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**UNIVERSITI TUN HUSSEIN ONN MALAYSIA**

**FINAL EXAMINATION  
SEMESTER I  
SESSION 2021/2022**

COURSE NAME : MATERIAL SCIENCE  
COURSE CODE : BWC 30503  
PROGRAMME CODE : BWC  
EXAMINATION DATE : JANUARY / FEBRUARY 2022  
DURATION : 4 HOURS  
INSTRUCTION : 1. ANSWER **ALL** QUESTIONS  
2. THIS FINAL EXAMINATION IS A **TAKE HOME ASSESSMENT AND CONDUCTED VIA OPEN BOOK**

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

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- Q1** (a) (i) Explain the reason why an amorphous materials may form in nature. (2 marks)
- (ii) Discuss why some materials melt and some materials soften when heated. (4 marks)
- (b) A Debye-Scherrer powder diffraction experiment using incident copper (Cu)  $K_{\alpha}$  ( $\lambda = 1.54 \text{ \AA}$ ) radiation gave the following set of reflections expressed as  $2\theta$ : 26.52, 37.85, 46.81, and 54.60.
- (i) Determine the crystal structure. (6 marks)
- (ii) Calculate the lattice constant,  $a$ . (5 marks)
- (iii) Calculate the density of this element which has an atomic weight of 183.49 g/mol and the Avogadro's constant is  $6.02214086 \times 10^{23} \text{ mol}^{-1}$ . (3 marks)
- (c) Define the following term;
- (i) Eutectic  
(ii) Peritectic  
(iii) Isomorphous  
(iv) Eutectoid  
(v) Peritectoid (5 marks)

**Q2** **Figure Q2** represents the phase diagram of Fe-Fe<sub>3</sub>C phase diagram.

- (a) Analyze the phase diagram and calculate the percentage of the phases present for 0.5 wt% C Fe<sub>3</sub>C at the following temperature:
- (i) 1000 °C  
(ii) 760 °C  
(iii) 720 °C (12 marks)
- (b) Sketch the possible microstructural development at **FOUR (4)** different stages that occurs for Fe-Fe<sub>3</sub>C at 0.5 wt% C cooling from 1200 °C to 450 °C using the aid of the Fe-Fe<sub>3</sub>C phase diagram. (8 marks)
- (c) Explain the differences in terms of the microstructures formed in the hypo-eutectoid region and the hyper-eutectoid region. (5 marks)

- Q3** (a) Discuss the metal fabrication techniques used in the application of vehicles industry. (Hint: Sketch suitable diagram to support your discussion) (9 marks)
- (b) Austenite and martensite structure forms differently due to the cooling rate of the steel alloy. Differentiate the process to form these two structures and their characteristics. (8 marks)
- (c) Based on the time-temperature-transformation (TTT) diagram of 0.77 wt% C steel shown in **Figure Q3 (c)**, analyze and calculate the following:
- (i) the time required for austenite to transform to 50 % pearlite at 600 °C.
  - (ii) the time required for austempering at 5 °C above the  $M_s$  temperature. (8 marks)
- Q4** (a) Differentiate between thermoplastic and thermoset polymers. (4 marks)
- (b) There are different types of plastics and each one are made to suit different applications. Explain **THREE (3)** types of plastic, their properties and their applications. (12 marks)
- (c) Nanomaterials are structures within the nanometer scale with superior properties as compared to its bulk material. Discuss the advantages of using nanomaterials as compared to their bulk materials for different types of applications. (9 marks)

