

**FINAL
Examination Paper**

(COVER PAGE)

Session : April 2018

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

Course : EGM1182/EGM1184 : Structures and Properties of Materials

Date of Examination : August 1, 2018 (Wednesday)

Time : 11:00 am – 1:00 pm 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) : Iylia Elena Abdul Jamil & Aaron Edward Teo Sheng Jye

Moderator : Dr How Ho Cheng

This paper consists of 6 printed pages, including the cover page.

DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING (DEEI)
DIPLOMA IN MECHANICAL ENGINEERING (DMEN)
EGM1182/1184: STRUCTURES AND PROPERTIES OF MATERIALS
FINAL EXAMINATION: APRIL 2018 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) Write down the electron configuration of Al and Al^{3+} . (4 marks)
- (b) How many atoms are there in 1 g of gold? (2 marks)
- (c) A solder contains 52 wt % tin and 48 wt % lead. What are the atomic percentages of Sn and Pb in the solder? (8 marks)
- (d) Show that the atomic packing factor for BCC is 0.68. (7 marks)
- (e) Draw direction vectors in unit cells for both cubic directions: $[1\bar{1}\bar{1}]$ and $[1\bar{1}0]$ (4 marks)

Question 2

- (a) Draw in unit cube the crystal plane that has the following Miller index: $(30\bar{2})$ (4 marks)
- (b) Describe and illustrate the solidification process of a pure metal in terms of the nucleation and growth of crystals. (9 marks)
- (c) Describe the relationship of Burgers vector–dislocation line orientations for edge and screw dislocations. (4 marks)
- (d) A cupronickel alloy consists of 80 wt % Cu and 20 wt % Ni. What are the atomic percentages of Cu and Ni in the alloy? (8 marks)

Question 3

- (a) What is the mass in grams for one atom of molybdenum?
(2 marks)
- (b) For a BCC crystal structure, how many atoms are there per unit cell and what is the coordination number?
(2 marks)
- (c) If 500 g of a 40 wt % Ag–60 wt % Cu alloy is slowly cooled from 1000°C to just below 780°C (refer Figure Q3) :
- (i) How many grams of liquid and proeutectic alpha are present at 850°C?
(4 marks)
 - (ii) How many grams of liquid and proeutectic alpha are present at 780°C + ΔT ?
(4 marks)
 - (iii) How many grams of alpha are present in the eutectic structure at 780°C - ΔT ?
(2 marks)
 - (iv) How many grams of beta are present in the eutectic structure at 780°C - ΔT ?
(2 marks)
- (d) What is the difference between homogeneous and heterogeneous nucleation for the solidification of a pure metal.
(3 marks)
- (e) Briefly describe a solid solution.
(3 marks)

