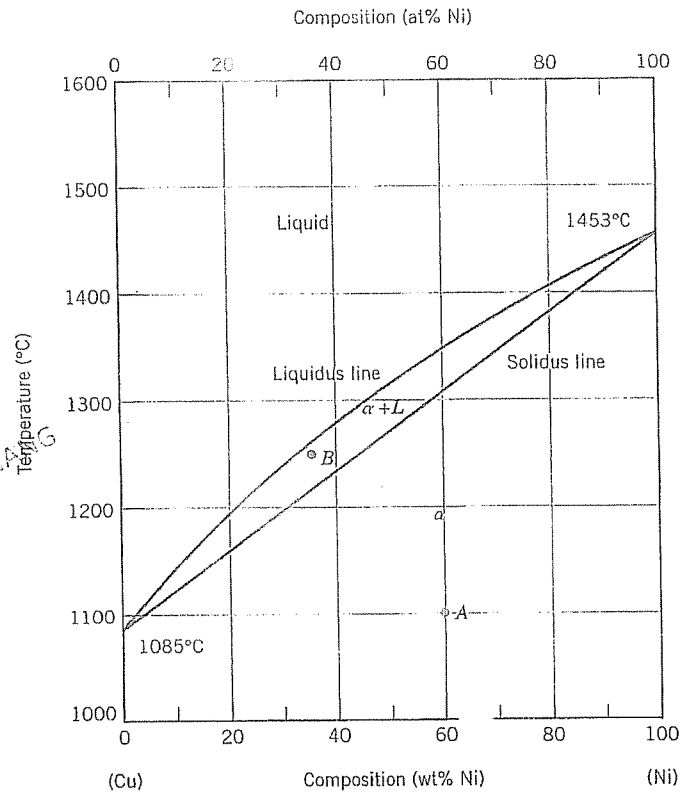


Figure 2a

(b) (i) If the atomic radius of aluminum is 0.143 nm, calculate the volume of its unit cell in cubic meters. Which has a face-centered cubic structure.

(5 marks)

(ii) Calculate the radius of a vanadium atom, given that V has a BCC crystal structure, a density of 5.96 g/cm³, and an atomic weight of 50.9 g/mol.

(5 marks)

(c) Determine the Miller indices for the A and B plane shown in the following unit cell (Figure 2b).

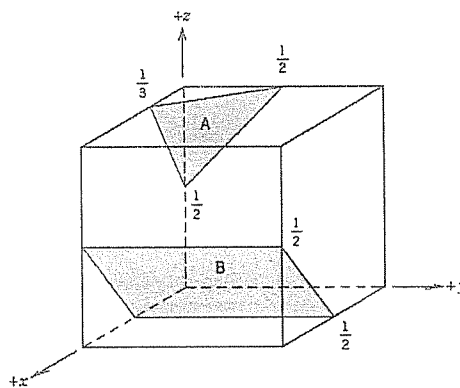


Figure 2b

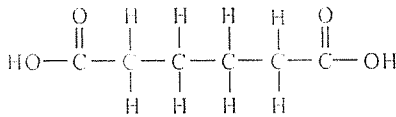
(6 marks)

(d) What is the composition, in atom percent, of an alloy that consists of 30 wt% Zn and 70 wt% Cu?

(5 marks)

Question 3

- (a) Nylon 6,6 may be formed by means of a condensation polymerization reaction in which hexamethylene diamine $[\text{NH}_2-(\text{CH}_2)_6-\text{NH}_2]$ and adipic acid react with one another with the formation of water as a by-product. Write out this reaction in the manner of chemical equation. Note: the structure for adipic acid is



INTI INTERNATIONAL COLLEGE PENANG

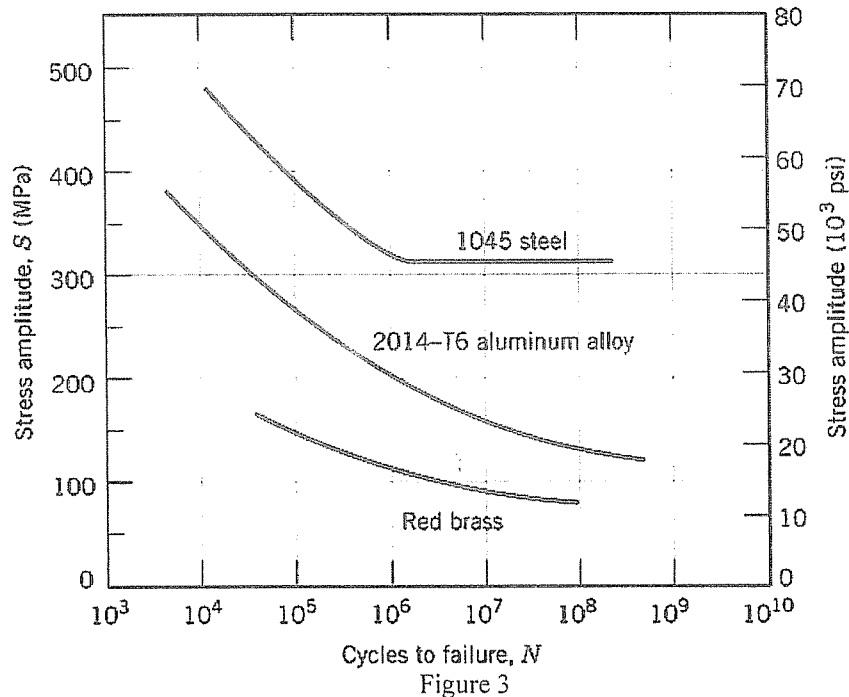
(4 marks)

