



**UTHM**  
Universiti Tun Hussein Onn Malaysia

**UNIVERSITI TUN HUSSEIN ONN MALAYSIA**

**FINAL EXAMINATION  
SEMESTER II  
SESSION 2022/2023**

COURSE NAME : MATERIALS SCIENCE

COURSE CODE : BDA 10803

PROGRAMME CODE : BDD

EXAMINATION DATE : JULY/AUGUST 2023

DURATION : 3 HOURS

INSTRUCTION : 1. ANSWERS **ALL THE** QUESTIONS  
2. THIS FINAL EXAMINATION IS  
CONDUCTED VIA **CLOSED** BOOK.  
3. STUDENTS ARE **PROHIBITED** TO  
CONSULT THEIR OWN MATERIALS  
OR ANY EXTERNAL RESOURCES  
DURING THE EXAMINATION  
CONDUCTED VIA **CLOSED** BOOK.

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

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- Q1** (a) List TWO (2) types of materials classification in engineering and give ONE (1) example or application. (4 marks)
- (b) Calculate the atomic packing factor for FCC cubic crystal structure. (6 marks)
- (c) Identify the Miller indices of the directions and planes as shown in **Figure Q1(c)**. (10 marks)
- Q2** (a) List TWO (2) types of mechanical testing (2 marks)
- (b) Sketch a stress-strain graph for a ductile metal. Indicate in the graph all the stated information below: (6 marks)
- (i) Fracture point.
  - (ii) Ultimate tensile strength.
  - (iii) Elastic region.
  - (iv) Plastic region.
  - (v) Elastic (Young) modulus.
- (c) Consider an aluminium bar which is subjected to a load with 250 KPa. The initial diameter and after loading are measured as below:  
Initial specimen diameter,  $d_o = 0.05$  cm  
Diameter of specimen under load,  $d_i = 0.049$  cm  
Calculate: (12 marks)
- i) Engineering stress.
  - ii) Engineering strain.
  - iii) True stress.
  - iv) True strain.
- Q3** (a) Describe and illustrate the following imperfections that can exist in crystal lattices: (5 marks)
- (i) Frenkel imperfection.
  - (ii) Schottky imperfection.

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- (b) Discuss the reasons why interstitial diffusion is normally more rapid than vacancy diffusion. (5 marks)
- (c) The surface of a steel gear made of 1022 steel (0.22 wt % C) is to be gas-carburized at 927°C. Calculate the time necessary to increase the carbon content to 0.30 wt % at 0.030 cm below the surface of the gear. Assume the carbon content of the surface to be 1.20 wt %.  $D$  (C in  $\lambda$  iron) at 927°C =  $1.28 \times 10^{-11}$  m<sup>2</sup>/s. Tabulation of errors function values is provided in Table Q3(c). (10 marks)

- Q4** (a) (i) State THREE (3) types of binary phase diagram. (3 marks)
- (ii) Sketch ALL THREE (3) phase diagram in (a)(i) complete with solvus and solidus line with an appropriate example of metal system. (3 marks)
- (b) Refer to **Figure Q4(b)**, consider an alloy containing 85 wt% Ag and 15 wt% Cu. Calculate a phase analysis at 1050°C+ $\Delta$ T, 850°C and 780°C- $\Delta$ T by assuming the equilibrium conditions.
- (i) State the phases that are present. (3 marks)
- (ii) Calculate the chemical composition of each phase. (3 marks)
- (iii) Calculate the amount of each phase is present. (4 marks)
- (iv) Sketch the microstructure of the alloy using circular microscopic fields. (4 marks)

- Q5** (a) Discuss TWO (2) properties of thermoplastic and thermoset (4 marks)
- (b) Discuss the differences between metal, ceramic and polymer in terms of bonding, structure and properties. (9 marks)
- (c) State THREE (3) main types of composites materials (3 marks)
- (d) By using at least TWO (2) criteria discuss the advantages and limitation of composite materials as compared to other types of materials. (4 marks)

