INTI
International College Penang
LAUREATE INTERNATIONAL UNIVERSITIES*

FINAL
Examination Paper

(COVER PAGE)

Session	:	**April 2016**
Programme	:	Diploma in Electrical and Electronic Engineering (DEEI)
Course	:	**EGM 1182: Structures and Properties of Material**
Date of Examination	:	26 July 2016, Tuesday 2016
Time	:	5.00pm – 7.00pm
Duration	:	2 Hours Reading Time : Nil
Special Instructions	:	

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

IMPORTANT NOTE : **THIS PAPER SHOULD NOT BE TAKEN OUT OF THE EXAMINATION HALL**

Materials Permitted :

Nil

Materials Provided :

Answer Booklet

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

Moderator : Prof. Ir. Dr. Cheong Kuan Yew

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

INTI INTERNATIONAL COLLEGE

DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING (DEEI)
EGM 1182: STRUCTURES AND PROPERTIES OF MATERIAL
FINAL EXAMINATION: APRIL 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) Briefly describe the following material:
(i) Crystalline material
(ii) Single crystal material
(iii) Polycrystalline material.

(5 marks)

(b) Write the electron configurations of the following ion by using *spdf* notation:
(i) Cr^{2+},
(ii) Br^{-}.

(6 marks)

(c) An optical fiber for telecommunication is made of SiO_2 glass (density = 2.20 Mg/m^3). How many Si atoms and O atoms are present per millimeter of length of a fiber with diameter of 10 μm? (Given $N_A = 6.023 \times 10^{23}$)

(8 marks)

(d) Calculate the ionic packing factor (or atomic packing factor) of CaO, which shares the NaCl type structure. Given the radius of Ca^{2+} is 0.106 nm and the radius of O^{2-} is 0.132 nm.

(6 marks)

Question 2

(a) Calculate the density of zinc blende (with tetrahedral structure) in term of g/cm^3. Given the radius of Zn^{2+} is 0.083 nm and the radius of S^{2-} is 0.174 nm.

(6 marks)

(b) To produce a p-type of semiconductor, small level of impurities (aluminium) are added to an essentially pure semiconductor (silicon) in order to produce desirable electrical properties. For 5×10^{21} aluminium atoms per cubic meter in solid solution of silicon, calculate
(i) the atomic percent of aluminium atoms. Given the density of silicon as $2.33 Mg/m^3$.
(ii) the weight percent of aluminium atoms.

(11 marks)

(c) Calculate the center to center separation distance (or lattice constant) of two Fe atoms along the [1 0 0] direction in unstressed α – iron. Given the radius of iron atom is 0.124nm.
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) Given the Al – Si phase diagram in Figure 3. Calculate
(i) The weight fraction of the α phase that is proeutectic in a 10 wt% Si – 90 wt% Al alloy at 576 °C, and
(ii) The weight fraction of the β phase that is proeutectic in 20 wt% Si – 80 wt% Al alloy at 576 °C.

