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FINAL
Examination Paper

(COVER PAGE)

Session	:	April 2014
Programme	:	Diploma in Electrical and Electronic Engineering (DEEI)
Course	:	**EGM 1182: Structures and Properties of Materials**
Date of Examination	:	24 JULY 2014
Time	:	8.00am – 10.00pm Reading Time : Nil
Duration	:	2 Hours
Special Instructions	:	

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

Materials permitted :

Nil

Materials provided :

Periodic table

Examiner(s)	:	**Phua Chin Lai**
Moderator	:	**Dr. Cheah Kean Seng**

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: APRIL 2014 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) Calculate the number of atoms contained in a cylinder 1μm in diameter by 1μm deep of lead. Given the density of lead is 11.34 g/cm^3 and Avogadro's number is 6.022×10^{23}.

(5 marks)

(b) Suppose an element has a valence of 2 and atomic number 27. Based only on the quantum numbers. How many electrons must be present in the 3*d* energy level, list the electron configuration of this element and lastly provide the name of this element.

(3 marks)

(c) The density of silver is 10.49 g/cm^3. Calculate the number of electrons capable of conducting an electrical charge in 10 cm^3 of silver.

(7 marks)

(d) Define or briefly explain the following:

(i) Phase diagram (4 marks)
(ii) Alloy system (2 marks)
(iii) Eutectic (4 marks)

Question 2

(a) What is meant by the term *polymerization* and list 2 types of polymerization?

(7 marks)

(b) A typical paper clip weighs 0.59 g and consists of BCC iron. Given the density of iron is 7.87 g/cm^3, lattice constant of BCC is 0.289 nm. Calculate
(i) The number of unit cells; and
(ii) The number of iron atoms in the paper clips

(6 marks)

(c) Determine the indices for the planes A, B and C in the cubic cell shown in Figure 2c.

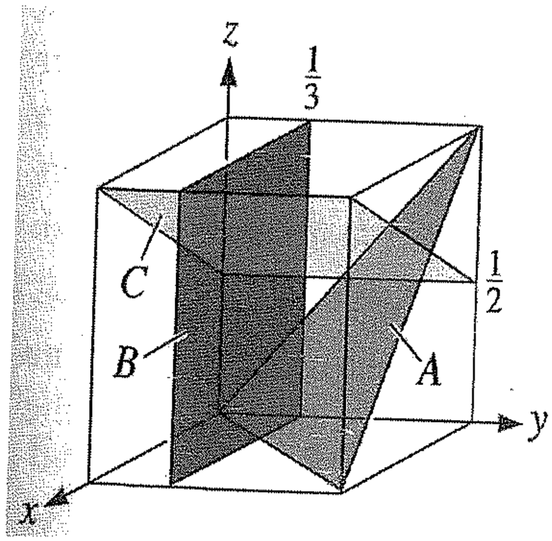

Figure 2c

(6 marks)

(d) Determine the indices for the directions in cubic unit cell shown in Figure 2d

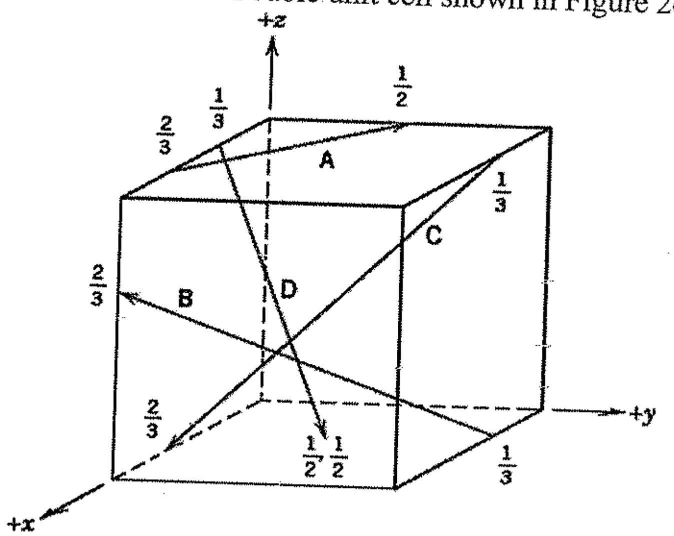

Figure 2d

(6 marks)

Question 3

(a) When making hardness measurements, what will be the effect of making an indentation very close to a preexisting indentation? Why?

