INTI
International College Penang
LAUREATE INTERNATIONAL UNIVERSITIES*

FINAL
Examination Paper

(COVER PAGE)

Session	:	January 2017
Programme	:	Diploma in Electrical and Electronic Engineering (DEEI)
Course	:	**EGM 1182: Structures and Properties of Materials**
Date of Examination	:	8 March 2017 (Wednesday)
Time	:	11:00am – 1:00pm 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	:	Professor Ir. 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: JANUARY 2017 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) Sterling silver contains 92.5 wt% of silver and 7.5 wt % copper. Copper is added to silver to make the metal stronger and more durable. A small silver spoon has a mass of 80 g. Calculate the **number of copper and silver atoms** in the spoon. ($N_A = 6.022\times10^{23}$)

(4 marks)

(b) Write the **electron configurations** of the following ions using ***spdf*** notation:

(i) Se^{4+}
(ii) Se^{6+}
(iii) Se^{2-}

(6 marks)

(c) Calculate the **volume** in cubic nanometers of a unit cell of titanium crystal structure. Titanium is HCP at 20°C with $a = 0.29504$ nm and $c = 0.46833$ nm.

(4 marks)

(d) **Briefly explain the following terms** related to solidification of metals.

(i) Homogeneous nucleation

(3 marks)

(ii) Heterogeneous nucleation

(3 marks)

(iii) Embryos

(3 marks)

(iv) Grain

(2 marks)

Question 2

(a) A tensile specimen of aluminum alloy is tested to fracture. At the fracture point, it has an engineering stress of 180 MPa and engineering strain of 34%. Calculate

(i) the **true stress** a fracture, and (7 marks)
(ii) the **true strain** at fracture. (3 marks)

(b) **Briefly explain the following terms** related to diffusion in solid.

(i) **Substitutional diffusion** (3 marks)
(ii) **Self-diffusion** (2 marks)
(iii) **Interstitial diffusion** (2 marks)

(c) **Calculate** the center to center separation distance (or **lattice constant**) of two Fe atoms along [1 0 0] direction in an unstressed α – iron. Given the radius of an 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)

Question 3

(a) A fatigue test is made with maximum stress of 172 MPa and a minimum stress of −27.6 MPa. **Calculate**
(i) the **stress amplitude,**
(ii) the **mean stress.**
(4 marks)

(b) If 500 g of a 40 wt % Ag – 60 wt % Cu alloy is slowly cooled from 1000 °C to just below 779 °C. Refer to Figure Q3 to determine the following.

(i) How many grams of liquid and proeutectic alpha are present at 850 °C?
(ii) How many grams of liquid and proeutectic alpha are present at 779 °C + ΔT ?
(iii) How many grams of alpha are present in the eutectic structure at 779 °C −ΔT ?
(iv) How many grams of beta are present in the eutectic structure at 779 °C −ΔT ?
(10 marks)

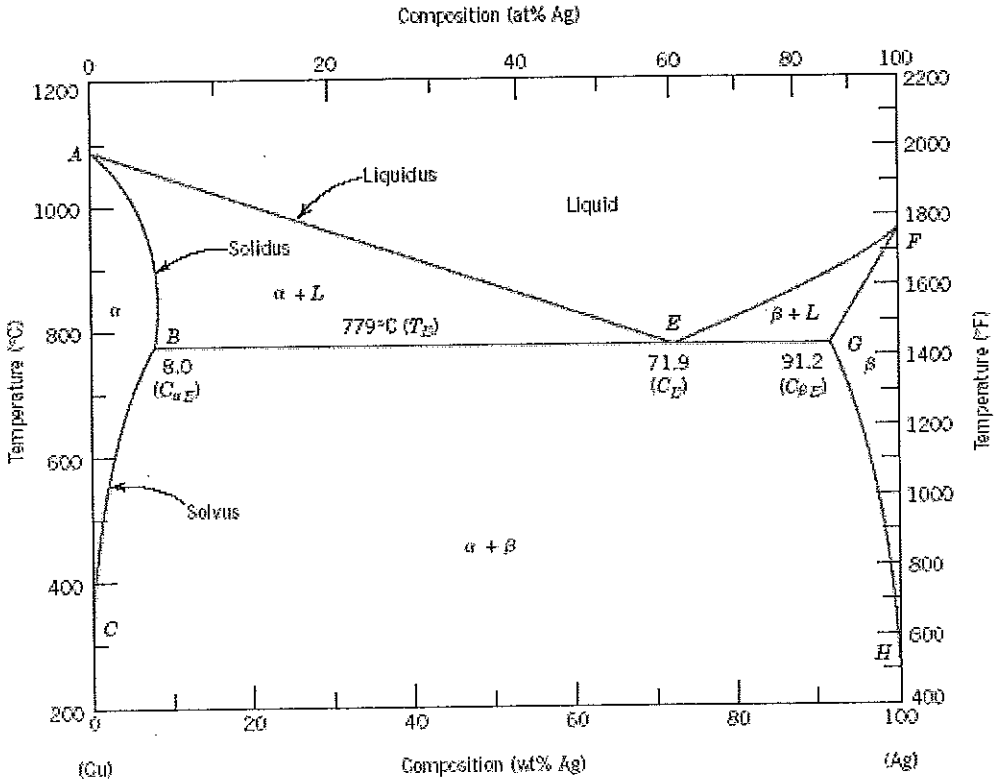


Figure Q3

(c) **Briefly explain the following terms** that relate to an iron carbide metal.
(i) **Eutectoid cementite**
(ii) **Pearlite**

(8 marks)

(d) A high molecular weight polyethylene $-[C_2H_4]_n-$ has an average molecular weight of 410,000 g/mol. What is its **average degree of polymerization**?

