INTI International University & Colleges

FINAL
Examination Paper

(COVER PAGE)

Session	:	**August 2019**
Programme	:	Diploma in Electrical and Electronic Engineering (DEEI) Diploma in Mechanical Engineering (DMEN)
Course	:	**EGM1182/EGM1184 : Structures and Properties of Materials**
Date of Examination	:	December 10, 2019 (Tuesday)
Time	:	8:00 am – 10:00 am 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 : Calculator

Materials provided : Periodic Table

Examiner (s)	:	**Richard Lai Tian Fat** and Iylia Elena Abdul Jamil
Moderator	:	Mr Abdolreza Toudehdehghan

*This paper consists of **9** printed pages, including the cover page.*

DIPLOMA IN ELECTRICAL & ELECTRONIC ENGINEERING PROGRAMME (DEEI)
DIPLOMA IN MECHANICAL ENGINEERING PROGRAMME (DMEN)
EGM1182/1184: STRUCTURES AND PROPERTIES OF MATERIAL
FINAL EXAMINATION: AUGUST 2019 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) Metallic bonds one of the primary bonds that can be formed between atoms.

(i) Sketch a schematic of the metallic bond.

(3 marks)

(ii) Describe how a metallic bond is formed.

(5 marks)

(iii) Name the other types of primary bonds.

(2 marks)

(b) Copper is added to silver to create sterling silver, which is stronger and more durable. The amount of copper added is 7.5 wt %. A sterling silver spoon has a mass of 100 grams. Calculate the number of copper and silver atoms in the spoon.

(6 marks)

(c) What is the chemical formula of an intermetallic compound that consists of 37 wt % Ti and 63 wt % Al?

(9 marks)

Question 2

(a) Write the electron configuration of the following atoms and ions using *spdf* notation.

(i) Mo and Mo^{4+}

(4 marks)

(ii) Se^{6+} and Se^{2-}

(4 marks)

(b) A metallic element can have different crystal arrangements, like the face-centered cubic (FCC). For an FCC unit cell,

(i) How many atoms are inside the cell?

(2 marks)

(ii) What is the coordination number for the atoms?

(2 marks)

(iii) What is the relationship between the length of the side a and the radius of atoms in the cell?

(4 marks)

(iv) Calculate the atomic packing factor.

(4 marks)

(c) Draw in a unit cube a crystal plane that has Miller index of $[3\bar{2}1]$.

(5 marks)

Question 3

(a) The solidification of metals is a key process in producing engineering metals.

(i) Describe and sketch the there stage of this process.

(6 marks)

(ii) Explain how the degree of undercooling affects the critical size of the neucleus.

(2 marks)

(iii) What is the difference between a nucleus and an embryo?

(2 marks)

(b) Describe and sketch the following types of defects that can be present in a metal.

(i) Vacancy

(3 marks)

(ii) Intersticialcy

(3 marks)

(c) Calculate the number of atom in a critically sized nucleus for the homogeneous nucleation of pure iron. Iron forms a BCC structure with atomic radius of 9.72 nm.

(9 marks)

Question 4

(a) The temperature of 1 kg of the alloy shown in Figure Q4 (a) is lowered slowly until the liquid-solution composition is 18 wt %B and the solid-solution composition is 66 wt% B.

Calculate the amount of each phase.

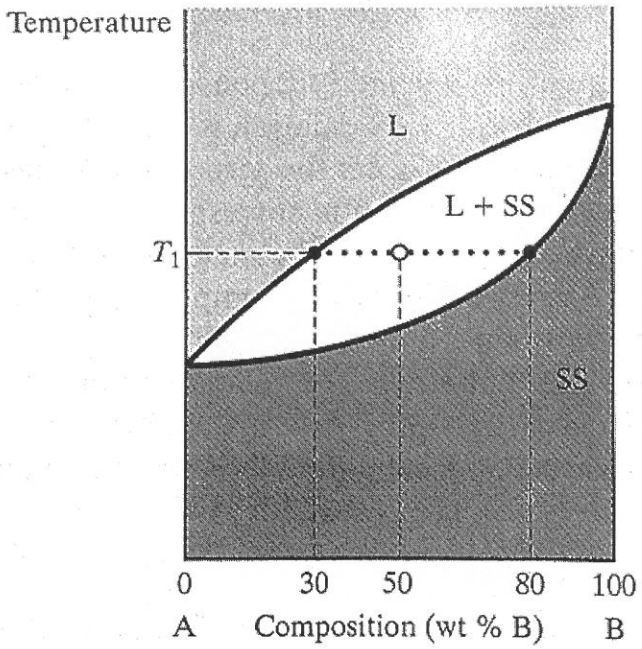

Figure Q4 (a)