(4 marks)

(b) A force of 100,000 N is applied to a 10 mm × 20 mm iron bar having a yield strength of 400 MPa and a tensile strength of 480 MPa. Determine whether the bar will plastically deform; and whether the bar will experience necking. State your reason as well.

(7 marks)

(c) Suppose that we would like a part produced from the acetal polymer shown in Figure 3c to survive for one million cycles under conditions that provide for equal compressive and tensile stresses.

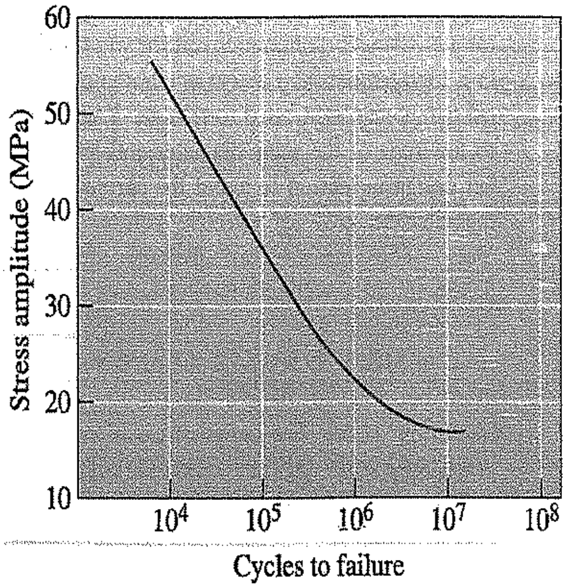

Figure 3c

(i) What is the fatigue strength, or maximum stress amplitude required?

(ii) What are the maximum stress, minimum stress, and the mean stress on the part during its use?

(4 marks)

(d) Twenty-cm-long rod with a diameter of 0.250 cm is loaded with a 5500 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.

(10 marks)

Question 4

(a) One kg of an alloy of 70% Pb and 30% Sn is slowly cooled from 300°C. With reference to the lead-tin phase diagram in Figure 4a, calculate the following:

(i) What are the phases exist at 200°C? and what are the weight % of these phases?

(3 marks)

(ii) The weight % of these phases at 183°C + ΔT and their weight in kg.

(4 marks)

(iii) The weight in kg of eutectic α and β formed by the eutectic reaction.

(4 marks)