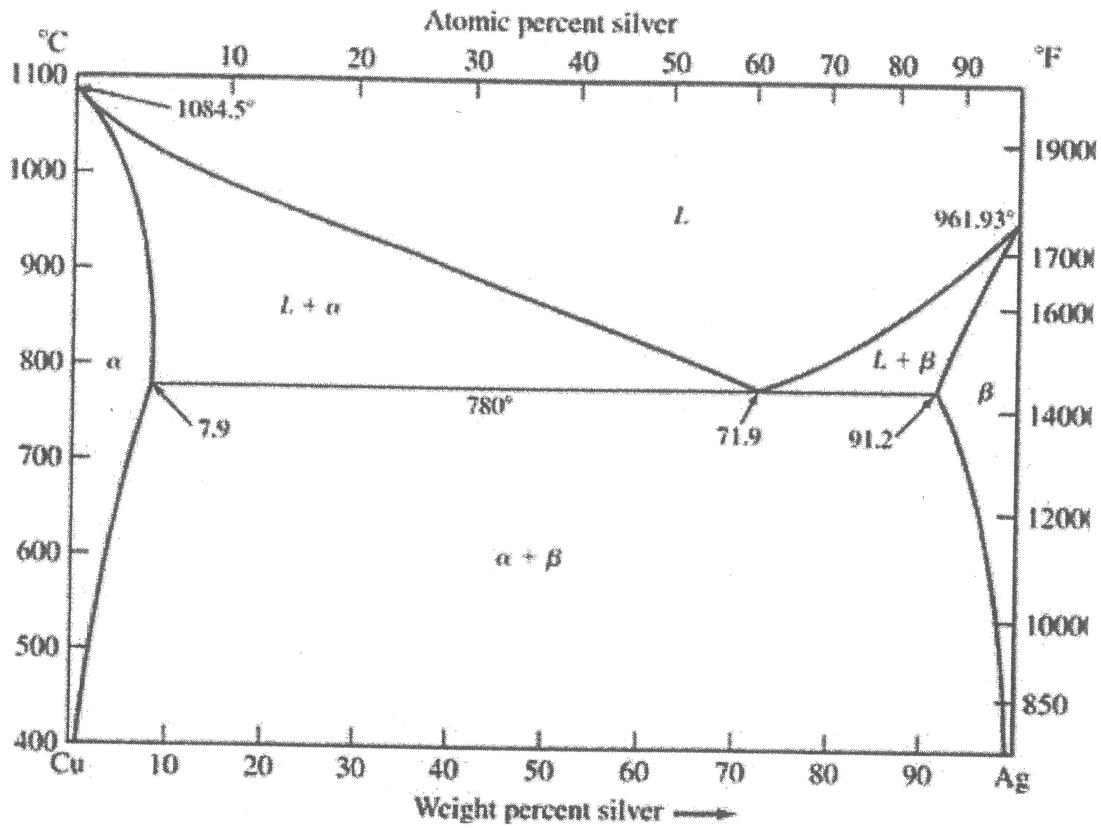


Figure Q3

Question 4

- (a) 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 while material volume is retained, determine
- the engineering stress and strain at this load.
 - the true stress and strain at this load.

(12 marks)

- (b) When a cold-worked metal is heated into the temperature range where recovery takes place, how are the following affected:
- (i) internal residual stresses (2 marks)
 - (ii) strength (2 marks)
 - (iii) ductility (2 marks)
 - (iv) hardness (2 marks)
- (c) A brass wire is cold-drawn 25 percent to a diameter of 1.10 mm. It is then further cold-drawn to 0.900 mm. What is the total percent cold reduction? (5 marks)

Question 5

- (a) What are some common properties of ceramic materials? (8 marks)
- (b) Explain the differences between the characteristics of thermoplastic and thermosetting plastics. (3 marks)
- (c) Briefly explain the definition of the following polymeric materials and give examples of item made from it:
- (i) Plastics. (3 marks)
 - (ii) Elastomers. (3 marks)
- (d) An iron wire is to conduct a 6.5 A current with a maximum voltage drop of 0.005 V/cm. What must be the minimum diameter of the wire in meters at (20°C)? (Resistivity for iron at 0°C = $9.0 \times 10^{-6} \Omega \text{ cm}$, coefficient of resistivity = $0.0045^\circ\text{C}^{-1}$) (5 marks)

Question 6

- (a) A 5.0 mm diameter, 50 mm long cylindrical silicon specimen has a current of 0.1 A passing in axial direction. A voltage of 12.5 V is measured across two probes that are separated by 38 mm.
- (i) Find the electrical conductivity of the specimen.
- (ii) Compute the resistance over the entire 50 mm of the specimen.
- (5 marks)
- (b) At what temperature will an iron wire have the same electrical resistivity as an aluminum one has at 35°C? (Resistivity for iron at 0°C = $9.0 \times 10^{-6} \Omega \text{ cm}$, coefficient of resistivity = $0.0045^\circ\text{C}^{-1}$; Resistivity for aluminum at 0°C = $2.7 \times 10^{-6} \Omega \text{ cm}$, coefficient of resistivity = $0.0039^\circ\text{C}^{-1}$)
- (4 marks)
- (c) What is the formula for mean stress, stress amplitude and stress ratio.
- (6 marks)
- (d) A fatigue test is made with a mean stress 120 MPa and a stress amplitude of 165 MPa. Calculate:
- (i) the maximum and minimum stresses
- (5 marks)
- (ii) the stress ratio
- (2 marks)
- (iii) the stress range
- (2 marks)

