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INTERNATIONAL COLLEGE PENANG (507232-U)
LAUREATE INTERNATIONAL UNIVERSITIES

FINAL
Examination Paper

(COVER PAGE)

Session	:	January 2013
Programme	:	Diploma in Electrical and Electronic Engineering Programme
Course	:	**EGM1182 : Structures and Properties of Materials**
Date of Examination	:	4 March 2013
Time	:	11a.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**

This paper consists of 6 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: JANUARY 2013 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 Al^{3+} ion and atom of oxygen. (4 marks)

(b) Calculate the radius of an iridium atom, given that Ir has an FCC crystal structure, a density of 22.4 g/cm^3, and an atomic weight of 192.2 g/mol.
(4 marks)

(c) Derive planar density expressions for FCC (100) and (111) planes in terms of the atomic radius *R*. (8 marks)

(d) What is the difference between crystal structure and amorphous structure? And distinguish between elastic and plastic deformation of metal. (9 marks)

Question 2

(a) What is the composition, in weight percent, of an alloy that consists of 6 atomic % Pb and 94 atomic % Sn?
(4 marks)

(b) In your own words and with the information from Figure Q2, briefly describe the following heat treatment procedures for steel in full annealing and normalizing.
(10 marks)

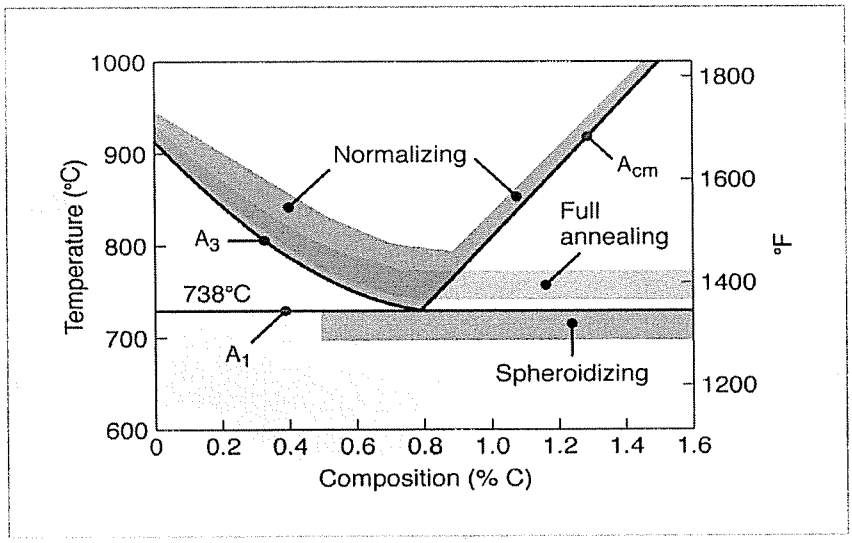

Figure Q2

(c) What is the main difference between heat-treatable and non-heat-treatable alloys?

(2 marks)

(d) Compute the atomic packing factor for the cesium chloride structure in which eight chloride anions surround a central cesium cation at the (½ , ½ , ½) position in an unit cell. Given $r_{cation}/r_{anion} = 0.735$.

(9 marks)

Question 3

(a) A cylindrical rod 380 mm long, having a diameter of 10.0 mm, is to be subjected to a tensile load. If the rod is to experience neither plastic deformation nor an elongation of more than 0.9 mm when the applied load is 24,500 N, which of the four metals or alloys listed in Table Q3 are possible candidates? Justify your choice(s).

(10 marks)

Material	*Modulus of Elasticity (GPa)*	*Yield Strength (MPa)*	*Tensile Strength (MPa)*
Aluminum alloy	70	255	420
Brass alloy	100	345	420
Copper	110	250	290
Steel alloy	207	450	550

Table Q3

(b) A cubic plane has the following axial intercepts: $x = -\frac{1}{2}$, $y = -\frac{1}{2}$ and $z = \frac{2}{3}$. What are the Miller indices of this plane and show the plane in a cubic crystallograhics unit cell.

(7 marks)

(c) Briefly explain what is meant by terms:

(i) Allotropy or polymorphism and give an example of allotropic material. (4 marks)

(ii) Crystalline and give the three most common crystalline structures found in metals

(4 marks)

Question 4

(a) A 1.5-kg specimen of a 90 wt% Pb-10 wt% Sn alloy is heated to 250°C; at this temperature it is entirely an α-phase solid solution (Figure Q4). The alloy is to be melted to the extent that 50% of the specimen is liquid, the remainder being the α-phase.

