



**UNIVERSITI TUN HUSSEIN ONN MALAYSIA**

**FINAL EXAMINATION  
SEMESTER I  
SESSION 2019/2020**

COURSE NAME : MATERIAL SCIENCE  
COURSE CODE : BWC 30503  
PROGRAMME CODE : BWC  
EXAMINATION DATE : DECEMBER 2019 / JANUARY 2020  
DURATION : 3 HOURS  
INSTRUCTION : ANSWER ALL QUESTIONS

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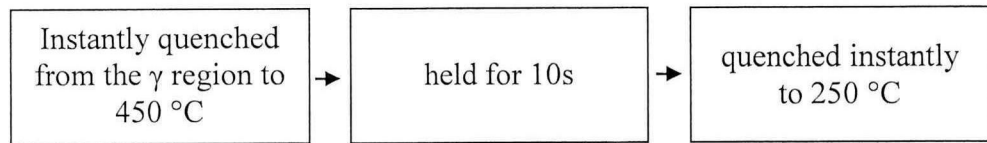
THIS QUESTION PAPER CONSISTS OF **SIX (6)** PAGES

- Q1** (a) Differentiate the characteristic properties of crystalline solid to an amorphous solid. Sketch diagrams to help support the differentiation. (8 marks)
- (b) The first three diffraction peak of a metal powder are  $2\theta = 44.4^\circ$ ,  $64.6^\circ$  and  $81.7^\circ$  using  $\text{CuK}_\alpha$  radiation.
- (i) Calculate the lattice parameter for this metal (5 marks)
- (ii) Determine the crystal structure (BCC or FCC) and justify your answer. (3 marks)
- (iii) Calculate the density of this metal in units of  $\text{g/cm}^3$ . (4 marks)
- Q2** **Figure Q2** shows the Cu-Ni phase diagram.
- (a) Apply the Gibbs phase rules to calculate the degree of freedom in each phase region in the Cu-Ni phase diagram. (6 marks)
- (b) Calculate the amount and the composition of each phase/s present at position
- (i) A
- (ii) B
- as labelled in **Figure Q2**. (6 marks)
- (c) Illustrate the microstructural changes that occurs upon cooling a 30% wt. Ni Cu-Ni alloy from  $1400^\circ\text{C}$  to  $1050^\circ\text{C}$ . Labels the illustration with percentage of each phase present and their composition. (8 marks)
- Q3** (a) **Figure Q3(a)** shows the Fe-Fe<sub>3</sub>C phase diagram. Assuming a total of 100 kg of cast iron is formed at  $1149^\circ$  of 3.0 wt% C.
- (i) Calculate the amount of proeutectic  $\gamma$  in the final microstructure. (4 marks)
- (ii) Plot the weight percent of phases present as a function of temperature for the 3.0 wt% C white cast from  $1400^\circ\text{C}$  cooled to  $400^\circ\text{C}$ . (8 marks)

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(b) With the aid of time-temperature-transformation (TTT) diagram shown in **Figure Q3(b)**,

(i) Determine the microstructure of 0.77% C steel that has the following treatment:



(3 marks)

(ii) Determine the resulting microstructure if the above process continue to be held for 1 day at 250 °C and then cooled to room temperature.

(2 marks)

(iii) Estimate the quench rate needed to avoid pearlite formation in the 0.77% C steel.

(3 marks)

**Q4** (a) Fiberglass is a classic example of a modern composite system. Name and sketch out **THREE (3)** common fiber configurations for composite reinforcement.

(6 marks)

(b) Differentiate between sand, die and investment casting process for metal fabrication.

(10 marks)

(c) Ceramics can be classified into silicate ceramics, non-silicate oxide ceramics, non-oxide ceramics and glass ceramics. Name **ONE (1)** application for each of the ceramic classes.

(4 marks)

**Q5** (a) Explain the process for both condensation and addition polymerization.

(8 marks)

(b) Distinguish the differences between thermoset and thermoplastic polymers.

(8 marks)

(c) Name **FOUR (4)** examples of advance materials used in today's technology.

(4 marks)

