Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020

COURSE NAME	:	MATERIALS SCIENCE
COURSE CODE	:	DAM 21603 / DAM 20802
PROGRAMME	:	DAM
EXAMINATION DATE	:	DECEMBER 2019/ JANUARY 2020
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	ANSWER **FIVE (5)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF **EIGHT (8)** PAGES

Q1 (a) Engineering materials are divided into three main fundamental classes which are metallic materials, polymeric materials and ceramic materials. List the advantages and disadvantages of each materials classes.

(6 marks)

(b) Body Centered Cubic (BCC) is one of crystal structure as shown in **Figure Q1 (b)**. Prove that 68% of the BCC unit cell is occupied with atoms and 32% is empty space.

(10 marks)

(c) Determine the Miller indices of the cubic crystallographic plane A and B shown in **Figure Q1(c)**.

(4 marks)

Q2 (a) The mechanical properties of materials are ascertained by performing carefully designed laboratory experiments that replicate as nearly as possible the service condition. Discuss **three (3)** factors to be considered in service condition.

(6 marks)

(b) In a tensile test on a zinc specimen of gauge length 100 mm and diameter 15 mm, a load of 100 kN produced an extension of 0.666 mm. Calculate the elastic modulus of the zinc specimen.

(4 marks)

(c) Hardness is a measure of the resistance of a metal to permanent (plastic) deformation. The hardness of a metal is measured by forcing an indenter into its surface. List **three** (3) types of indenters use in hardness testing.

(3 marks)

(d) A cylinder specimen of brass alloy with 7 mm in diameter and 70 mm long is pulled in tension with a force of 8000 N. If Poisson Ratio is 0.30, compute:

(i) the specimen elongation if strain is 0.002

(5 marks)

(ii) the reduction in specimen diameter (refer formula at the back)

(2 marks)

Q3 (a) Point defect happens due to deviation around a point or an atom in a crystal. There are several types of point defects. Describe each defect below:

(i) Lattice vacancy
(ii) Scottky imperfection
(iii) Frenkel imperfection

(6 marks)

(b) Describe **two (2)** types of bulk defects.

(4 marks)

(c) Consider an alloy which is undergoing carburizing process, initially has a uniform carbon concentration of 0.20 wt% and is to be treated at 950 °C. If the concentration of carbon at the surface is suddenly brought to and maintained at 1.25 wt%, determine how long will it take to achieve a carbon content of 0.70 wt% at a position 0.35 mm below the surface. The diffusion coefficient for carbon in iron at this temperature is 1.87×10^{-11} m^2/s; assume that the steel piece is semi-finite and refer to **Table 1** for tabulation of error function values.

(10 marks)

Q4 (a) Define and list **two (2)** purposes of heat treatment.

(4 marks)

(b) Describe the following heat treatment procedures for steels and, for each, the intended final microstructure.

(i) Annealing
(ii) Normalizing
(iii) Marquenching
(iv) Tempering
(v) Austempering

(10 marks)

(c) Discuss the properties of following phase.

(i) Pearlite
(ii) Bainite
(iii) Martensite

(6 marks)

Q5 (a) List **three (3)** important information that we could obtain from phase diagram?

(3 marks)

(b) Explain the properties of :

(i) Peritectic
(ii) Eutectic
(iii) Eutectoid

(3 marks)

(c) **Figure Q5(c)** shows the copper-silver alloy phase diagram. Named the item as label by:

Phase

(i) A
(ii) B
(iii) C
(iv) D
(v) E
(vi) F

Line

(vi) G
(vii) H
(vii) I

(9 marks)

(d) Refer phase diagram of Pb-Sn **Figure Q5(d)**;

(i) Plot the graph and make a phase analysis for composition of 30 % Sn at 183 °C + ΔT and 30 % Sn at 183 °C - ΔT.

(1 mark)

(ii) Determine each phase composition for 30 % Sn at 183 °C + ΔT and 35 % Sn at 183 °C -ΔT.

(2 marks)

(iii) Determine amount of weight proportion for each fraction for 30 % Sn at 183 °C + ΔT and 35 % Sn at 183 °C - ΔT.

(2 marks)

Q6 (a) Briefly explain electrochemical corrosion and cite **two (2)** locations where corrosion normally started.

(2 marks)

(b) Briefly explain the following types of corrosion.

(i) Uniform Attack – General Corrosion
(ii) Galvanic Corrosion
(iii) Crevice Corrosion
(iv) Pitting
(v) Intergranular Corrosion

(10 marks)

(c) Discuss **four (4)** steps to control or prevent corrosion in a metal.

