Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2016/2017

COURSE NAME	:	MATERIALS SCIENCES
COURSE CODE	:	BDA 10803
PROGRAMME CODE	:	BDD
EXAMINATION DATE	:	JUNE 2017
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWERS **FIVE (5)** QUESTIONS **ONLY**

THIS QUESTION PAPER CONSISTS OF **SIX (6)** PAGES

Q1 (a) Define 'Materials Science and Engineering'.

(3 marks)

(b) Explain 'smart materials'.

(5 marks)

(c) Illustrate the microstructures of different types of cast iron.

(8 marks)

(d) Differentiate the forging and rolling in forming process of metals.

(4 marks)

Q2 (a) List the factors that form the essence of Materials Science and Engineering.

(3 marks)

(b) Describe the procedure of solid casting and drain casting processes for ceramics.

(5 marks)

(c) Illustrate the green ceramics that may be produced from solid slip casting and drain slip casting.

(4 marks)

(d) Sketch a simple cubic unit cell and show the value of the atom at the corner of the cube.

(4 marks)

(e) Compare the different types of raw ceramic materials applied for slip casting, extrusion, injection moulding and dry pressing in forming process of ceramics.

(4 marks)

Q3 (a) What is an elastomer?

(3 marks)

(b) Explain the polymerization process.

(4 marks)

(c) Sketch the following in a cubic unit cell.
(i) $[1\ \bar{2}\ 0]$ and $(1\ \bar{2}\ 0)$
(ii) $[1\ 0\ \bar{3}]$ and $(1\ 0\ \bar{3})$

(6 marks)

(d) Sketch a crystal system of cubic unit cells which shows the lattice, lattice points and the lattice parameters.

(3 marks)

(e) Distinguish thermoplastics and thermosets in terms of its structure and recyclability.

(4 marks)

Q4 (a) Explain the function of THREE (3) main components in composite materials.

(6 marks)

(b) In an aligned and continuous glass fiber-reinforced nylon 6,6 composite, the fibers are to carry 94 % of load applied in the longitudinal direction. Elastic modulus for glass fiber and nylon 6,6 are 72.5 GPa dan 3.0 GPa respectively. Meanwhile the tensile strength are $\sigma_{glass\ fiber}$ = 3400 MPa and σ_{nylon} =76 MPa.

(i) Determine the volume fraction of fiber that will be required.

(4 marks)

(ii) What will be the tensile strength, σ_c for this composite? Assume that the matrix stress at fiber failure is 30 MPa.

(2 marks)

(c) You are given a Metal X for certain engineering application. In order to confirm the capability of the Metal X for the required application, you need to know its properties such as the ability to withstand an applied stress and to deform plastically by absorbing energy. Choose TWO (2) suitable mechanical tests that can be carried out to determine the above properties for the metal.

(4 marks)

(d) Distinguish between elastic and plastic deformation.

(4 marks)

Q5 (a) Sketch a typical creep curve of strain versus time at constant stress and constant elevated temperature, and explain all three stages of creep.

(8 marks)

(b) Is it possible to have a Frenkel defect in covalent crystal? Why?

(2 marks)

(c) Describe TWO (2) examples of materials processing that applied diffusion mechanism.

(4 marks)

(d) The surface of a steel gear made of 1018 steel (0.18 wt % C) is to be gas-carburized at 927°C. Calculate the time necessary to increase the carbon content to 0.35 wt % at

1.00 mm below the surface of the gear after an 8.0 hour carburizing time. Assume the carbon content at the surface of the gear is 1.20 wt %. D (C in γ iron) at 927°C = 1.28 × 10^{-11} m^2/s. (Refer to **Table Q5 (d)** for Tabulation of Error Function Values)

Fick's Law for nonsteady-state diffusion;

$$\frac{C_s - C_x}{C_s - C_o} = erf\left(\frac{x}{2\sqrt{Dt}}\right) \quad \text{or} \quad \frac{C_x - C_o}{C_s - C_o} = 1 - erf\left(\frac{x}{2\sqrt{Dt}}\right)$$

(6 marks)

Q6 (a) Explain the following terms;

(i) a phase in material

(ii) a phase diagram

(4 marks)

(b) **Figure Q6 (b)** shows the phase diagram for Ag-Cu binary system. At 780 °C-ΔT, make a phase analysis for Ag-Cu alloy (50 wt% Cu) in its composition by assuming the system in equilibrium condition.