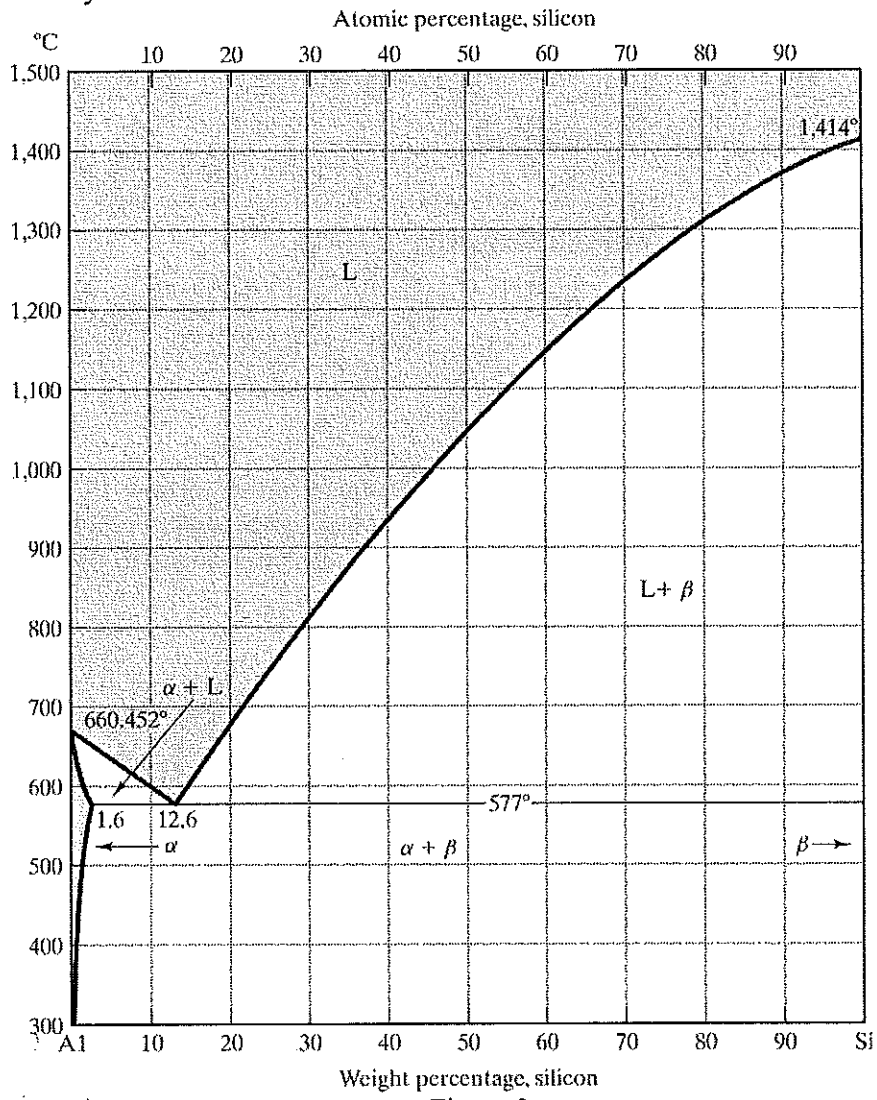

Figure 3

(10 marks)

(b) Calculate the atomic packing factor for polyethylene $-[C_2-H_4]_n-$. If the unit cell volume is 0.0933 nm^3, the radius of carbon and hydrogen are 0.077nm and 0.046nm respectively. Each unit cell would contain 2 repeating unit of monomer.

(7 marks)

(c) Define the following terms related to the mechanical behavior of materials
(i) Endurance limits,
(ii) Fatigue strength,
(iii) Engineering stress and its SI unit,
(iv) Engineering strain and its SI unit.

(8 marks)

Question 4

(a) A cylindrical specimen of steel having an original diameter of 12.8mm is tensile tested to fracture and found to have an engineering fracture strength of 460MPa. If its cross sectional is 10.7mm, determine:

(i) The engineering stress and true stress

(5 marks)

(i) The engineering strain and true strain

(5 marks)

(b) Define or briefly explain the following:

(i) Annealing of steels

(4 marks)

(ii) Tempering of steels

(4 marks)

(c) A steel bar 100mm long and having a square cross section 20mm × 20mm is pulled in tension with a force of 8.9×10^4 N, and experiences an elongation of 0.1mm. Assuming that the deformation is entirely elastic, calculate the modulus of elasticity of the steel.

(7 marks)

Question 5

(a) Distinguish between traditional ceramic and engineering ceramic materials and for <u>each type of ceramic</u>, gives TWO (2) examples.

(6 marks)

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

(4marks)

(c) Refer to Figure 5. Define the following phases that exist in the Fe-Fe_3C phase diagram:

(i) austenite,
(ii) α ferrite,
(iii) cementite,
(iv) δ ferrite.

