UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2022/2023

COURSE NAME	:	MATERIALS SCIENCE
COURSE CODE	:	BDA 10803
PROGRAMME	:	1 BDD
EXAMINATION DATE	:	FEBRUARY 2023
DURATION	:	3 HOURS
INSTRUCTION		1. ANSWER ALL QUESTIONS
		2.THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSED BOOK**.
		3.STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

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

Q1 (a) List FOUR (4) type of Bravais unit cells

(2 marks)

(b) Explain how the simple cubic structure will having 48% of empty space in a unit cell

(4 marks)

(c) Identify the Miller indices of the cubic crystal for the directions and planes as in **Figure Q1(c)**

(4 marks)

(d) (i) Calculate the volume in cubic nanometer of the titanium crystal structure unit cell. Titanium is hexagonal close pack (HCP) at 20°C with $a = 0.2950$ nmand $c = 0.4683$ nm.

(5 marks)

(ii) Face centre cubic (FCC) Aluminum has a lattice constant of 0.4049 nm. Calculate the atomic density for the direction [100] and plane (100).

(5 marks)

Q2 (a) List TWO (2) types of mechanical testing

(2 marks)

(b) Explain briefly the different between izod and charpy impact test

(2 marks)

(c) Describe the deformation of ductile and brittle materials by giving an appropriate plot of stress and strain diagram for both materials

(4 marks)

(d) Consider an aluminium bar is subjected to a load with 360 KPa. The initial diameter and after loading are measured and given as below:
Initial specimen diameter, $d_o = 0.05$ m
Diameter of specimen under load, $d_i = 0.04$ m

Calculate :

(i) Engineering stress
(ii) Engineering strain.
(iii) True stress
(iv) True strain.

(12 marks)

Q3 (a) State TWO (2) types of volume defects.

(2 marks)

(b) Demonstrate the application of diffusion mechanism in the materials processing

(4 marks)

(c) Describe a substitutional solid solution and an interstitial solid solution.

(4 marks)

(d) Phosphorus is diffused into a thick slice of silicon with no previous phosphorus in it at a temperature of 1000°C. If the surface concentration of the phosphorus is 1×10^{18} atoms/cm^3 and its concentration at 1 μm is 1×10^{15} atoms/cm^3, how long must the diffusion time be? $D = 3.0 \times 10^{-13}$ cm^2/s for P diffusing in Si at 1000°C. Given Tabulation of Error Function Values in **Table Q3(d).**

(7 marks)

(e) If the diffusivity in **Q3 (d)** had been 1.5×10^{-13} cm^2/s, at what depth in micrometers would the phosphorus concentration be 1×10^{15} atoms/cm^3?

(3 marks)

Q4 (a) Define heat treatment.

(2 marks)

(b) Relate the heat treatment with its purpose.

(6 marks)

(c) An alloy is the combination of metal X and metal Y. The melting temperature are 1050°C and 900°C for metal X and metal Y respectively. The eutectic reaction occurred at 45 wt% X and 600°C. The solidus and solvus line meet at 10 wt%Y and 90 wt%Y respectively. Sketch the alloy phase diagram.

(6 marks)

(d) **Figure Q4(d)** shows the TTT diagram. Sketch and label the time-temperature paths to produce the following microstructures:

(i) 50 % bainite, 50% martensite
(ii) 100% bainite
(iii) 50% pearlite, 50% martensite

Attach the **Figure Q4(d)** with your answer script.

(6 marks)

Q5 (a) Identify suitable materials with their properties that can be proposed as a ship propeller, spark plug, bicycle helmet and surgical implant (**Figure Q5(a)**).
(8 marks)

(b) Sketch hand-lay-up and filament winding techniques and list the steps involved in the fabrication of composites parts
(12 marks)

-END OF QUESTIONS-

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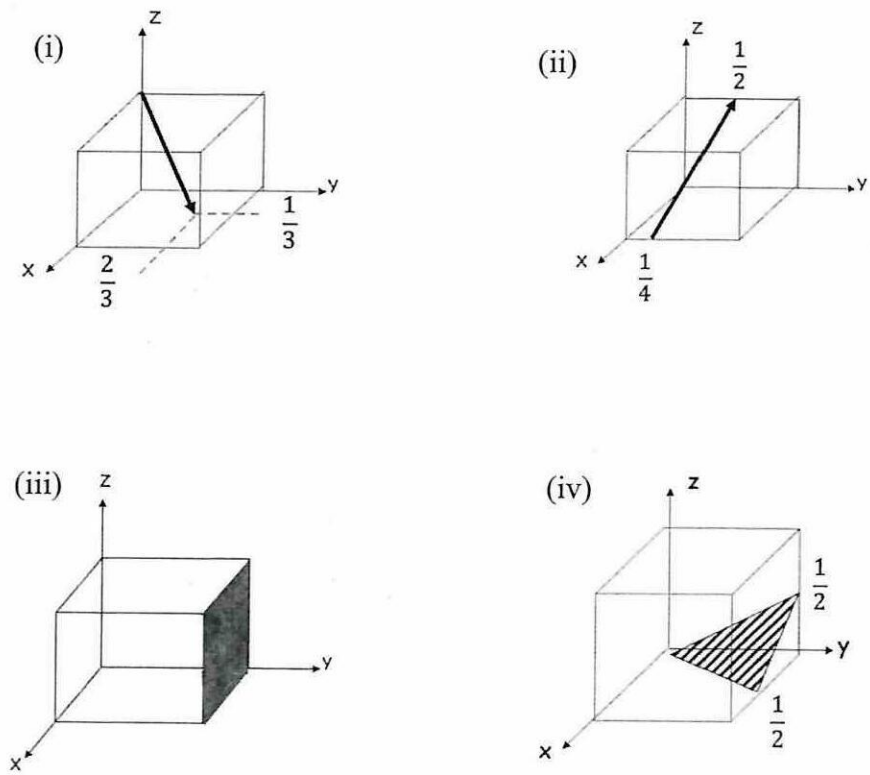