(i) This may be accomplished by either heating the alloy, to what temperature must the specimen be heated? (2 marks)

(ii) OR changing its composition while holding the temperature constant. How much tin must be added to the 1.5-kg specimen at 250°C to achieve this state?

(8 marks)

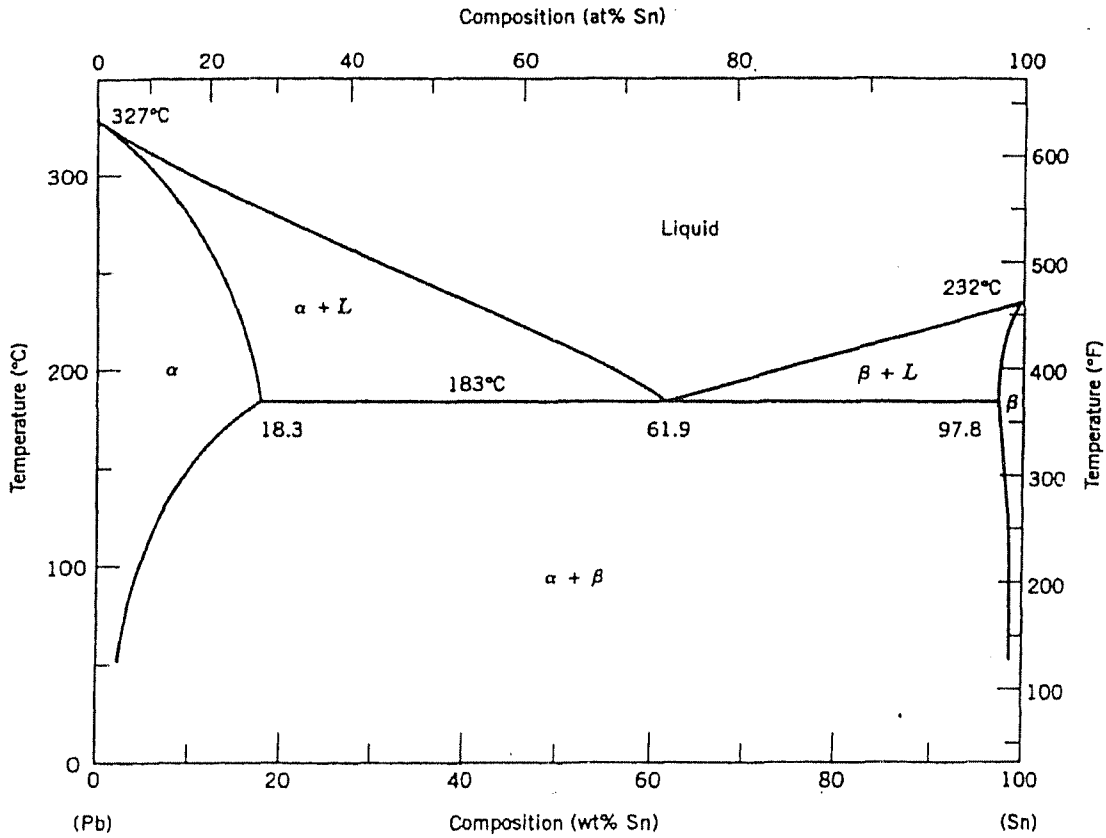

Figure Q4

(b) Silver atoms can be regarded as spheres having a radius R of 1.44 Å. Silver metal has an FCC (Face-centered cubic) structure. On the assumption that silver atoms are just in contact along the direction of closest packing in the crystal. Show the relationship of lattice parameter a with the atomic radius R, and what is the lattice parameter of silver in terms of nm. (Given 1 Å = 10^{-10} m)

(5 marks)

(c) Define the following terms:
(i) electrical conductivity
(ii) p-type extrinsic semiconductor
(iii) electron drift velocity
(iv) band gap energy

(10 marks)

Question 5

(a) Describe the three stages in the ductile fracture of a metal. (9 marks)

(b) Twenty-cm-long rod with a diameter of 0.250 cm is loaded with a 5000 N weight. If the diameter decreases to 0.210 cm, determine
(i) the engineering stress and strain at this load and
(ii) the true stress and strain at this load.

(8 marks)

(c) Define the polymeric materials
(i) plastics
(ii) elastomers. (6 marks)

Question 6

(a) Draw a section of the graphite structure. Why are the layers of graphite able to slide past each other easily?

(6 marks)

(b) In polymerization of polymer,
(i) define the degree of polymerization.