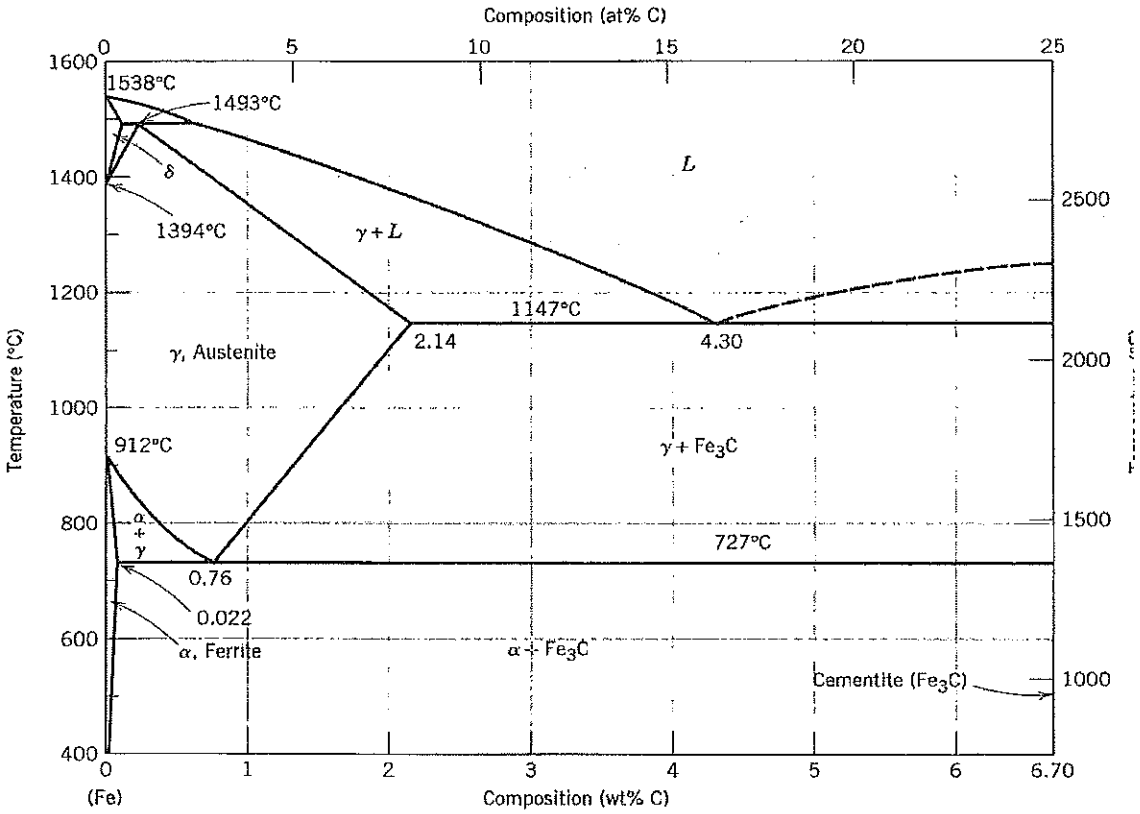

Figure 5

(10 marks)

(d) Write Ohm's law equation for microscopic form. Define the symbols and indicate their SI units.

(5 marks)

Question 6

(a) Define the following terms:

(i) electrical conductivity
(ii) n-type extrinsic semiconductor
(iii) electron drift velocity
(iv) band gap

(8 marks)

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

(i) 400°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 $1.67\times10^{-6}\,\Omega.cm$ and its temperature resistivity coefficient is 0.0068/°C.

(7 marks)

(c) Determine the Miller indices for the A, B and C plane shown in the following unit cell (Figure 6).

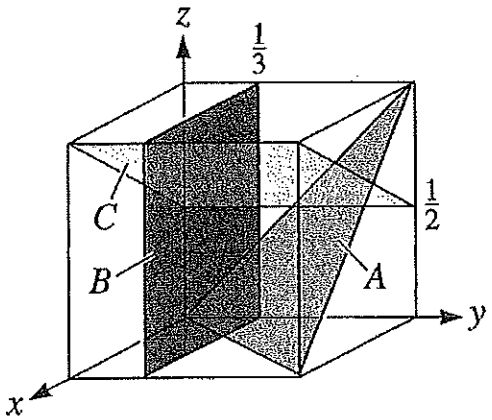

Figure 6

(6 marks)

(d) 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),

(iii)solid xenon.

(4 marks)

-THE END-

APPENDIX 1

PERIODIC TABLE

KEY

Atomic Number — Symbol of element — Name of element

Atomic Mass

Example: 79 Au 197·0 Gold

																	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												

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.