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Universiti Tun Hussein Onn Malaysia

**UNIVERSITI TUN HUSSEIN ONN MALAYSIA**

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

COURSE NAME : FATIGUE AND FRACTURE MECHANICS

COURSE CODE : BDC40403

PROGRAMMECODE : BDD

EXAMINATION DATE : JULY / AUGUST 2023

DURATION : 3 HOURS

INSTRUCTION

1. ANSWER FOUR (4) QUESTIONS ONLY

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 **THREE (3)** PAGES

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- Q1** (a) Explain the basic concepts and assumptions of linear elastic fracture mechanics and describe how they are used to predict crack propagation in materials. (10 marks)
- (b) A through-thickness crack of length  $2a = 20$  mm is subjected to a tensile stress of 100 MPa and fracture toughness is  $50 \text{ MPa}\sqrt{\text{m}}$ . Will the crack propagate under these conditions? If so, calculate the critical stress intensity factor  $K_{IC}$  for the material. (Use  $K = 1.12\sigma\sqrt{\pi a}$ ) (10 marks)
- (c) Compare and contrast the crack opening displacement and J-integral approaches to elastic-plastic fracture mechanics, including their advantages and disadvantages for predicting crack propagation in structures. (5 marks)
- Q2** (a) Explain the difference between elastic and elastic-plastic fracture mechanics. What are the key assumptions made in each approach? (10 marks)
- (b) Consider a scenario where a material experiences cleavage fracture.
- (i) Describe the key differences between the fracture process in this case and the ductile fracture process. (5 marks)
- (ii) How can fracture toughness be measured in this case? (10 marks)
- Q3** (a) Describe the stages of fatigue crack growth and explain how they are related to the S-N curve for a material. (5 marks)
- (b) Consider a component made of a ductile material that is subjected to cyclic loading.
- (i) Explain how the material's microstructure and mechanical properties can influence its fatigue behaviour. (5 marks)
- (ii) What factors can cause fatigue crack initiation? (5 marks)
- (c) Consider a scenario where a component experiences high-cycle fatigue.
- (i) How does the stress amplitude, mean stress, and stress ratio affect the fatigue life of the component? (5 marks)

- (ii) What is the effect of surface finish on fatigue behaviour? (5 marks)
- Q4** (a) Crack closure is a phenomenon that occurs during the cyclic loading. When a crack is subjected to a cyclic load, the crack faces open and close as the load is applied and removed.
- (i) Explain the concept of crack closure in fatigue crack propagation. (5 marks)
- (ii) How does crack closure affect the stress intensity factor range. (5 marks)
- (b) Referring to the S-N curve of Paris Regime, the threshold stress intensity factor ( $K_{th}$ ) is the minimum stress intensity factor range.
- (i) Describe the concept of threshold stress intensity factor. (5 marks)
- (ii) How can this parameter be experimentally determined. (5 marks)
- (iii) What is its significance for predicting the fatigue life of a component? (5 marks)
- Q5** (a) What information can be obtained from examining the fracture surfaces of a material after it has failed? (5 marks)
- (b) How do the characteristics of a fracture surface, such as the crack propagation direction and the appearance of the fracture surface, depend on the material and the loading conditions? (10 marks)
- (c) What is the difference between a ductile and a brittle fracture surface, and how do they differ in terms of their appearance and the mechanisms that cause them? (10 marks)

-END OF QUESTIONS-

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