- (b) (i) A specimen of aluminum having a rectangular cross section $12 \text{ mm} \times 12.9 \text{ mm}$ is pulled in tension with $35,600 \text{ N}$ force, producing only elastic deformation. Calculate the resulting strain. Given the elastic modulus for Al is 69 GPa (or $69 \times 10^9 \text{ N/m}^2$). (3 marks)

- (ii) A cylindrical specimen of a titanium alloy having an elastic modulus of 108 GPa and an original diameter of 3.9 mm will experience only elastic deformation when a tensile load of 2000 N is applied. Compute the maximum length of the specimen before deformation if the maximum allowable elongation is 0.42 mm . (3 marks)

- (c) Briefly explain the differences between recovery and recrystallization processes. (5 marks)

- (d) A 12.5 mm diameter cylindrical rod fabricated from a 2014-T6 aluminium alloy (Figure 3) is subjected to a repeated tension-compression load cycling along its axis. Compute the maximum and minimum loads that will be applied to yield a fatigue life of 1.0×10^7 cycles. Assume that the stress plotted on the vertical axis is stress amplitude, and data were taken for a mean stress of 50 MPa .



(10 marks)

Question 4

(a) (i) What is the difference between hypoeutectoid and hypereutectoid steels? (4 marks)

(ii) In a hypoeutectoid steel, both eutectoid and proeutectoid ferrite exist. Explain the difference between eutectoid and proeutectoid ferrite in hypoeutectoid steel. (4 marks)

(b) Show that the minimum cation-to-anion radius ratio for a coordination number of 4 is 0.225, given the supporting diagram in Figure 4.

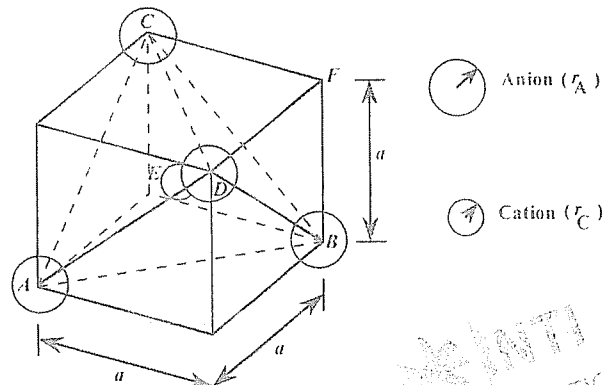
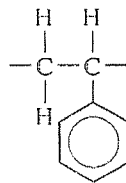


Figure 4

(10 marks)

(c) (i) Compute the repeat unit molecular weight of polystyrene. Given the repeating unit of polystyrene as



(5 marks)

(ii) Compute the number-average molecular weight for a polystyrene for which the degree of polymerization is 26,000. (2 marks)

Question 5

(a) For a ceramic compound, what are the two characteristics of the component ions that determine the crystal structure? (4 marks)

(b) Define or briefly explain the following:

(i) hardening of steels

(ii) normalizing of steels

(5 marks)

(c) (i) Compute the electrical conductivity of a 5.0 mm diameter cylindrical silicon specimen 50 mm long in which a current of 0.1 A passes in an axial direction. A voltage of 12.5 V is measured across two probes that are separated by 38 mm. (5 marks)

(ii) Compute the resistance over the entire 50 mm of the specimen. (3 marks)

(d) At room temperature the electrical conductivity and the electron mobility for copper are $6.0 \times 10^7 (\Omega \cdot \text{m})^{-1}$ and $0.0030 \text{ m}^2/\text{V} \cdot \text{s}$, respectively. Given the electron charge as $1.602 \times 10^{-19} \text{ C}$.

(i) Compute the number of free electrons per cubic meter for copper at room temperature.

(ii) What is the number of free electrons per copper atom? Assume a density of 8.9 g/cm^3 . (8 marks)

Question 6

(a) What type(s) of bonding would be expected for each of the following materials:

- (i) brass (copper-zinc alloy),
- (ii) rubber,
- (iii) barium sulfide (BaS),
- (iv) solid xenon.

(5 marks)

(b) Iodine has an orthorhombic unit cell for which the a , b , and c lattice parameters are 0.481, 0.720, and 0.981 nm, respectively.

(i) If the atomic packing factor and atomic radius are 0.547 and 0.177 nm, respectively, determine the number of atoms in each unit cell. (a simple orthorhombic structure shown in Figure 6)

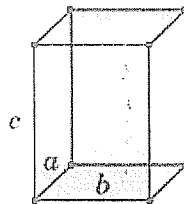


Figure 6

(7 marks)

(ii) The atomic weight of iodine is 126.91 g/mol; compute its theoretical density. (4 marks)

(c) Calculate the composition, in weight percent, of an alloy that contains 218.0 kg titanium, 15 kg of aluminum, and 10 kg of vanadium. (3 marks)

(d) Describe and illustrate with sketches the solidification process of a pure metal in terms of the nucleation and growth of crystals. (6 marks)

--THE END--

EGM 1182(F)AUG 12/CL PHUA/14/10/12