(6 marks)

(b) For 1 kg of eutectoid steel at room temperature, calculate the amount of each phase (α and Fe_3C) presents. Refers to the diagram shown in Figure Q4 (b).

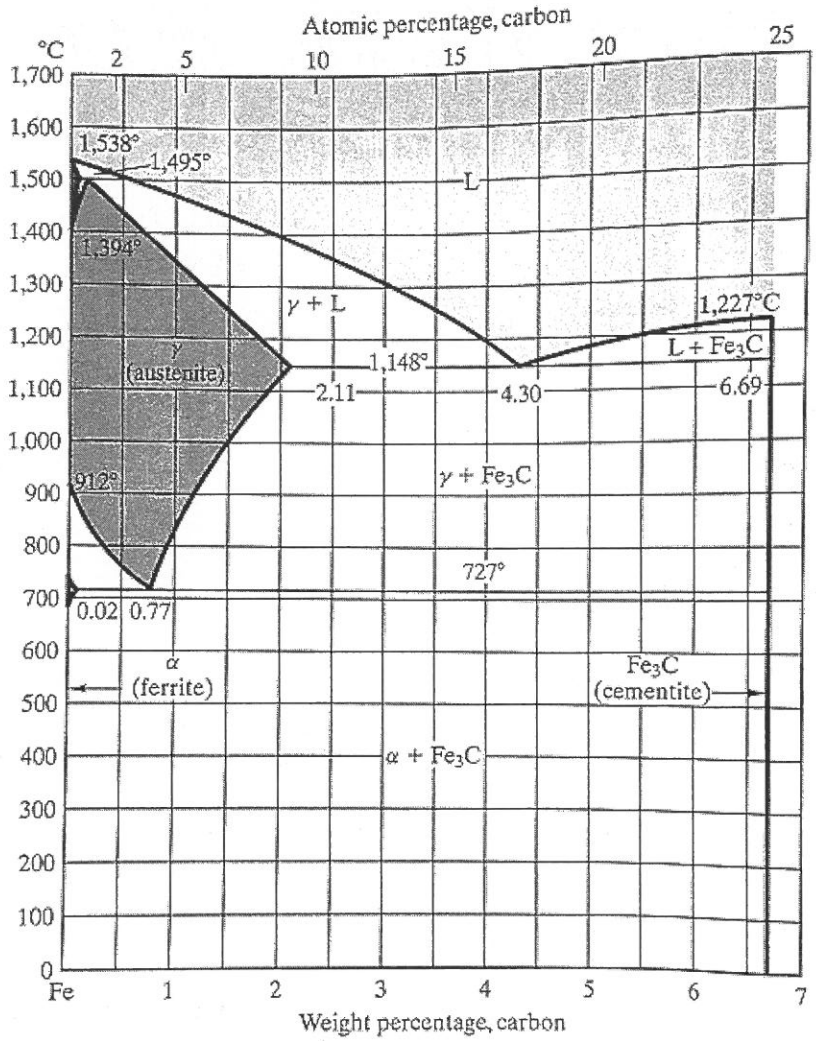

Figure Q4 (b).

(6 marks)

(c) From Figure Q4 (c), determine:

(i) the solubility of tin in solid lead (Pb) at 100°C.

(2 marks)

(ii) the maximum solubility of lead (Pb) in solid tin (Sn).

(2 marks)

(iii) the amount of β that forms if a Pb - 10% Sn alloy is cooled to 0°C.

(3 marks)

(iv) the masses of tin contained in the α and β phases.

(3 marks)

(v) the mass of lead contained in the α and β phases.