(i) What phases are present?

(ii) What is the chemical composition of each phase?

(iii) What amount of each phase is present (portion of each phase)?

(iv) Sketch the microstructure.

(11 marks)

(c) Sketch time-temperature cooling paths for a 1080 steel on an isothermal transformation diagram that will produce the following microstructures. Start with the steels in the austenitic condition at time = 0 and 850°C.

(i) 100 percent martensite,

(ii) 50 percent martensite and 50 percent coarse pearlite

(iii) 100 percent lower bainite

(5 marks)

-END OF QUESTIONS –

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Table Q5 (d): Tabulation of Error Function

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	0.9253
0.5	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

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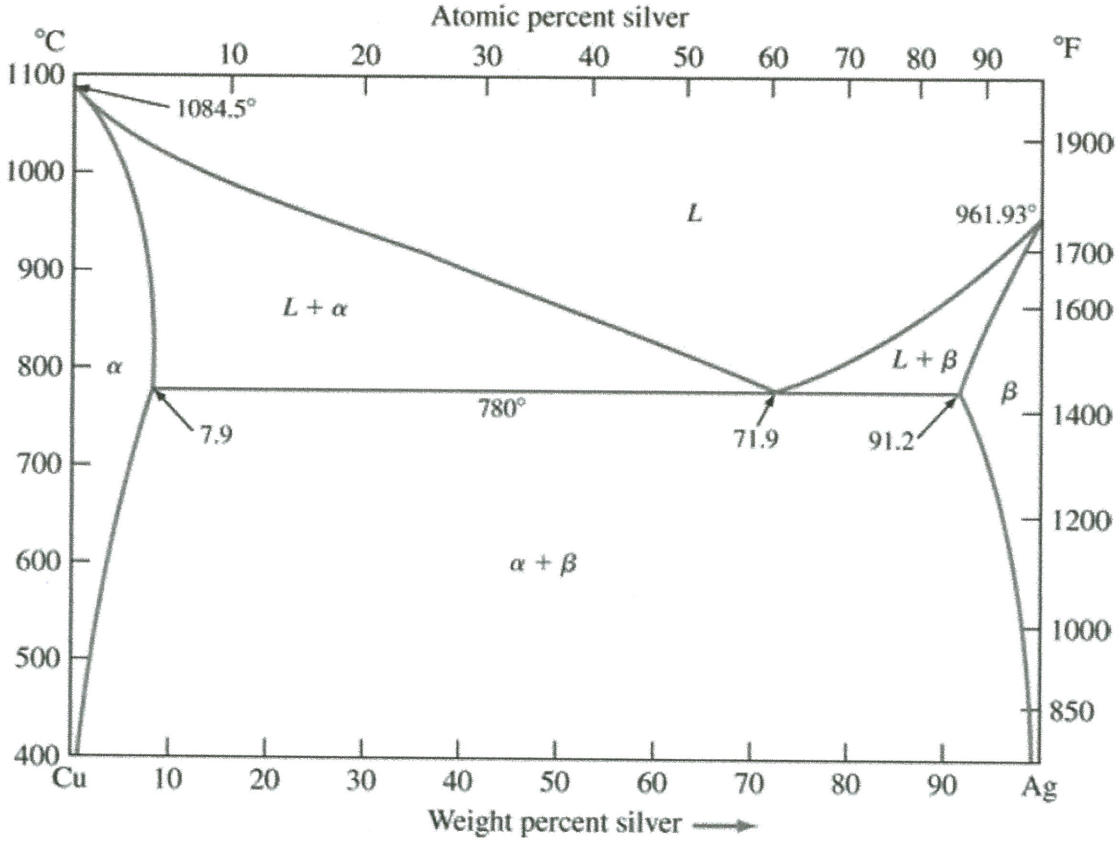

Figure Q6 (b): Tabulation of Error Function Values