

CONFIDENTIAL



UNIVERSITI TUN HUSSEIN ONN MALAYSIA

**FINAL EXAMINATION
SEMESTER II
SESSION 2023/2024**

- COURSE NAME : MATERIAL SCIENCES
- COURSE CODE : DAM 14203
- PROGRAMME CODE : DAM
- EXAMINATION DATE : JULY 2024
- DURATION : 3 HOURS
- INSTRUCTIONS :
1. ANSWER **ALL** QUESTIONS
 2. THIS FINAL EXAMINATION IS CONDUCTED VIA
 - Open book
 - 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 **FOUR (4)** PAGES

TERBUKA

CONFIDENTIAL

- Q1** (a) The properties of solid materials determine their behavior.
- (i) List three (3) categories of properties in solid materials (3 marks)
 - (ii) Based on the answer in Q1(a)(i), give two (2) examples of each of the categories. (3 marks)
- (b) Describe the differences between Material Science and Material Engineering, according to their primary goals and areas of focus. (4 marks)
- (c) Sketch the crystallographic direction from the direction indices given.
- (i) $[1 \bar{1} 0]$ (2 marks)
 - (ii) $[2 0 \bar{1}]$ (2 marks)
- (d) Sketch the following crystallographic planes in cubic unit cells.
- (i) $(0 2 1)$ (2 marks)
 - (ii) $(4 2 1)$ (2 marks)
 - (iii) $(1 1 2)$ (2 marks)
- Q2** (a) Construct the stress-strain diagram of aluminium, indicating the elastic region and plastic region. (4 marks)
- (b) Differentiate between elastic deformation and plastic deformation. (4 marks)
- (c) Metal deformation occurs when crystal planes slip past each other.
- (i) Sketch a schematic diagram of the crystal plane before and after the tensile test. (3 marks)
 - (ii) Explain the process of atomic planes slipping and rearranging when a force is applied to a tensile specimen. (3 marks)
- (d) A 10 mm-diameter rod of 3003-H14 aluminum alloy is subjected to a 6 kN tensile load. Given that the elastic modulus of the rod is 70×10^3 MPa, calculate;
- (i) the tensile stress, (3 marks)
 - (ii) the tensile strain. (3 marks)

TERBUKA

Q3 Figure Q3.1 shows the lead-tin (Pb-Sn) phase diagram.

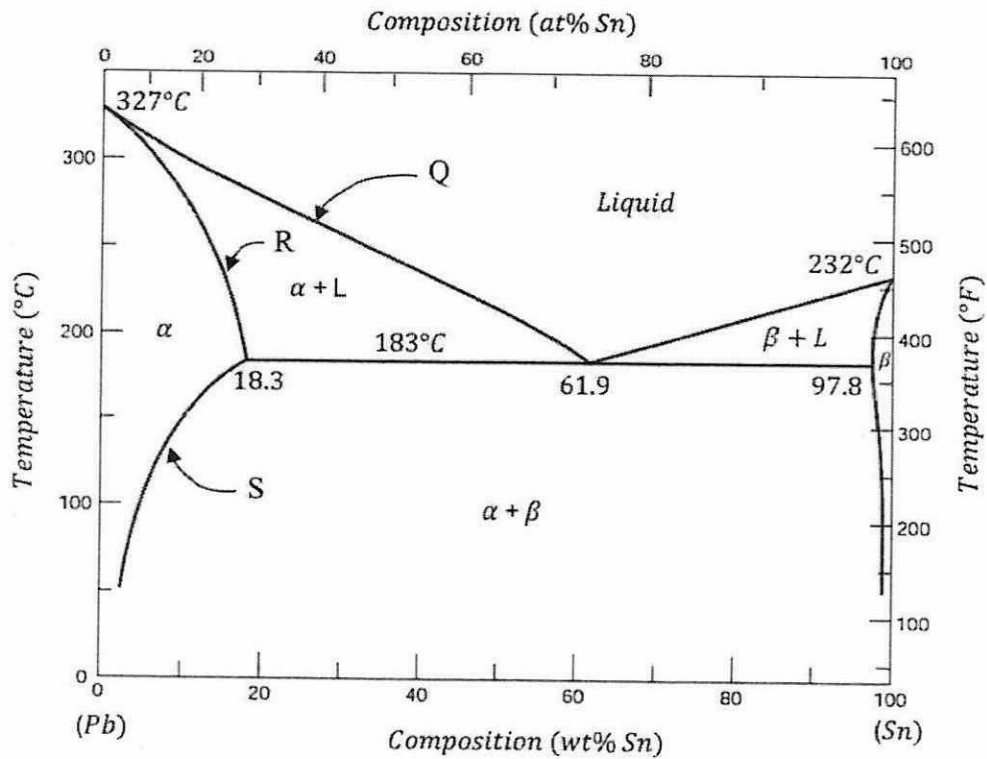


Figure Q3.1

- (a) Identify the type of lines labeled (Q, R and S) in Figure Q3.1. (3 marks)
- (b) Based on the Q3(a) answer, explain the lines labeled (Q, R and S). (3 marks)
- (c) The eutectic point influences the behavior of a binary system during solidification.
 - (i) Explain the eutectic invariant reactions. (2 marks)
 - (ii) Determine the temperature and composition of the eutectic point for the Pb-Sn phase diagram as shown in Figure Q3.1. (2 marks)
- (d) Referring to the Pb-Sn phase diagram in Figure Q3.1, for a 30 wt% Sn-70 wt% Pb alloy at a temperature of 200°C;
 - (i) identify the composition of the phases, (3 marks)
 - (ii) calculate the mass fraction of the phases, (6 marks)
 - (iii) identify the dominant phase. (1 mark)

- Q4** (a) General attack corrosion reaction proceeds uniformly on the entire surface. Propose two (2) methods that can be used to control it. (2 marks)
- (b) (i) Identify three (3) main types of coatings used to protect the metal from corrosion (3 marks)
- (ii) Based on the answer in Q4(b)(i), determine their respective characteristics and applications. (3 marks)
- (c) Explain the formation of martensite in steel. (3 marks)
- (d) Describe the following heat treatment procedures for steels and, for each, the intended final microstructure.
- (i) Annealing (3 marks)
- (ii) Normalizing (3 marks)
- (iii) Tempering (3 marks)
- Q5** (a) Identify two (2) examples of materials for ferrous metals and nonferrous metals. (4 marks)
- (b) Explain the fundamental differences between ferrous metals and nonferrous metals. (5 marks)
- (c) There are four commonly used types of cast iron; gray, nodular, white, and malleable.
- (i) Propose a cast iron that is suitable for high-strength gears. (1 mark)
- (ii) Justify your suggestion regarding its strength and microstructure. (4 marks)
- (d) Discuss the advantages (in terms of weight, corrosion resistance and recyclability) of polymers compared to traditional steel alloys used as automotive components. (6 marks)

- END OF QUESTIONS -

TERBUKA