UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
(ONLINE)
SEMESTER II
SESSION 2020/2021

COURSE NAME	:	MATERIALS SCIENCE
COURSE CODE	:	BDA 10803
PROGRAMME	:	BDD
EXAMINATION DATE	:	JULY 2021
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **FIVE (5)** PAGES

SECTION A

Q1 (a) Convert these indices into 3D space lattice with suitable x, y and z axis. Show your brief calculation.

(i) [1 0 2]
(ii) [2 3 1]
(iii) (3 4 5)
(iv) (3 0 2)

(8 marks)

(b) Prove that more than 8% volume change took place when ferritic iron changes its structure to austenitic iron when heated above 723°C. Assume that iron atomic radius maintained.

(12 marks)

Q2 (a) How toughness can be measured from mechanical testing? Explain.

(8 marks)

(b) A tensile test on a 1 mm diameter coupon ends up with the data as shown in **Table Q2(b)**.

(i) Plot a stress-strain graph using the given data.

(10 marks)

(ii) Calculate the Young's modulus of this material.

(2 marks)

Q3 (a) What factors would you consider in order for establishing an alloy by means of interstitial solid solution?

(8 marks)

(b) Refer to the **Table Q3(b)**, Calculate the activation energy in kJ/mol for the diffusion of carbon atoms in the FCC iron lattice. [R = 8.314 J/(mol·K).]

(4 marks)

(c) The FCC iron bar is undergoing the caburizing process at temperature 1000°C. Initially carbon concentration is 0.25 wt% and maintained at 1.20 wt% on the surface. How long will it take to achieve a carbon content of 0.80% at a position 0.5 mm below the surface? The diffusion coefficient for carbon in iron at this temperature is 1.6×10^{-11} m^2/s

(4 marks)

(d) Sketch the posible diffusion of carbon atoms in FCC iron lattice and diffusion of iron atoms in FCC iron lattice.

(4 marks)

Q4 (a) Explain the process to produce steel martempering and austempering by using time-temperature-transformation (TTT) diagram.

(8 marks)

(b) The metallic alloy A-B starts to melt at 150°C. However, the melting process of pure metal A is complete at 250°C while the melting point of pure metal B is complete at 330°C. The metal A is produces α-phase and metal B is produces β-phase. The eutectic phase is observed when 60wt% of pure metal A combine with metal B. Sketch with an appropriate label the phase diagram of metallic alloy A-B.

(4 marks)

(c) Based on the sketched phase diagram of metallic alloy A-B in Q4(b), calculate the percentage of eutectic-α and eutectic-β at the constitution point of A-80wt% B and 100°C.

(8 marks)

Q5 (a) You received 2 different rigid thin panels (panel A and B) for your research project. The panels were made from thermoplastic and thermoset. Unfortunately, there were not labelled. What you can do to identify them accurately?

(4 marks)

(b) Sketch the possible structure of panel A and B in Q5(a) if the panel A is identified as polypropylene and panel B is polyester.

(4 marks)

(c) Illustrate with explaination the process to produce the raw material that have been used in panel A

(8 marks)

(d) The panel A has limitation to be used in structure application due to its low strength. Explain the modification that can be applied to improve the strength of the material.

(4 marks)

-END OF QUESTIONS –

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Table Q2(b)

Load (kN)	Elongation (mm)
0	0
2	0.5
4	1
5	1.5
8	2
8.5	2.8
8.7	4
8.9	5.5
9	7
8.8	9

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Table Q3(b)

Solute	Solvent (host structure)	Diffusivity, m^2/s 500°C (930°F)	Diffusivity, m^2/s 1000°C (1830°F)
1. Carbon	FCC iron	(5×10^{-15})*	3×10^{-11}
2. Carbon	BCC iron	10^{-12}	(2×10^{-9})
3. Iron	FCC iron	(2×10^{-23})	2×10^{-16}
4. Iron	BCC iron	10^{-20}	(3×10^{-14})
5. Nickel	FCC iron	10^{-23}	2×10^{-16}
6. Manganese	FCC iron	(3×10^{-24})	10^{-16}
7. Zinc	Copper	4×10^{-18}	5×10^{-13}
8. Copper	Aluminum	4×10^{-14}	10^{-10} M†
9. Copper	Copper	10^{-18}	2×10^{-13}
10. Silver	Silver (crystal)	10^{-17}	10^{-12} M
11. Silver	Silver (grain boundary)	10^{-11}	
12. Carbon	HCP titanium	3×10^{-16}	(2×10^{-11})