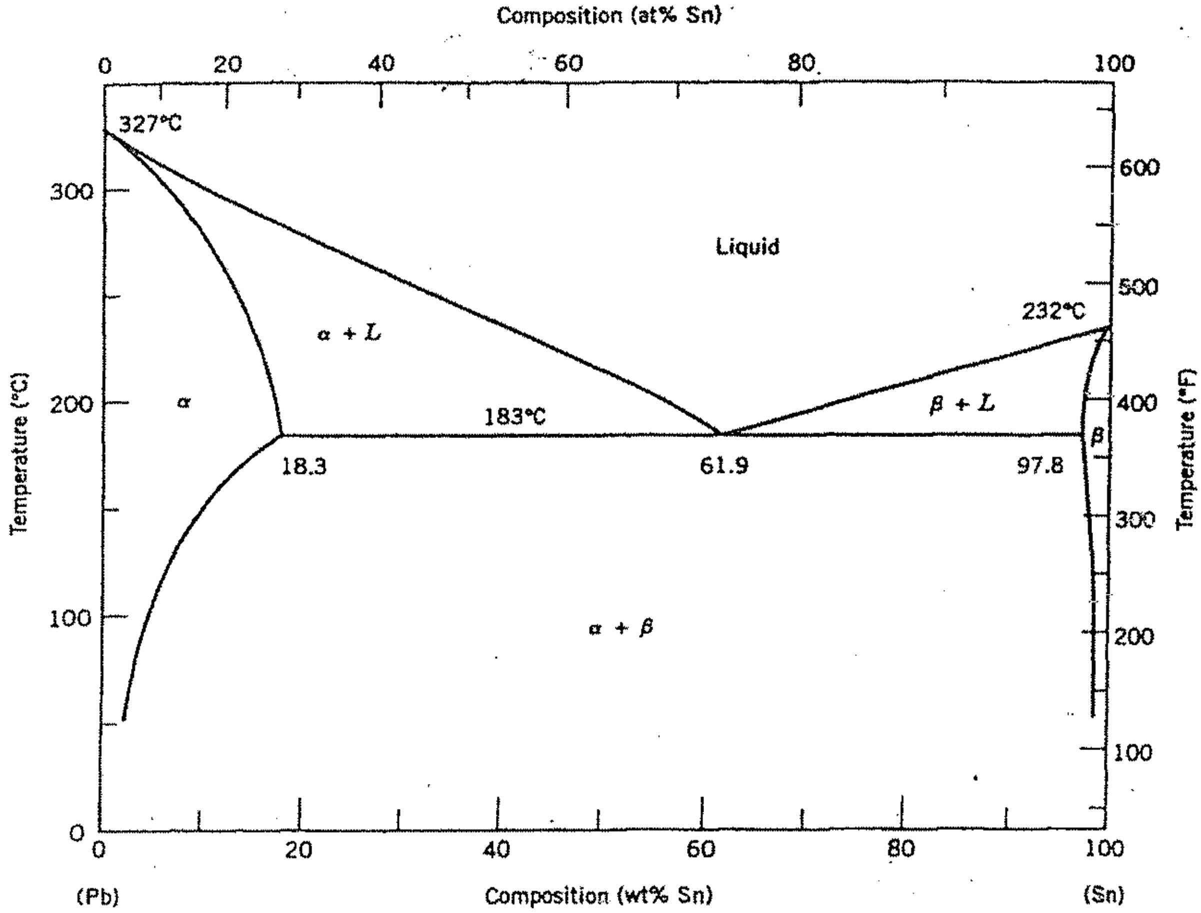

Figure 4a

(b) Explain the following terms obtained from fatigue testing of materials:

(i) Endurance limits

(4 marks)

(ii) Surface of fatigue failure

(4 marks)

(c) Calculate the electrical conductivity of pure copper at:

(i) 300°C

(ii) -100°C

Comment on your results obtained in terms of the effect of temperature on conductivity of copper with the given resistivity of copper at 0°C is $1.67 \times 10^{-6}\ \Omega.cm$ and its temperature resistivity coefficient is 0.0068/°C.

(6 marks)

Question 5

(a) The atomic weight, density, and atomic radius for three hypothetical alloys are listed in the following Table 5a. For each, determine whether its crystal structure is FCC or BCC and then justify your determination. Given the Avogadro's number is 6.022×10^{23}.

Alloy	*Atomic Weight (g/mol)*	*Density (g/cm³)*	*Atomic Radius (nm)*
A	107.6	13.42	0.133
B	50.9	5.97	0.132

Table 5a

(8 marks)

(b) List the four classifications of steels. For each, briefly provide one of its mechanical properties and typical applications.

(12 marks)

(c) Phosphorus is added to make an n-type silicon semiconductor with an electrical conductivity of $250\ \Omega \cdot m^{-1}$. Calculate the necessary number of charge carriers required.

(Assuming an electron mobility of $\mu_n = 0.1350\ m^2/(V.s)$, and absolute value of electron or hole charge is 1.6×10^{-19}C)

(5 marks)

Question 6

(a) Briefly describe the following types of secondary bonding:
- (i) fluctuating dipole,
- (ii) permanent dipole and provide an example.
- (iii) a choice between the noble gases krypton and xenon, which noble gas would be expected to have the strongest dipole bonding and why?

(12 marks)

(b) Describe the structure of a grain boundary. (3 marks)

(c) Calculate the radius of the largest interstitial void in BCC_α iron lattice. The atomic radius of the iron atom in this lattice is 0.124nm, and the largest interstitial void occurs at the (¼,½,0); (½,¾,0); (¾,½,0); and (½,¼,0), etc., type position.

(10 marks)

--THE END--

PERIODIC TABLE

KEY

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

1 H 1·008 Hydrogen																	2 He 4·003 Helium
3 Li 6·941 Lithium	4 Be 9·012 Beryllium											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
11 Na 22·99 Sodium	12 Mg 24·31 Magnesium											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
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												

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

This sheet case be REMOVED for your convenience.