– END OF QUESTIONS –

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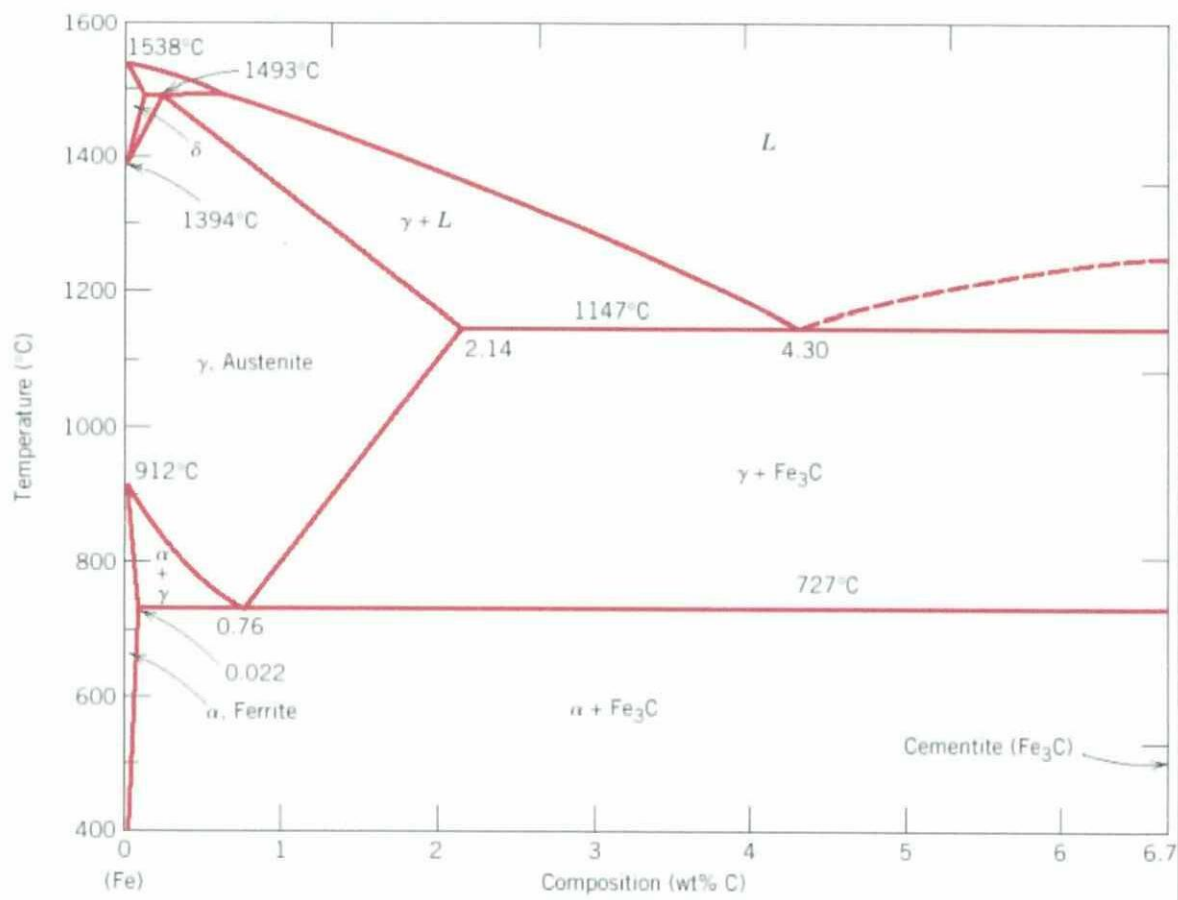


Figure Q2

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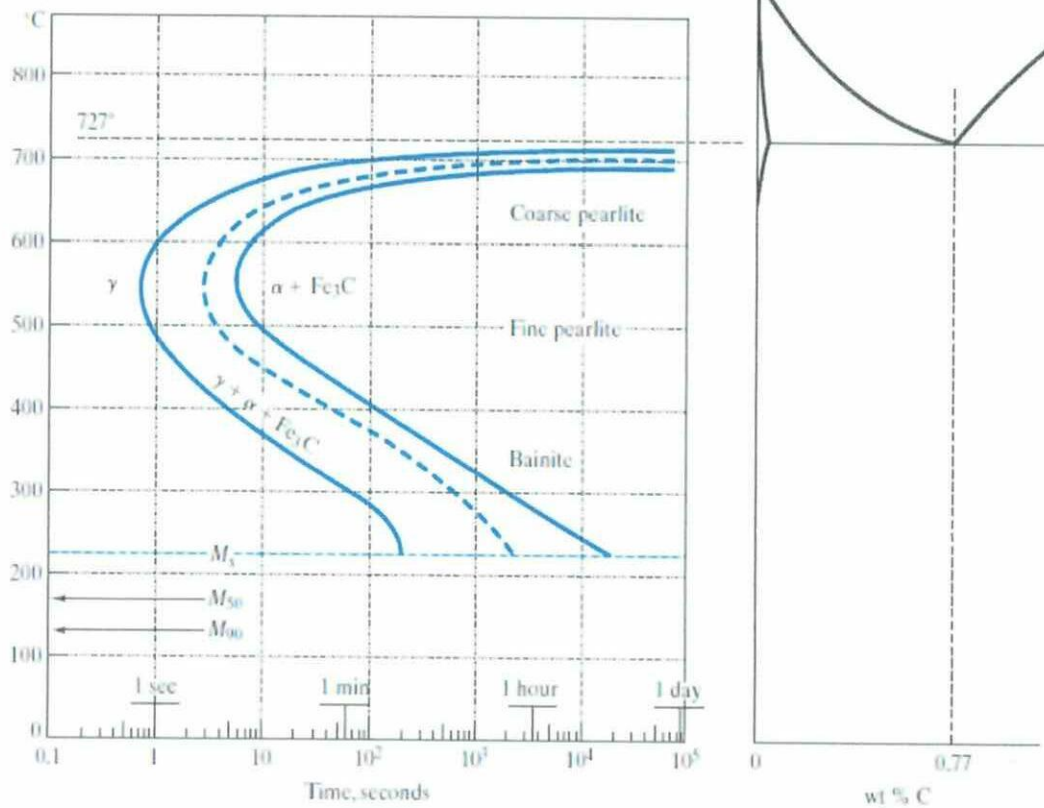


Figure Q3 (c)

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