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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

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

COURSE NAME : MATERIAL SCIENCES
COURSE CODE : DAM14203
PROGRAMME CODE : DAM
EXAMINATION DATE : JULY / AUGUST 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 **SIX (6)** PAGES

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- Q1** (a) Define the following terms.
- i. Phase (1 marks)
 - ii. Phase diagram (1 marks)
 - iii. Component. (1 marks)
- (b) List out **THREE (3)** types of invariant reaction. (3 marks)
- (c) Sketch a schematic phase diagram of Cu-Ni completed with labels at every phase region, the boundary line and the axis. (Given that the melting point of pure Cu and Ni is 1085 °C and 1453 °C, respectively). (7 marks)
- (d) **Figure Q1(d)** shows the Cu-Ag phase diagram.
- i. Illustrate the microstructure at points A and B, complete with labels. (4 marks)
 - ii. Determine the percentage of α and β at point B. (3 marks)
- Q2** (a) Define heat treatment. (2 marks)
- (b) Explain **THREE (3)** different types of heat treatment for steel, including the specific procedures involved in each process and the intended resulting microstructure (6 marks)
- (c) Explain the Time-Temperature Transformation (TTT) Diagram (3 marks)
- (d) Eutectoid steel (contain 0.8% carbon) was heated-treated to obtain the following microstructure. Draw the schematic TTT diagram and the cooling curve.
- i. 100% Banite (2 marks)
 - ii. 100% pearlite (2 marks)
 - iii. 50% pearlite 50% martensite (2 marks)
- (e) Describe the effect of carbon on the hardenability of steel. (3 marks)

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- Q3**
- (a) List **TWO (2)** types of metals, provide **TWO (2)** examples for each type, and describe their common applications. (4 marks)
 - (b) Explain the effect of chromium on steel, particularly on corrosion resistance, strength and hardness. (3 marks)
 - (c) Describe the primary benefits and drawbacks of using aluminium in vehicle components. (4 marks)
 - (d) Explain the properties of unalloyed copper and suggest how to improved it. (2 marks)
 - (e) List **TWO (2)** copper alloys, including their predominant alloying elements, the percentage of alloying elements, and their respective applications. (3 marks)
 - (f) Draw a schematic microstructure of nodular cast iron and grey cast iron with labels indicating the phases present in each microstructure. (4 marks)
- Q4**
- (a) Explain the differences between elastomers, thermoplastics, and thermosets in terms of their properties and behavior under heat and stress. (3 marks)
 - (b) Describe how composite materials work by explaining the roles of the reinforcing components and the matrix, and how they transfer loads effectively. (3 marks)
 - (c) Explain the classification of composites and provide examples for each type. (6 marks)
 - (d) Explain the differences between traditional and advanced ceramics in terms of their raw material, application, properties, and ceramic example. (4 marks)
 - (e) By using an appropriate sketch, differentiate the atom structure of glass and glass ceramic and the resultant properties. (4 marks)

- Q5** (a) Explain the **TWO (2)** factors that affect the rate of corrosion in metals and how they influence the corrosion rate. (4 marks)
- (b) **Figure Q5 (b)** shows a bolt that is made from copper and a nut made from iron, which will be used inside a water tank. Determine the potential corrosion problems that could occur, explain which part will corrode and the reason for it, and provide recommendations to eliminate such issues. (4 marks)
- (c) Explain how stainless steels are more corrosion resistant than carbon steel in a wide range of situations. (4 marks)
- (d) A fabrication company has discovered a defect in the stainless-steel welded structure, as shown in **Figure Q5 (d)**. The company wants you to produce a report that contains the following: -
- i. The type of defect (1 mark)
 - ii. The root cause of the defect (2 marks)
 - iii. An illustration of the microstructure at the defect (2 marks)
 - iv. Proposed techniques to eliminate the defect. (3 marks)

