INTI
INTERNATIONAL COLLEGE PENANG (507232-U)
LAUREATE INTERNATIONAL UNIVERSITIES

FINAL
Examination Paper

(COVER PAGE)

Session : AUGUST 2016

Programme : DIPLOMA IN ELECTRICAL & ELECTRONIC ENGINEERING

Course : **EGM1182: Structures and Properties of Materials**

Date of Examination : 7 December 2016 (Wednesday)

Time : 5:00pm – 7:00pm 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 :

Non-Programmable Calculator

Materials provided :

Examiner(s) : **Phua Chin Lai**

Moderator : **Prof. Dr. Cheong Kuan Yew**

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: Aug 2016 SESSION

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

Question 1

(a) A gold O-ring is used to form a gastight seal in a high vacuum chamber. The ring is formed a 80-mm length of 1.5-mm diameter wire. Calculate **the number of gold atoms** in the O-ring. Given the density of gold is 19.28 Mg/m^3, $N_A = 6.022 \times 10^{23}$.

(5 marks)

(b) Write the **electron configurations** of manganese by using ***spdf*** notation and determine the **number of valence electron**. Then write the **electron configurations** of its ion.

(5 marks)

(c) Given the atomic radius of nickel is 0.1243 nm. Determine the **planar density** of FCC nickel in the following planes.

(i) (1 0 0)
(ii) (1 1 0)

(9 marks)

(d) **Define the following terms** related to the mechanical behavior of materials

(i) Creep

(3 marks)

(ii) Intergranular

(3 marks)

Question 2

(a) Suppose we introduce one carbon atom for every 100 atoms in an interstitial position in a BCC iron, giving a lattice parameter of 0.2867 nm. For the Fe-C alloy, find **the density (in g/cm^3)** and **the atomic packing factor**. Given atomic radius of carbon is 0.077 nm and atomic radius of iron is 0.1241 nm.

(7 marks)

(b) (i) **Compute the electrical conductivity** of a 5 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.

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

(5 marks)

(c) **Calculate** the center to center separation distance (or **lattice constant**) of two Fe atoms along the [1 0 0] direction in an unstressed α – iron. Given the radius of iron atom is 0.124 nm.
Subsequently determine **the separation distance** of two atoms along the same direction under a tensile stress of 1000 MPa. Given the modulus of elasticity of α – iron as 125 GPa.

(8 marks)

(d) **Define the following terms** related to the polymer materials
(i) Branched polymer

(ii) Copolymer

(5 marks)

Question 3

(a) A 50 wt% Pb–50 wt% Mg alloy is slowly cooled from 700°C to 200°C. Refer to Figure Q3.