– END OF QUESTIONS –

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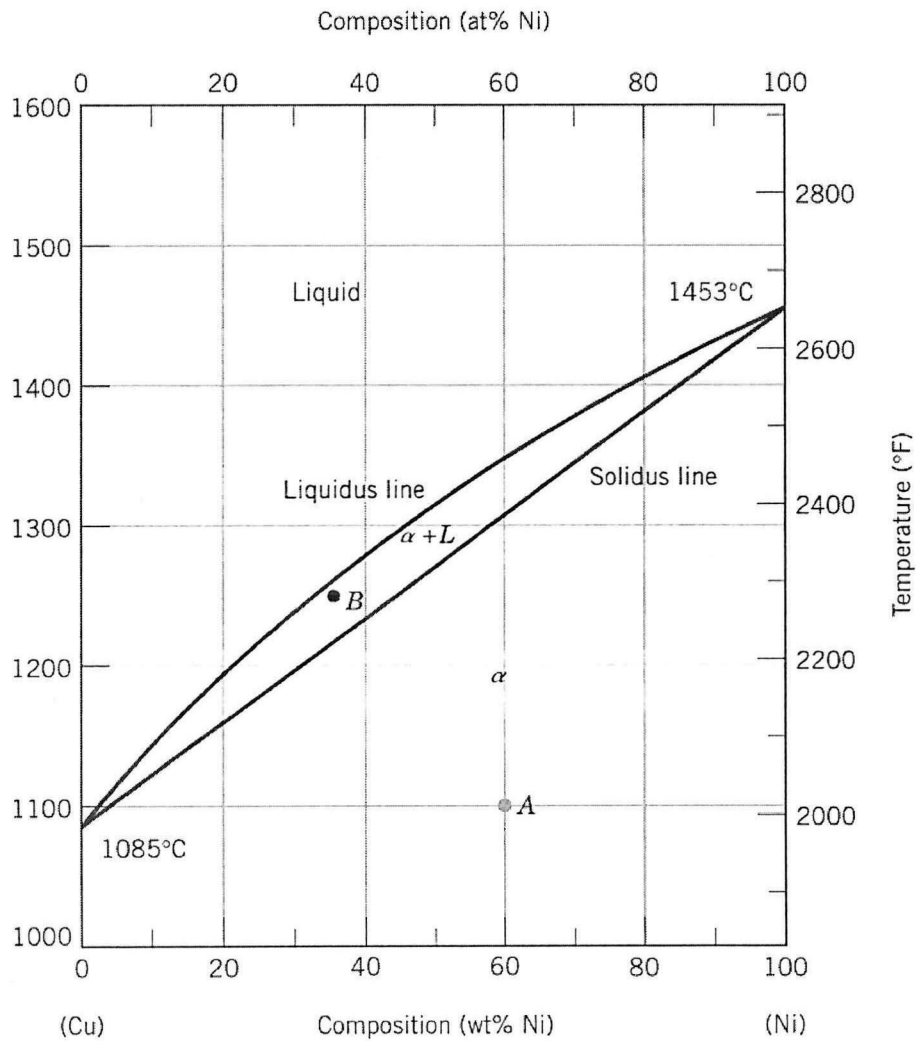


Figure Q2

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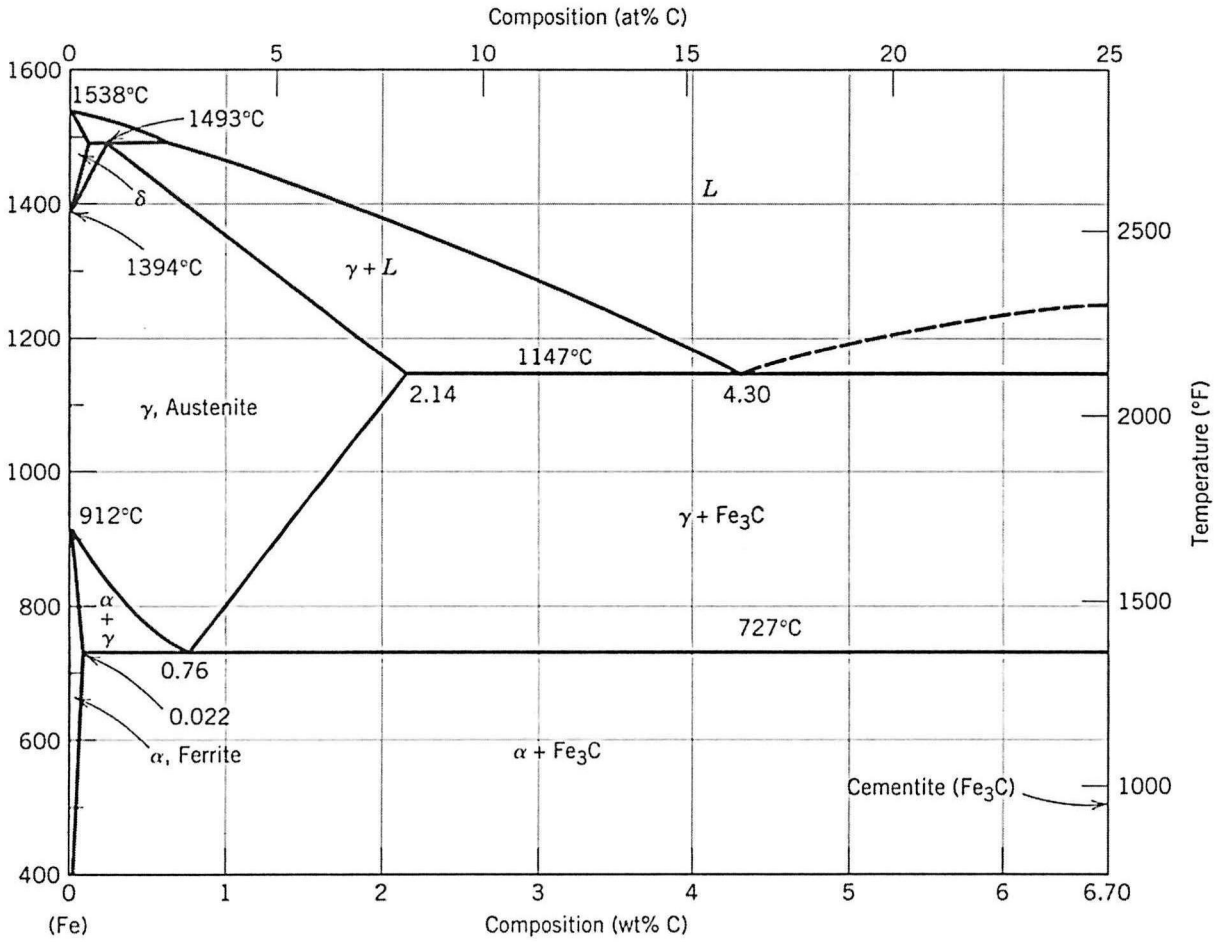


