

**FINAL
ALTERNATIVE ASSESSMENT**

(COVER PAGE)

Session : April 2020

Programme : Diploma in Electrical & Electronic Engineering (DEEI)
Diploma in Mechanical Engineering (DMEN)

Course : **EGM1182/EGM1184: Structures and Properties of Materials**

Date of Examination : 3 August 2020 (Monday)

Time : 4.00pm – 6.15pm Reading Time : Nil

Duration : 2 Hours 15 Minutes

Special Instructions :

This paper consists of **FOUR (4)** questions. Answer all **FOUR (4)** questions.

Material permitted : Non-Programmable Scientific Calculator

Materials provided : Periodic Table

Examiner(s) : **Mr Johnny Wong**

Chief Moderator : Ms Iylia Elena

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

DIPLOMA IN MECHANICAL ENGINEERING PROGRAMME (DMEN)
 DIPLOMA IN ELECTRICAL & ELECTRONICS ENGINEERING PROGRAMME (DEEI)
 EGM1182/EGM1184: STRUCTURES AND PROPERTIES OF MATERIALS
 FINAL ALTERNATIVE ASSESSMENT: APRIL 2020 SESSION

Instructions: This paper consists of **FOUR (4)** questions. Answer all **FOUR (4)** questions.

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. ($N_A = 6.022 \times 10^{23}$) (4 marks)
- (b) Write the electron configurations of the following ions using *spdf* notation:
 i. Se^{6+}
 ii. Se^{2-} (4 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)
- (e) Determine Miller indices for the planes in the cubic unit cell shown in Figure Q1e.

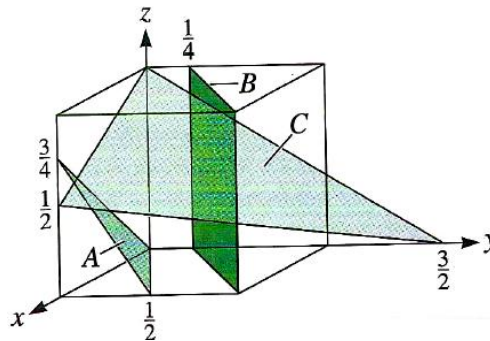


Figure Q1e

(7 marks)

Question 2

(a) Determine the direction indices of A, B, C and D as shown in Figure Q2a.

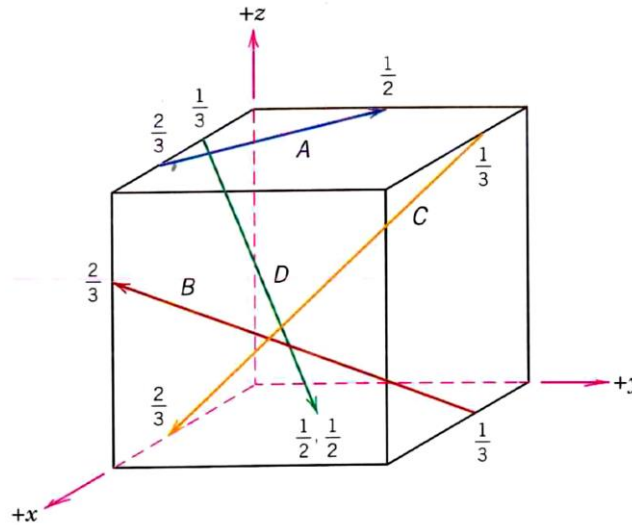


Figure Q2a

(8 marks)

(b) Tin substitutional atoms are introduced into a FCC copper crystal, producing an alloy with a lattice parameter of 3.7589×10^{-8} cm and a density of 8.772 g/cm³. Calculate the atomic percentage of tin present in the alloy. ($N_A = 6.022 \times 10^{23}$ atoms/mol)

(8 marks)

(c) Briefly describe the following terms that related to fatigue test of materials.

(i) Endurance limit

(3 marks)

(ii) Fracture surface of fatigue failure

(3 marks)

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

(3 marks)

Question 3

- (a) A fatigue test is made with maximum stress of 172 MPa and a minimum stress of -27.6 MPa. Calculate
- the stress amplitude
 - 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 Q3b to determine the following.
- How many grams of liquid and proeutectic alpha are present at 850 °C?
 - How many grams of liquid and proeutectic alpha are present at 779 °C + ΔT ?
 - How many grams of alpha are present in the eutectic structure at 779 °C $-\Delta T$?
 - How many grams of beta are present in the eutectic structure at 779 °C $-\Delta T$?