(3 marks)

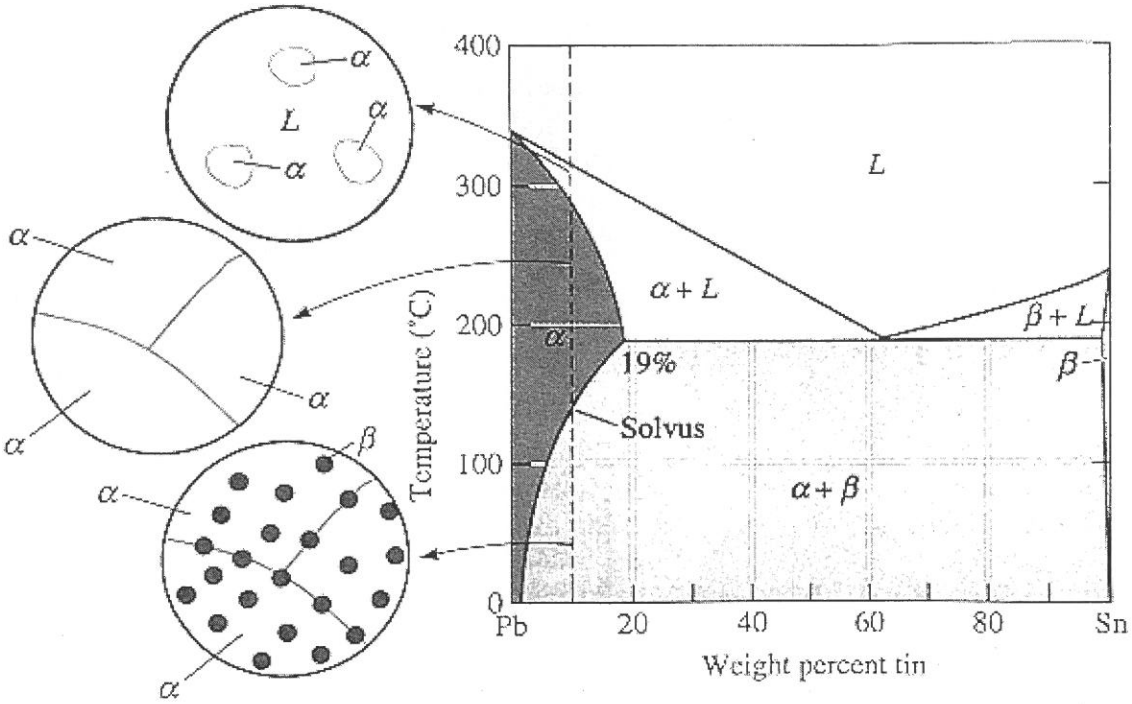

Figure Q4 (c)

Question 5

(a) Distinguish between natural aging and artificial aging for a precipitation metal hardening

(4 marks)

(b) If a particular type of polyethylene has a molecule mass of 150000 g/mol, what is its degree of polymerization (DP) ?

(5 marks)

(c) Distinguish between a homopolymer and a copolymer.

(2 marks)

(d) Illustrate the following types of copolymers by using filled and open circles for their mers:

(i) random,

(ii) alternating,

(iii) block, and

(iv) graft.

(8 marks)

(e) List **SIX (6)** mechanical properties of ceramic materials?

(6 marks)

Question 6

(a) Design an electrical transmission line 1500 m long that will carry a current of 50 A with no more than 5×10^5 W loss in power. The electrical conductivity of several materials is shown in Table Q6 (a).

(8 marks)

	σ (ohm^{-1} · cm^{-1})	A (cm^2)	Diameter (cm)
Aluminum	3.77×10^5	0.00199	0.050
Copper	5.98×10^5	0.00125	0.040
Silver	6.80×10^5	0.00110	0.037

Table Q6 (a)

(b) Write equations for the

(i) macroscopic.

(3 marks)

(ii) microscopic forms of Ohm's law.

(3 marks)

Define the symbols in each of the equations and indicate their SI units.

(c) Assuming all of the valence electrons contribute to current flow :

(i) calculate the mobility of an electron in copper.

(3 marks)

(ii) calculate the average drift velocity for electrons in a 100 cm copper wire when 10 V are applied.

(2 marks)

(d) 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 strain at this load and

(ii) the modulus of elasticity.

(6 marks)

-THE END-

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APPENDIX 1

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 — 79 — Symbol of element

Atomic Mass — Au 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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