(3 marks)

Question 4

(a) Calculate **the density in grams per cubic centimeter** of ZrO_2, which has the CaF_2 crystal structure shown in Figure Q4. Ionic radii are $Zr^{4+} = 0.087$ nm and $O^{2-} = 0.132$ nm. ($N_A = 6.022\times10^{23}$)

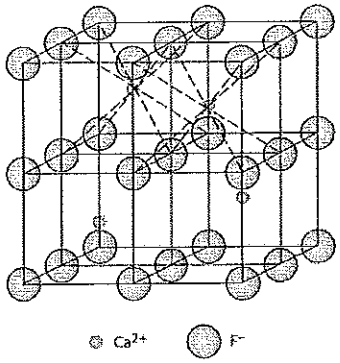


Figure Q4

(9 marks)

(b) **Briefly explain** the following terms related to electrical properties of materials.

(i) n-type extrinsic semiconductor

(3 marks)

(ii) Hole

(2 marks)

(c) Calculate **electrical resistance** of an iron rod with 0.720-cm diameter and 0.850-m long at 20°C. [electrical resistvity $\rho(at\ 20°C) = 10.0 \times 10^{-6}\ \Omega.cm.$]

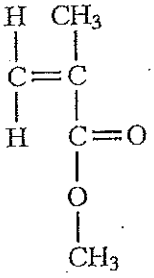
(4 marks)

(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 **diameter** of the wire and the **voltage** imposed on the wire. Given the conductivity of gold is $4.26 \times 10^5\ (\Omega cm)^{-1}$.

(7 marks)

Question 5

(a) The monomer of a typical acrylic polymer , polymethyl methacrylate, is shown below



Calculate **the molecular weight** of the polymethyl methacrylate molecule with degree of polymerization, $n = 500$.

(4 marks)

(b) **Sketch planes (2 2 0), (3 1 1) and (4 0 0) in a cubic unit cell** with appropriate axes and intercepts labeling. (To avoid confusion, use a separate sketch for each plane)

(9 marks)

(c) **Briefly explain** the following terms;

(i) Atomic packing factor (3 marks)

(ii) Cold working (3 marks)

(iii) Permanent deformation (3 marks)

(d) The following two data points are provided for a titanium alloy.

No	ε	σ (MPa)
1	0.002778	300
2	0.005556	600

Calculate the **modulus of elasticity *E*** for this alloy.

(3 marks)

Question 6

(a) Determine **the direction indices** of A, B, C and D as shown in Figure Q6.

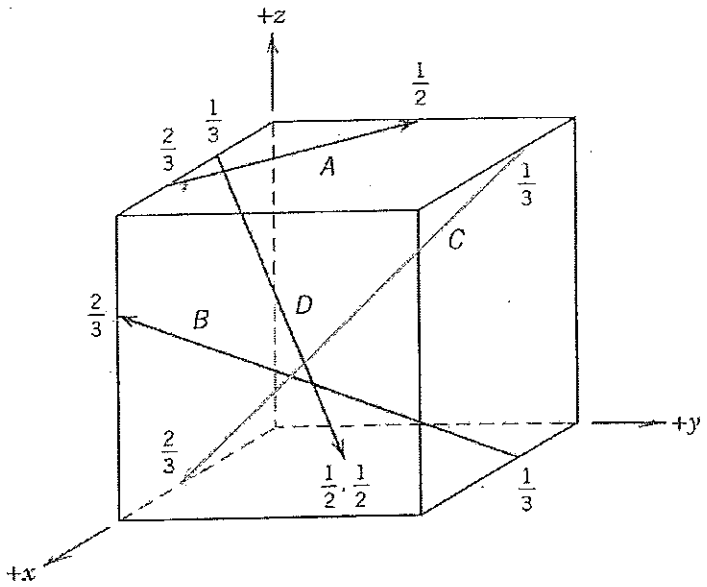


Figure Q6

(8 marks)

(b) Briefly explain the following terms that relate to polymeric materials.

(i) plastics

(ii) elastomers.

(8 marks)

(c) Molybdenum (Mo) forms a substitutional solid solution with tungsten (W). Compute the weight percent of molybdenum that must be added to tungsten to yield an alloy that contains 1.0×10^{22} Mo atoms per cubic centimeter. The densities of pure Mo and W are 10.22 and 19.30 g/cm^3, respectively. ($N_A = 6.022 \times 10^{23}$)

(9 marks)

--THE END--

APPENDIX 1

PERIODIC TABLE

																	2 He 4·003 Helium
												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: 79
Symbol of element: Au
Atomic Mass: 197·0
Name of element: Gold

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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