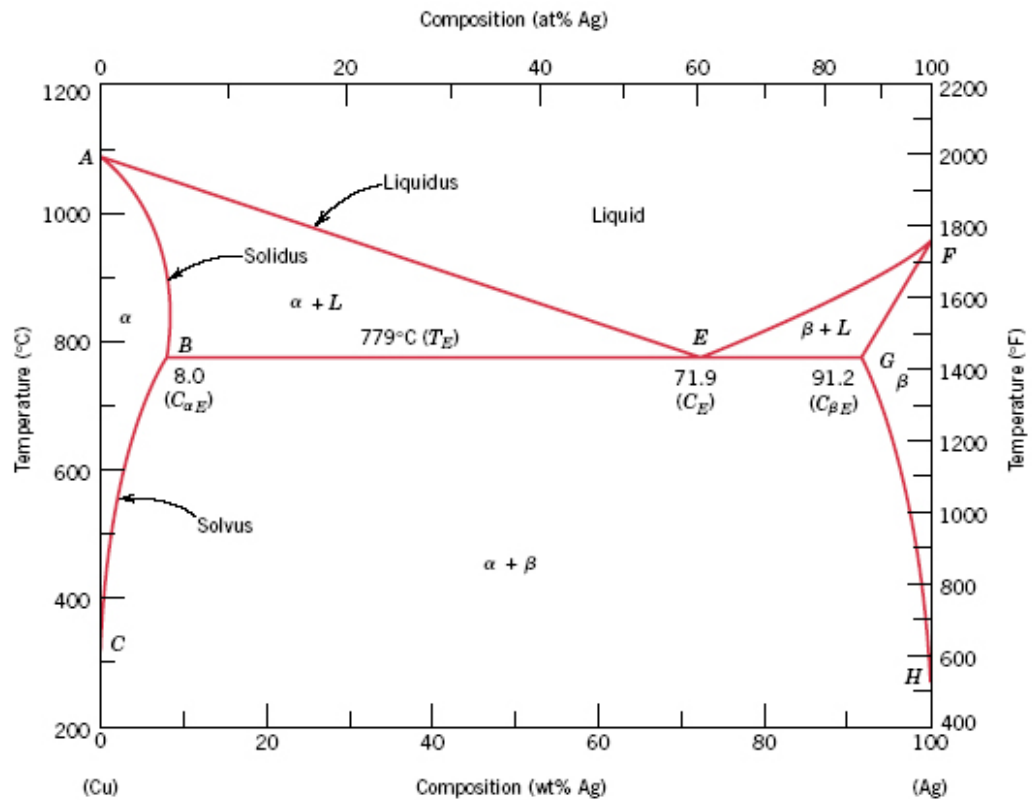


Figure Q3b

(10 marks)

- (c) Briefly explain the following terms that relate to an iron carbide metal.

- Eutectoid cementite
- Pearlite

(8 marks)

- (d) A high molecular weight polyethylene $-\text{[C}_2\text{H}_4\text{]}_n-$ has an average molecular weight of 410,000 g/mol. What is its average degree of polymerization?

(3 marks)

Question 4

- (a) The monomer of a typical acrylic polymer, polymethyl methacrylate, is shown in the figure Q4a below.

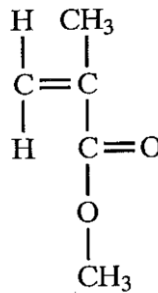


Figure Q4a

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

(4 marks)

- (b) The following table Q4b contains two data points for a titanium alloy.

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

Figure Q4b

Calculate the modulus of elasticity E for this alloy.

(3 marks)

- (c) Calculate electrical resistance of an iron rod with 0.720 cm diameter and 0.850 m length at 20°C. [Electrical resistivity ρ (at 20°C) = $10.0 \times 10^{-6} \Omega \cdot \text{cm}$.]

(4 marks)

- (d) A current density of 100,000 A/cm² is applied to a 50 m long gold wire. 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 $4.26 \times 10^5 (\Omega \cdot \text{cm})^{-1}$.

(6 marks)

(e) Briefly describe the following terms that are related to mechanical test.

i. Ductility

(2 marks)

ii. Modulus of elasticity

(3 marks)

iii. Impact test (with an example)

(3 marks)

~ The End ~

egm1182/1184 /apr2020

PERIODIC TABLE

1	H 1-008 Hydrogen	2	He 4-003 Helium
3	Li 6-941 Lithium	4	Be 9-012 Beryllium
11	Na 22-99 Sodium	12	Mg 24-31 Magnesium
19	K 39-10 Potassium	20	Ca 40-08 Calcium
37	Rb 85-47 Rubidium	38	Sr 87-62 Strontium
55	Cs 132-9 Cesium	56	Ba 137-3 Barium
87	Fr — Francium	88	Ra 226-0 Radium
21	Sc 44-96 Scandium	22	Ti 47-88 Titanium
39	Y 88-91 Yttrium	40	Zr 91-22 Zirconium
57	La 138-9 Lanthanum	58	Ce 140-1 Cerium
71	Lu 175-0 Lutetium	72	Hf 178-5 Hafnium
89	Ac — Actinium	90	Th 232-0 Thorium
23	V 50-94 Vanadium	24	Cr 52-00 Chromium
41	Nb 92-91 Niobium	42	Mo 95-94 Molybdenum
73	Ta 180-9 Tantalum	74	W 183-9 Tungsten
105	— — —	106	— — —
25	Mn 54-94 Manganese	26	Fe 55-85 Iron
43	Tc 98-91 Technetium	44	Ru 101-1 Ruthenium
75	Re 186-2 Rhenium	76	Os 190-2 Osmium
93	Np 237-0 Neptunium	94	Pu — Plutonium
99	Es — Einsteinium	100	Fm — Fermium
27	Co 58-93 Cobalt	28	Ni 58-69 Nickel
45	Rh 102-9 Rhodium	46	Pd 106-4 Palladium
77	Ir 192-2 Iridium	78	Pt 195-1 Platinum
95	Am — Americium	96	Cm — Curium
101	Md — Mendelevium	102	No — Nobelium
29	Cu 63-55 Copper	30	Zn 65-39 Zinc
47	Ag 107-9 Silver	48	Cd 112-4 Cadmium
79	Au 197-0 Gold	80	Hg 200-6 Mercury
103	Lr — Lawrencium	104	Rf — Rutherfordium
105	Db — Dubnium	106	Sg — Seaborgium
107	Bh — Bohrium	108	Hs — Hassium
109	Mt — Meitnerium	110	Ds — Darmstadtium
111	Cn — Copernicium	112	Fl — Flerovium
113	Nh — Nihonium	114	Mc — Moscovium
115	Uu — Ununpentium	116	Lv — Livermorium
117	Uus — Ununseptium	118	Og — Oganesson

KEY
 Atomic Number
 Atomic Mass
 Symbol of element
 Name of element

This sheet ~~can~~ be REMOVED for your convenience.