-END OF QUESTIONS-

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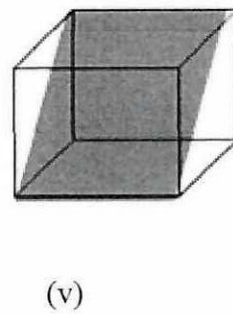
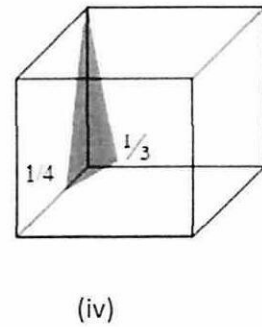
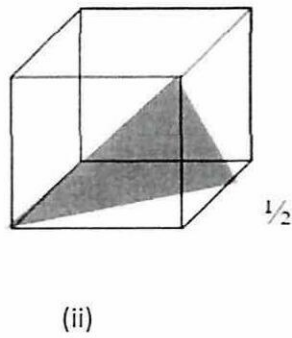
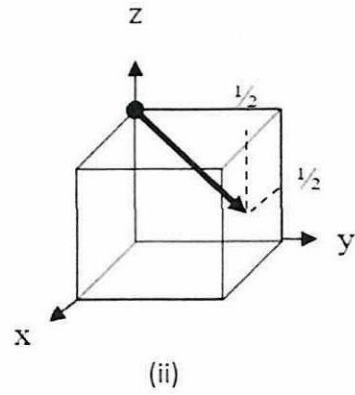
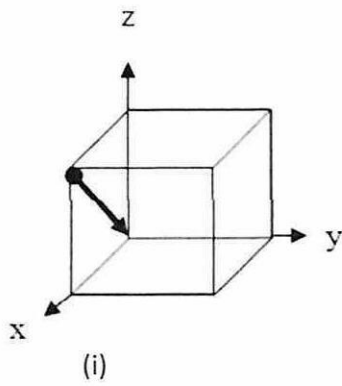


Figure Q1(c) : Plane and direction of cubic crystal structure

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**FINAL EXAMINATION**SEMESTER / SESSION : SEM II/ 2022/2023  
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$z$	$erf(z)$	$z$	$erf(z)$	$z$	$erf(z)$
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

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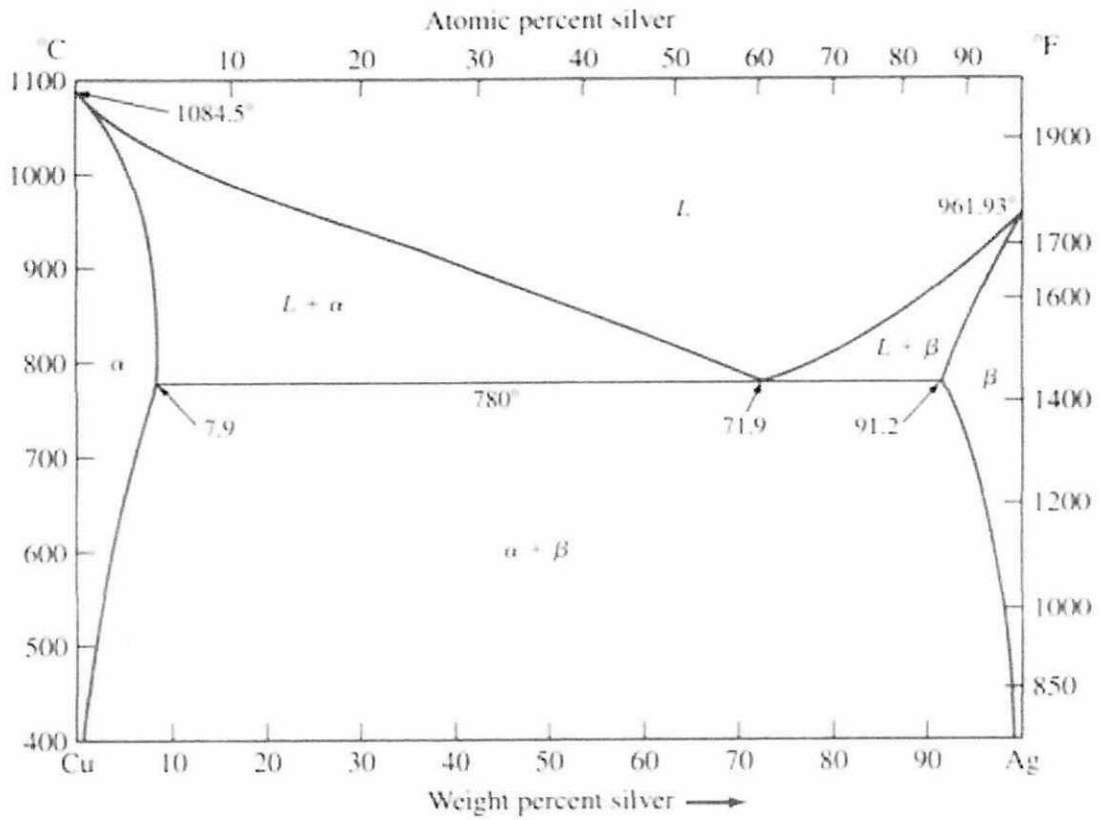


Figure Q4(b) : Binary Phase diagram of Cu-Ag in equilibrium

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