(8 marks)

- END OF QUESTION -

FINAL EXAMINATION

SEMESTER/SESSION	: SEM 1 2019/2020	*PROGRAMME*	: DAM
COURSE	: MATERIALS SCIENCE	*CODE COURSE*	: DAM 21603/ DAM20802

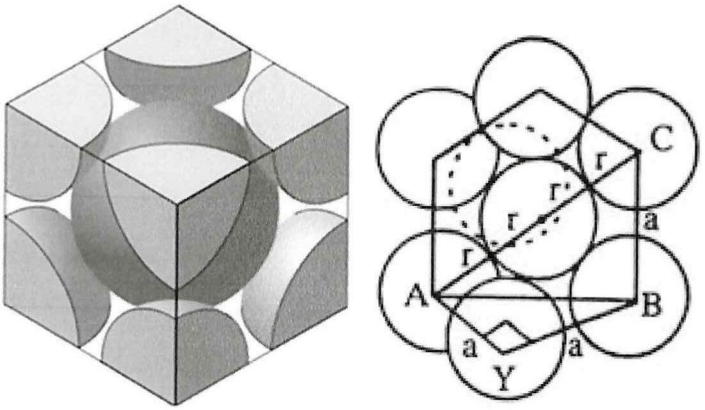

Figure Q1(b)

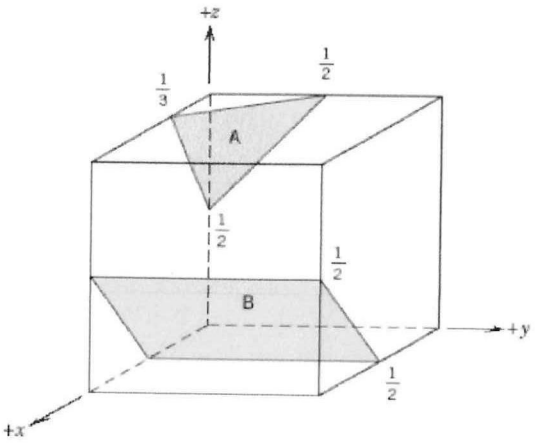

Figure Q1(c)

Formula for Q2 (d) (ii) :

$$v = -\frac{\varepsilon_x}{\varepsilon_z} = -\frac{(\Delta d/d_o)}{(\Delta l/l_o)}$$

FINAL EXAMINATION

SEMESTER / SESSION	: SEM 1 2019/2020	*PROGRAMME*	: DAM
COURSE	: MATERIALS SCIENCE	*CODE COURSE*	: DAM21603/DAM20802

Table 1

z	*erf (z)*	*z*	*erf (z)*	*z*	*erf (z)*
0	0	0.55	0.5633	1.3	0.9340
0.025	0.0282	0.60	0.6039	1.4	0.9523
0.05	0.0564	0.65	0.6420	1.5	0.9661
0.10	0.1125	0.70	0.6778	1.6	0.9763
0.15	0.1680	0.75	0.7112	1.7	0.9838
0.20	0.2227	0.80	0.7421	1.8	0.9891
0.25	0.2763	0.85	0.7707	1.9	0.9928
0.30	0.3286	0.90	0.7970	2.0	0.9953
0.35	0.3794	0.95	0.8209	2.2	0.9981
0.40	0.4284	1.0	0.8427	2.4	0.9993
0.45	0.4755	1.1	0.8802	2.6	0.9998
0.50	0.5205	1.2	0.9103	2.8	0.9999