– END OF QUESTIONS –

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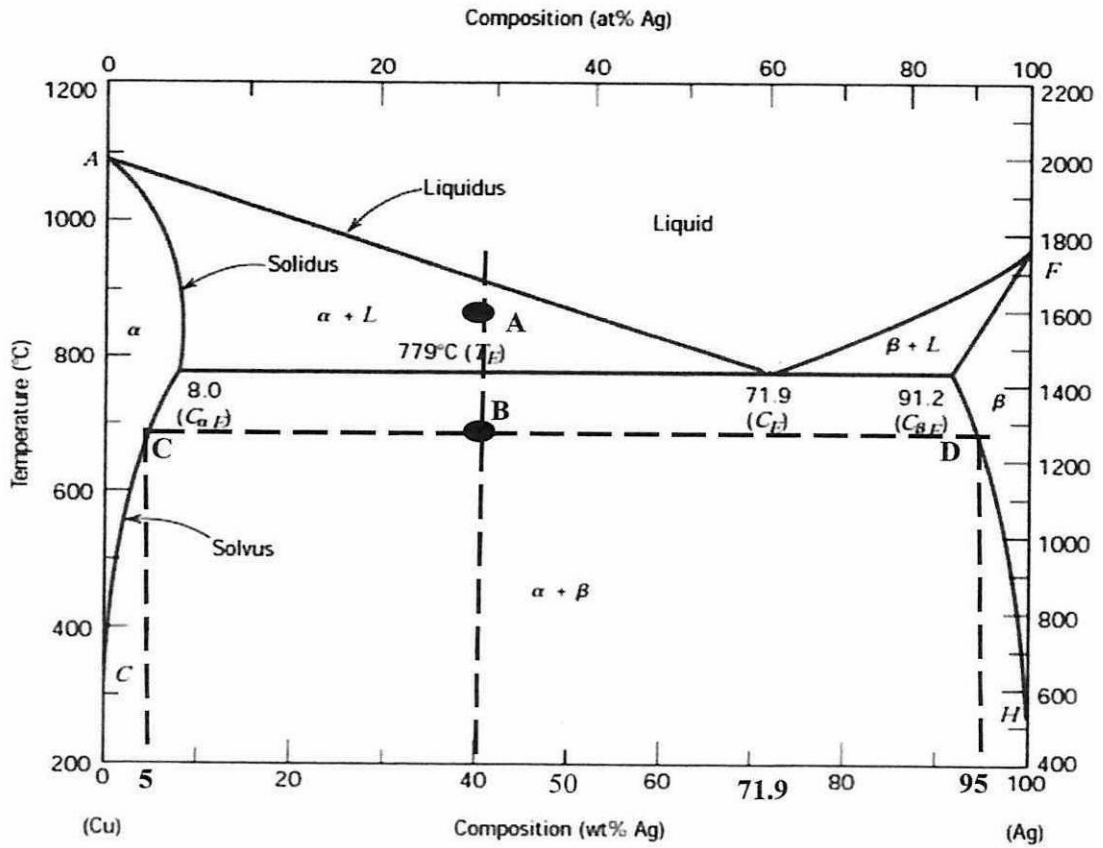


Figure Q1(d): Cu-Ag phase diagram

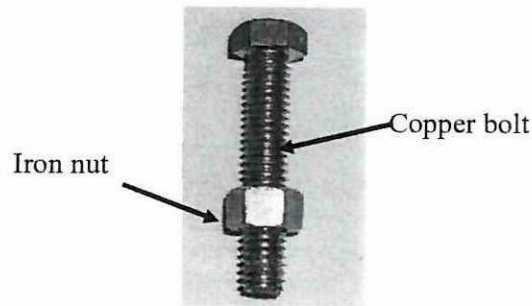


Figure Q5(b): Copper bolt and iron nut

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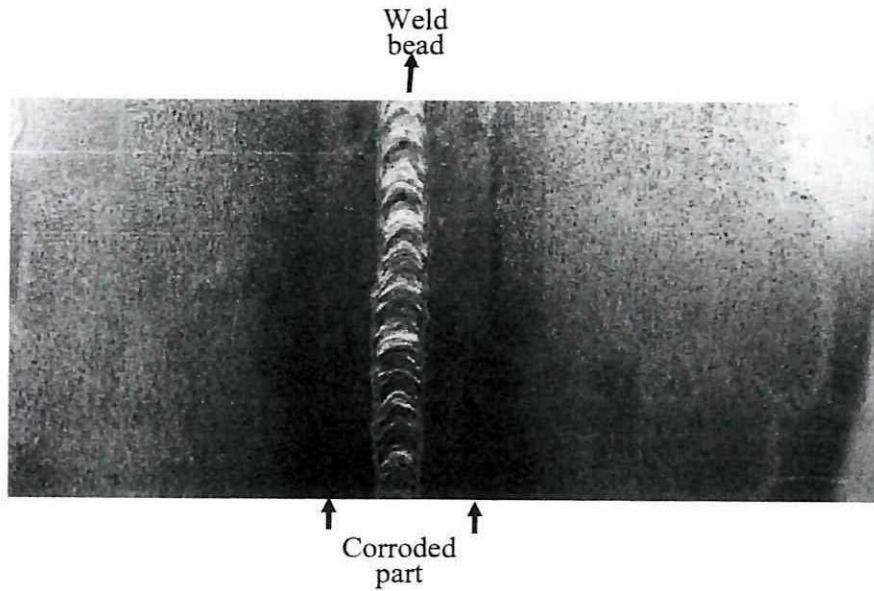


Figure Q5 (d): Corroded stainless steel after weld