Figure Q3 (a)

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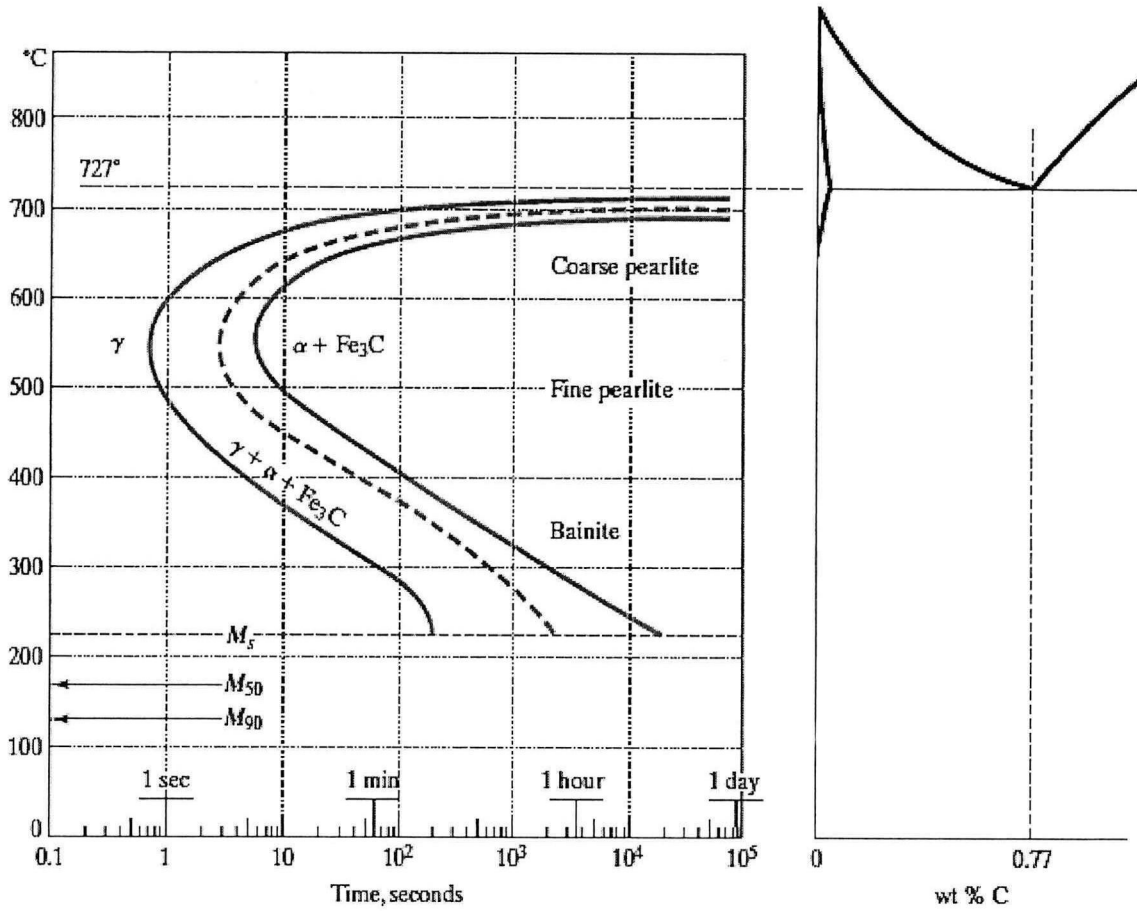


Figure Q3 (b)

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