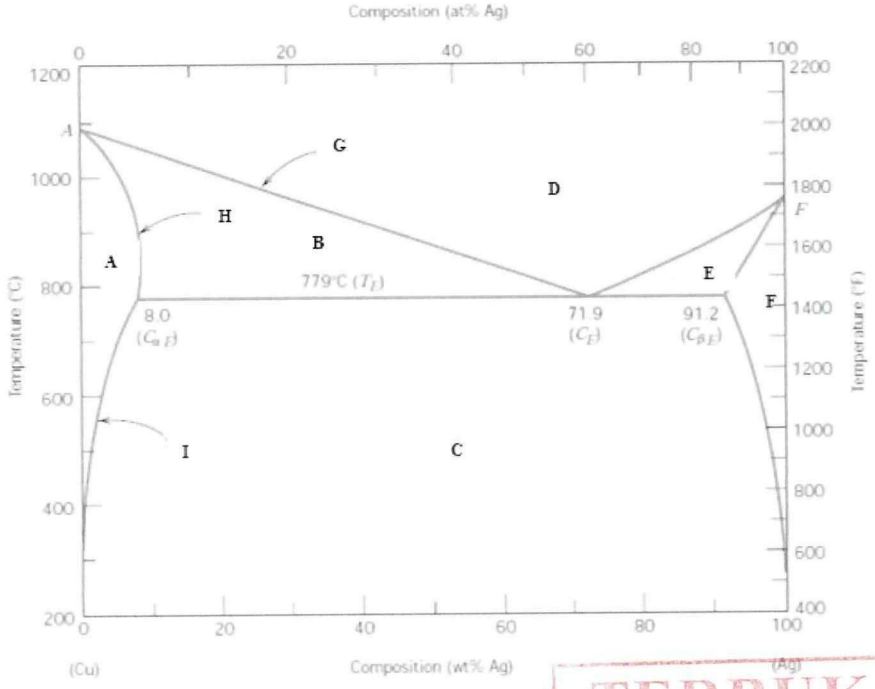

Figure Q5(c)

FINAL EXAMINATION

SEMESTER / SESSION	:	SEM 1 2019/2020	*PROGRAMME*	:	DAM
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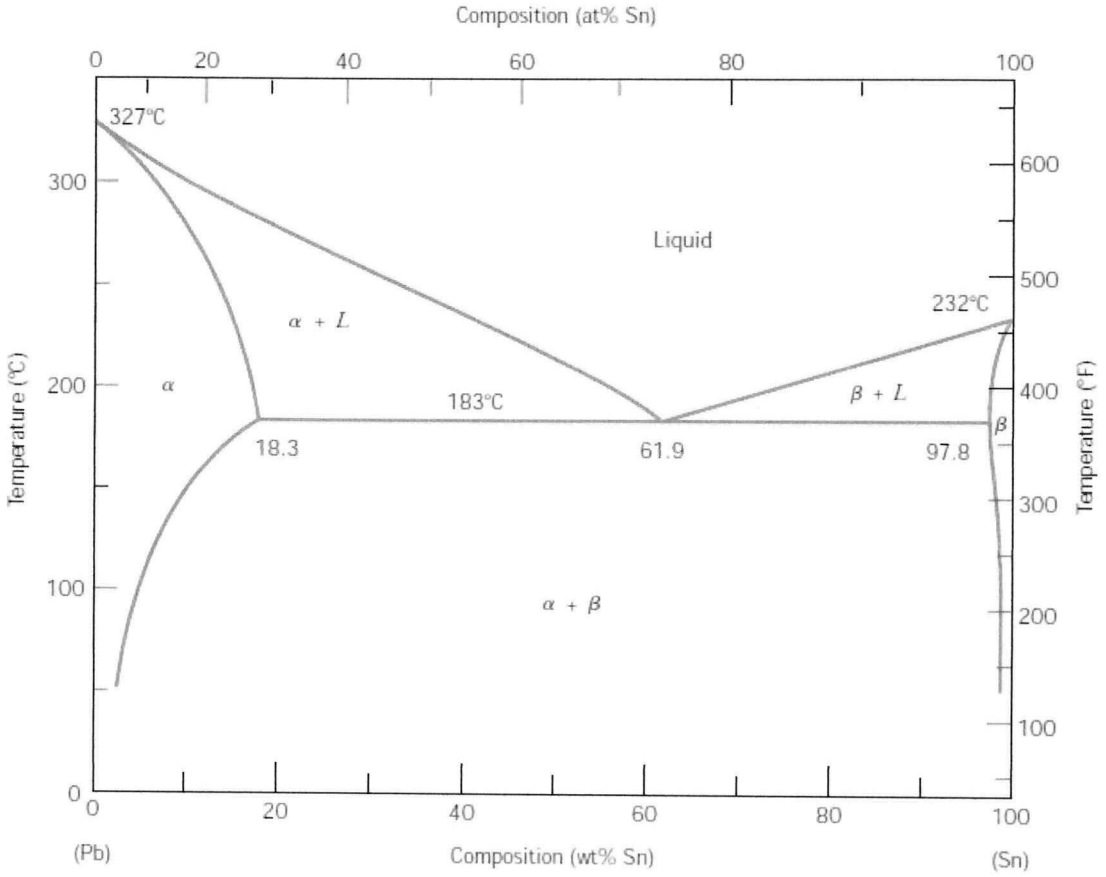

Figure Q5(d)