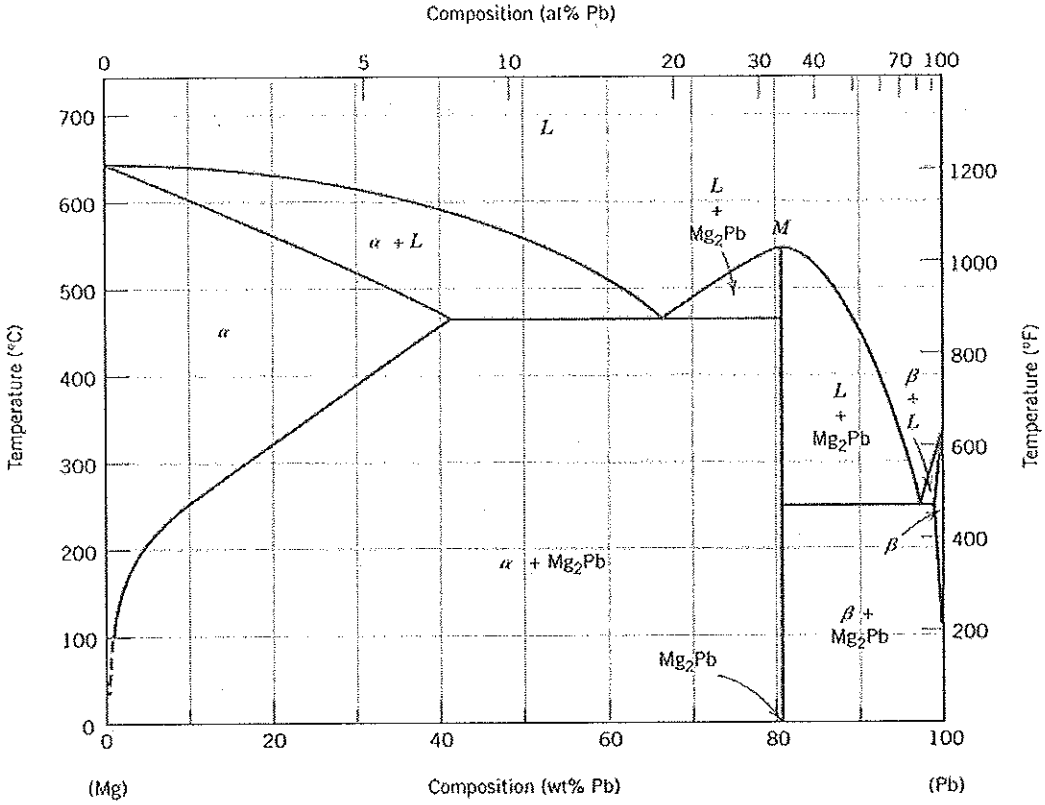

Figure Q3

(i) At what temperature does the first solid phase form? (2 marks)

(ii) What is the composition of Mg in this solid phase from (i)? (2 marks)

(iii) At what temperature does the liquid completely solidify? (2 marks)

(iv) What is the composition of Mg in this last remaining liquid phase prior to complete solidification? (2 marks)

(v) Determine the wt % of α phase when the temperature drop to 200°C. (2 marks)

(b) Make comparisons of thermoplastic and thermosetting polymers
(i) on the basis of **mechanical characteristics** upon heating, and

(ii) according to possible **molecular structures**.

(7 marks)

(c) A cylindrical specimen of aluminum having a diameter of 20 mm and length of 210 mm is deformed elastically in tension with a force of 48,800 N. The modulus of elasticity of aluminum is 69×10^9 N/m^2. Determine the following

(i) The amount by which this specimen will **elongate** in the direction of the applied stress.

(3 marks)

(ii) The **change in diameter** of the specimen. Will the diameter increase or decrease?

(5 marks)

Question 4

(a) True strain and engineering strain are denoted by ϵ_T and ε_E respectively.

(i) **Derive the relationship of true strain ϵ_T in term of engineering strain ε_E.** (Hint: Start with expression for engineering strain)

(4 marks)

(ii) **Derive a relationship of true stress σ_T in term of engineering stress σ_E and engineering strain ε_E.** (Hint: $\sigma_T = \frac{F}{A_0} \times \frac{A_0}{A_i}$, where F is the tensile force, A_0 and A_i are the original and instantaneous cross sectional area of specimen respectively)

(4 marks)

(b) **Briefly explain** the following:

(i) Proeutectoid α ferrite

(3 marks)

(ii) Martensite

(2 marks)

(iii) Cementite

(3 marks)

(c) Calculate **the density in grams per cubic centimeter** of CsI, which has the CsCl structure. Ionic radii of $Cs^+ = 0.165$ nm and $I^- = 0.220$ nm. $N_A = 6.022\times10^{23}$.

(9 marks)

Question 5

(a) **Sketch** in a cubic unit cell directions of [1 0 0] and [2 1 0] and **determine the angle** between these directions.

(5 marks)

(b) Calculate the **molecular weight** of chloroprene (a common synthetic rubber) with a degree of polymerization of 500. (The mer formula for chloroprene is C_4H_5Cl.)

(4marks)

(c) **Briefly explain** the following:

(i) Hardenability of steels (3 marks)

(ii) Cold working (3 marks)

(iii) Plastic deformation (3 marks)

(d) A current density of 100,000 A/cm^2 is applied to a 50 m long gold. A resistance of 2 Ω is measured along the wire. Calculate **the diameter** of the wire and the **voltage** imposed on the wire. Given the conductivity of gold is 4.26×10^5 $(\Omega cm)^{-1}$.

(7 marks)

Question 6

(a) **Sketch** and **label** the following planes **within** a cubic unit cell:

(i) $(0\ \bar{1}\ \bar{3})$
(ii) $(\bar{1}\ 1\ 1)$
(iii) $(1\ \bar{3}\ 1)$

(9 marks)

(b) In the context of diffusion mechanisms;

(i) **Discuss** interstitial and vacancy atomic mechanism of diffusion.

(4 marks)

(ii) Cite **two reasons** why interstitial diffusion is normally more frequent and faster than vacancy diffusion.

(4 marks)

(c) A fatigue test was conducted in which the mean stress was 50 MPa and the stress amplitude was 225 MPa. Compute **the maximum and minimum stress** levels.

(8 marks)

--THE END--

APPENDIX I

PERIODIC TABLE

KEY

Atomic Number — Symbol of element — Name of element

Atomic Mass

																	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 can be REMOVED for your convenience.