(ii) what is a monomer? Explain with an example. (6 marks)

(c) The room temperature electrical conductivity of a silicon specimen is 10^3 $(\Omega.m)^{-1}$. The hole concentration is known to be 1.0×10^{23} m^{-3}. The electron and hole mobility for silicon are 0.14 $m^2/V.s$ and 0.05 $m^2/V.s$ respectively.

(i) Compute the electron concentration.

(ii) Based on the obtained result above, is the specimen intrinsic, n-type extrinsic or p-type extrinsic? Explain why?

(6 marks)

(d) Draw the crystallographic plane for the following

(i) Plane (1 1 1) in a FCC unit cell and list the position coordinate of the atoms, whose center is the intersect of the plane (1 $\bar{1}$ 1),

(4 marks)

(ii) Hexagonal crystal plane with Miller-Bravais indices ($\bar{1}$ 2 $\bar{1}$ 0) (3 marks)

--THE END--

PERIODIC TABLE

																	2 He 4·003 Helium
			1 H 1·008 Hydrogen									5 B 10·81 Boron	6 C 12·01 Carbon	7 N 14·01 Nitrogen	8 O 16·00 Oxygen	9 F 19·00 Fluorine	10 Ne 20·18 Neon
3 Li 6·941 Lithium	4 Be 9·012 Beryllium											13 Al 26·98 Aluminium	14 Si 28·09 Silicon	15 P 30·97 Phosphorus	16 S 32·07 Sulfur	17 Cl 35·45 Chlorine	18 Ar 39·95 Argon
11 Na 22·99 Sodium	12 Mg 24·31 Magnesium																
19 K 39·10 Potassium	20 Ca 40·08 Calcium	21 Sc 44·96 Scandium	22 Ti 47·88 Titanium	23 V 50·94 Vanadium	24 Cr 52·00 Chromium	25 Mn 54·94 Manganese	26 Fe 55·85 Iron	27 Co 58·93 Cobalt	28 Ni 58·69 Nickel	29 Cu 63·55 Copper	30 Zn 65·39 Zinc	31 Ga 69·72 Gallium	32 Ge 72·59 Germanium	33 As 74·92 Arsenic	34 Se 78·96 Selenium	35 Br 79·90 Bromine	36 Kr 83·80 Krypton
37 Rb 85·47 Rubidium	38 Sr 87·62 Strontium	39 Y 88·91 Yttrium	40 Zr 91·22 Zirconium	41 Nb 92·91 Niobium	42 Mo 95·94 Molybdenum	43 Tc 98·91 Technetium	44 Ru 101·1 Ruthenium	45 Rh 102·9 Rhodium	46 Pd 106·4 Palladium	47 Ag 107·9 Silver	48 Cd 112·4 Cadmium	49 In 114·8 Indium	50 Sn 118·7 Tin	51 Sb 121·8 Antimony	52 Te 127·6 Tellurium	53 I 126·9 Iodine	54 Xe 131·3 Xenon
55 Cs 132·9 Cesium	56 Ba 137·3 Barium	57 La 138·9 Lanthanum	72 Hf 178·5 Hafnium	73 Ta 180·9 Tantalum	74 W 183·9 Tungsten	75 Re 186·2 Rhenium	76 Os 190·2 Osmium	77 Ir 192·2 Iridium	78 Pt 195·1 Platinum	79 Au 197·0 Gold	80 Hg 200·6 Mercury	81 Tl 204·4 Thallium	82 Pb 207·2 Lead	83 Bi 209·0 Bismuth	84 Po — Polonium	85 At — Astatine	86 Rn — Radon
87 Fr — Francium	88 Ra 226·0 Radium	89 Ac — Actinium	104	105	106												

KEY

Atomic Number / Atomic Mass — 79 Au 197·0 Gold — Symbol of element / Name of element

58 Ce 140·1 Cerium	59 Pr 140·9 Praseodymium	60 Nd 144·2 Neodymium	61 Pm — Promethium	62 Sm 150·4 Samarium	63 Eu 152·0 Europium	64 Gd 157·3 Gadolinium	65 Tb 158·9 Terbium	66 Dy 162·5 Dysprosium	67 Ho 164·9 Holmium	68 Er 167·3 Erbium	69 Tm 168·9 Thulium	70 Yb 173·0 Ytterbium	71 Lu 175·0 Lutetium
90 Th 232·0 Thorium	91 Pa 231·0 Protactinium	92 U 238·0 Uranium	93 Np 237·0 Neptunium	94 Pu — Plutonium	95 Am — Americium	96 Cm — Curium	97 Bk — Berkelium	98 Cf — Californium	99 Es — Einsteinium	100 Fm — Fermium	101 Md — Mendelevium	102 No — Nobelium	103 Lr — Lawrencium

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