-THE END-

Periodic Table of the Elements

Atomic Number	Symbol	Name	Atomic Mass
1	H	Hydrogen	[1.00784; 1.00811]
2	He	Helium	4.002602(2)
3	Li	Lithium	[6.938; 6.997]
4	Be	Beryllium	9.012183(15)
5	B	Boron	[10.806; 10.821]
6	C	Carbon	[12.0096; 12.0116]
7	N	Nitrogen	[14.00643; 14.00728]
8	O	Oxygen	[15.99903; 15.99977]
9	F	Fluorine	18.998403163(6)
10	Ne	Neon	20.1797(6)
11	Na	Sodium	22.98976928(2)
12	Mg	Magnesium	[24.304; 24.307]
13	Al	Aluminum	26.9815386(8)
14	Si	Silicon	[28.085; 28.086]
15	P	Phosphorus	[30.973761998(5)]
16	S	Sulfur	[32.059; 32.076]
17	Cl	Chlorine	[35.446; 35.457]
18	Ar	Argon	39.948(1)
19	K	Potassium	39.0983(1)
20	Ca	Calcium	40.078(4)
21	Sc	Scandium	44.955908(5)
22	Ti	Titanium	47.887(1)
23	V	Vanadium	50.9415(1)
24	Cr	Chromium	51.9961(6)
25	Mn	Manganese	54.938045(5)
26	Fe	Iron	55.845(2)
27	Co	Cobalt	58.933194(4)
28	Ni	Nickel	58.933(4)
29	Cu	Copper	63.546(3)
30	Zn	Zinc	65.38(2)
31	Ga	Gallium	69.723(1)
32	Ge	Germanium	72.630(8)
33	As	Arsenic	74.921595(5)
34	Se	Selenium	78.971(8)
35	Br	Bromine	[79.901; 79.907]
36	Kr	Krypton	83.798(2)
37	Rb	Rubidium	85.4678(3)
38	Sr	Strontium	87.62(1)
39	Y	Yttrium	88.90584(2)
40	Zr	Zirconium	91.224(2)
41	Nb	Niobium	92.90637(2)
42	Mo	Molybdenum	95.94(1)
43	Tc	Technetium	<98>
44	Ru	Ruthenium	101.07(2)
45	Rh	Rhodium	102.90550(2)
46	Pd	Palladium	106.42(1)
47	Ag	Silver	107.8682(2)
48	Cd	Cadmium	112.411(4)
49	In	Indium	114.818(1)
50	Sn	Tin	118.710(7)
51	Sb	Antimony	121.760(1)
52	Te	Tellurium	127.60(3)
53	I	Iodine	126.90447(3)
54	Xe	Xenon	131.293(6)
55	Cs	Cesium	132.90545196(3)
56	Ba	Barium	137.327(7)
57-71		Lanthanide Series	
57	La	Lanthanum	138.90547(7)
58	Ce	Cerium	140.116(1)
59	Pr	Praseodymium	140.907682(1)
60	Nd	Neodymium	144.242(3)
61	Pm	Promethium	<145>
62	Sm	Samarium	150.36(2)
63	Eu	Europium	151.964(1)
64	Gd	Gadolinium	157.25(3)
65	Tb	Terbium	158.92535(2)
66	Dy	Dysprosium	162.500(1)
67	Ho	Holmium	164.93032(2)
68	Er	Erbium	167.258(3)
69	Tm	Thulium	168.93422(2)
70	Yb	Ytterbium	173.054(5)
71	Lu	Lutetium	174.968(1)
72	Hf	Hafnium	178.49(2)
73	Ta	Tantalum	180.94788(2)
74	W	Tungsten	183.84(1)
75	Re	Rhenium	186.207(1)
76	Os	Osmium	190.23(3)
77	Ir	Iridium	192.221(3)
78	Pt	Platinum	195.084(9)
79	Au	Gold	196.966569(5)
80	Hg	Mercury	200.592(3)
81	Tl	Thallium	[204.382; 204.385]
82	Pb	Lead	207.2(1)
83	Bi	Bismuth	208.9804(1)
84	Po	Polonium	<209>
85	At	Astatine	<210>
86	Rn	Radon	<222>
87	Fr	Francium	<223>
88	Ra	Radium	<226>
89-103		Actinide Series	
89	Ac	Actinium	<227>
90	Th	Thorium	232.0377(4)
91	Pa	Protactinium	231.036882(2)
92	U	Uranium	238.02891(3)
93	Np	Neptunium	<237>
94	Pu	Plutonium	<244>
95	Am	Americium	<243>
96	Cm	Curium	<247>
97	Bk	Berkelium	<247>
98	Cf	Californium	<251>
99	Es	Einsteinium	<252>
100	Fm	Fermium	<257>
101	Md	Mendelevium	<258>
102	No	Nobelium	<259>
103	Lr	Lawrencium	<262>
104	Rf	Rutherfordium	<261>
105	Db	Dubnium	<268>
106	Sg	Seaborgium	<271>
107	Bh	Bohrium	<272>
108	Hs	Hassium	<270>
109	Mt	Meitnerium	<276>
110	Ds	Darmstadtium	<281>
111	Rg	Roentgenium	<280>
112	Cn	Copernicium	<285>
113	Uut	Ununtrium	unknown
114	Flerovium	Flerovium	<289>
115	Uup	Ununpentium	unknown
116	Lv	Livermorium	<293>
117	Uus	Ununseptium	unknown
118	Uuo	Ununoctium	unknown

Atomic mass values reflect the IUPAC accepted values as of 09/2013. Masses expressed in [tab] format show the lower and upper limit of atomic mass depending on the physical and chemical history of the element. Masses expressed in <> format are the mass numbers of the longest-lived isotope for elements with no stable nucleus.