Figure Q1(c)

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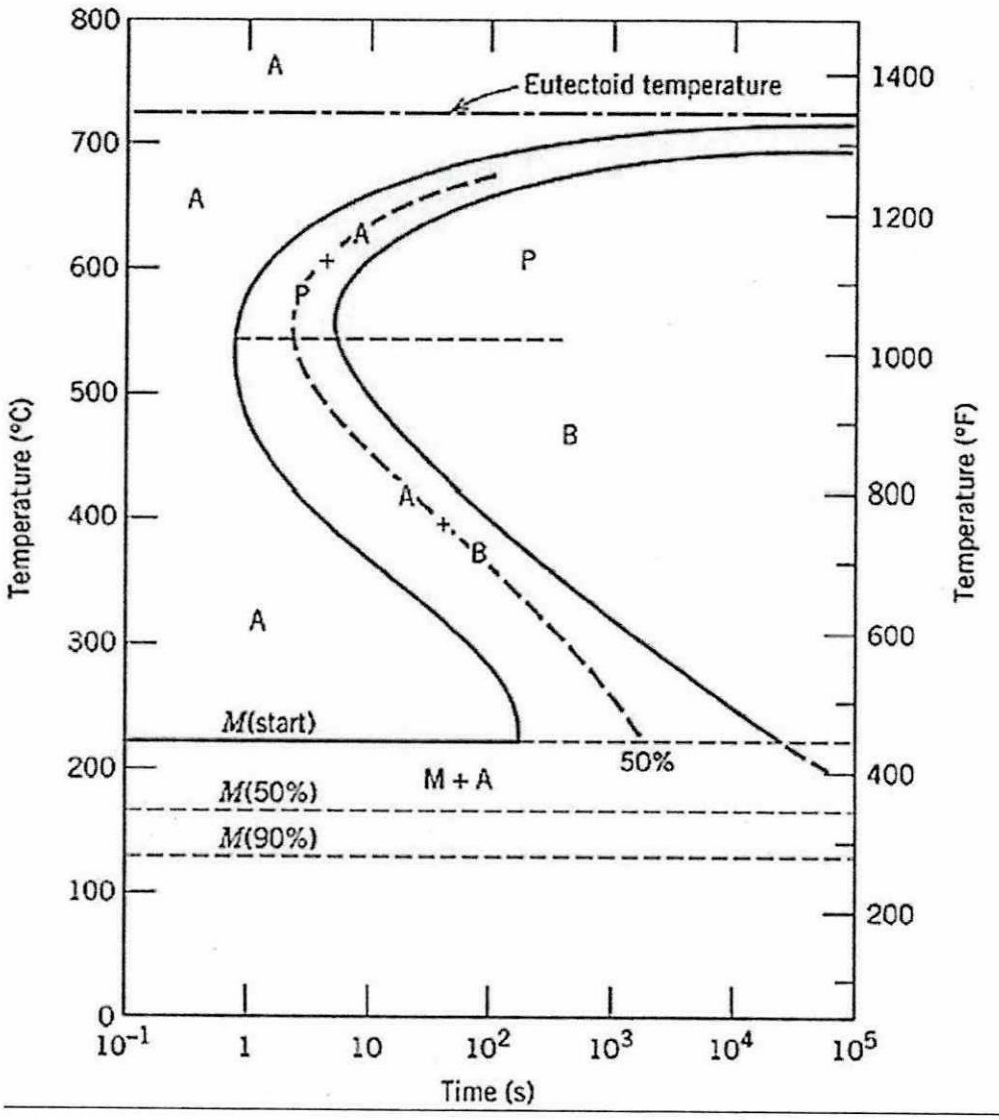

Figure Q4(d)

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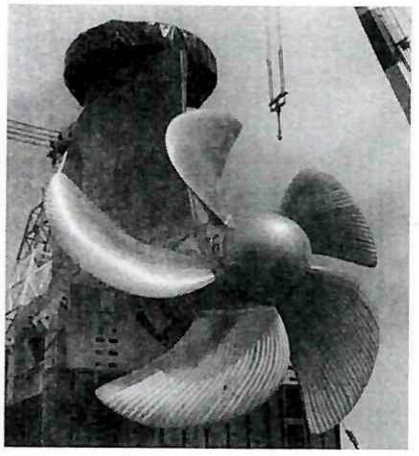

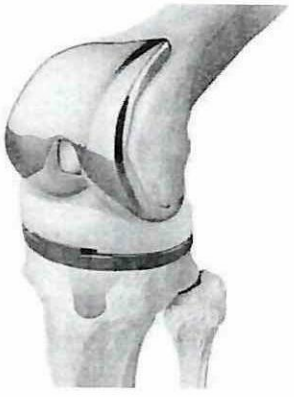

Figure Q5(a)

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Table Q3(d)

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