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Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

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

COURSE NAME : MATERIAL ENGINEERING
TECHNOLOGY

COURSE CODE : BDX 10703

PROGRAMME CODE : BDX

EXAMINATION DATE : JULY 2022

DURATION : 3 HOURS

INSTRUCTION : 1. ANSWERS FIVE (5) QUESTIONS
ONLY FROM SIX (6) QUESTIONS GIVEN

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 **FOUR (4)** PAGES

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- Q1** (a) Aluminium alloys, Titanium alloys, steels, composites and nickel-based alloys are the main groups of materials that are used in the aerospace manufacturing for aerospace structures and jet engine.
- (i) List **THREE (3)** other materials that are not mainstream materials. (3 marks)
- (ii) State the application for each material listed in (i). (3 marks)
- (b) Aluminium is the material of choice for most aircraft structures. State **FIVE (5)** benefits of using aluminium for the aircraft structures. (5 marks)
- (c) Vulcanization is a process to alter the properties of rubber.
- (i) Briefly explain the process of vulcanization. (5 marks)
- (iii) Define the purpose of adding sulphur during vulcanization. (4 marks)
- Q2** (a) Magnesium is the lightest of all the metals used in aircraft.
- (i) State the major drawback of using magnesium as an aerospace metals. (2 marks)
- (ii) Identify **TWO (2)** most damaging forms of drawback mentioned in (a) (i). (2 marks)
- (iii) Explain how these types of drawback in (a) (ii) occur. (6 marks)
- (b) Fracture toughness defines the resistance of a material against cracking.
- (i) Identify **TWO (2)** common methods to measure fracture toughness. (2 marks)
- (ii) Write the comparison of the methods stated in (b) (i) in terms of the specimen and the data used to calculate the fracture toughness. (8 marks)
- Q3** (a) Identify **TWO (2)** properties of the materials to be used in the aircraft structures. (2 marks)
- (b) Choose the tests to be carried out to identify all the properties listed in **Q3** (a) with a brief explanation of each test. (8 marks)

- (c) The International Alloy Designation System (IADS) is used by the aerospace industry to classify the alloys used in aircraft. Define the factor that is used to determine the series of the allocated aluminium alloy.
(2 marks)
- (d) Carbon fiber reinforced polymer (CFRP) is widely used in rocket nozzle and airplane plane brakes. Identify the properties of CFRP that makes it suitable for such application.
(2 marks)
- (e) Describe the properties of CFRP which makes it better compared to 6061 aluminium.
(3 marks)
- (f) List **THREE (3)** disadvantages of CFRP.
(3marks)
- Q4**
- (a) Grains in aerospace alloys typically range from about 1 mm (coarse or large grains) to 1 μ m (fine or small grains). Interpret the importance of the grain size in the aerospace alloys?
(8 marks)
- (b) Grain size does affect the yield strength of steel.
(i) Sketch and label a graph to illustrate the effect of grain size on the yield strength of steel.
(6 marks)
- (ii) Briefly explain the graph depicting the relationship between the grain size and the yield strength.
(6 marks)
- Q5**
- (a) Define why titanium has better resistance to corrosion than high-strength aluminium alloy.
(6 marks)
- (b) The microstructure and mechanical properties of the hypoeutectic steels used in aircraft structures is controlled by heat-treatment as well as the carbon and alloy contents.
(i) Relate the heat treatment with the changes of the steel properties.
(6 marks)
- (ii) Interpret the effect of carbon to the strength of steel.
(8 marks)

- Q6** (a) The materials used in jet engines must survive severe temperatures and withstand high stress for long periods. State **FOUR (4)** outstanding high temperature properties needed in materials to be applied in the hot sections of jet engines. (4 marks)
- (b) Define the reasoning for each of the properties mentioned in (a), correspondingly. (4 marks)
- (c) Small amounts of boron, hafnium and zirconium are often used as alloying elements in nickel to increase the creep strength. Explain briefly how these alloying elements increase the creep strength of the nickel. (4 marks)
- (d) Classify how are thermoplastic and thermoset polymer distinguished in terms of their properties. (8 marks)

- END OF QUESTIONS -

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