MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

UNIVERSITY EXAMINATIONS
2021/2022 ACADEMIC YEAR

FOURTH YEAR FIRST SEMESTER
SUPPLEMENTARY/SPECIAL
EXAMINATIONS
FOR THE DEGREE OF
BACHELOR OF SCIENCE
IN
MECHANICAL AND INDUSTRIAL ENGINEERING

COURSE CODE: **MIE 421**

COURSE TITLE: **FRACTURE OF MATERIALS**

DATE: **03/10/2022** **TIME: 12.00-2.00PM**

INSTRUCTIONS

Answer question **ONE** and any other **TWO** questions

TIME 2 Hours

MMUST observes ZERO tolerance to examination cheating.

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Question 1 (40 Marks)

a) Define the following terms as used in fracture mechanics

i) Fatigue failure

ii) Creep Failure

iii) Brittle fracture

iv) Endurance limit **(4 Mks)**

b) Describe the Charpy impact test for metallic materials **(10 mks)**

c) A rocket motor case is made from a thin sheet of steel whose proof stress is 1200MPa ,Young's modulus is 200GPa and fracture toughness is 24 $MJ/m^{5/2}$.

The design code specifies that the design should not exceed $\frac{\sigma_y}{1.4}$ where σ_y represents the proof stress. Calculate the minimum size of defect required to cause brittle fracture in service **(4 mks)**

d) In a particular design, a steel frame is to be made by welding mild steel plates of yield strengths 350 MPa . The component has a geometric stress concentration factor of 1.3 and the design stress is 300MPa. The steel has a critical COD of 0.15mm and Young's modulus of 207GPa.

i) If the plate was stress relieved after welding what is the maximum allowable crack size in the frame

ii) What is the maximum allowable crack size if the plate was not stress relieved? **(12Mks)**

Question 2 (20 Marks)

a) For a BCC material, show by the aid of a sketch the influence of test temperature on the uniaxial yield stress σ_y, the cleavage fracture stress σ_f and the applied fracture stress σ_F in an un-notched tensile specimen. Indicate the nil ductility temperature (T_{nil}) **(6 mks)**

b) By the aid of a suitable sketch, describe the effects of grain side diameter on the yield stress of material **(4 mks)**

c) Describe the experimental procedure for determining plane strain Fracture toughness using the 4 point loading method. **(10 mks)**

Question 3 (20 Marks)

a) Sketch and fully label the following forms of fatigue stress cycles

i) Completely reversed cycle

ii) Repeated cycle **(8 Mks)**

b) Study the cyclic strain curve shown Fig Q3C. If σ_B =75N/mm^2 and ε_B =0.000645. Taking fatigue ductility coefficient =0.3., E= 22x10^4 N/mm^2. Determine

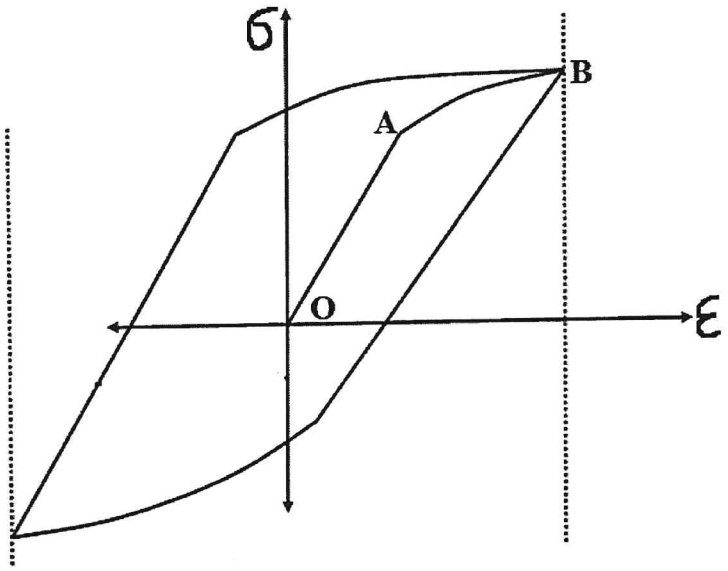

FIG Q 3C

i) Change in elastic strain ($\Delta\varepsilon_e$) ii) Change in plastic strain ($\Delta\varepsilon_p$) iii) No of cycles to failure. **(12 mks)**

Question 4 (20 Marks)

a) Define the term fracture **(2 mks)**

b) Briefly explain FOUR reasons that could have contributed to the origin and study of fracture of materials **(8mks)**

c) Derive the strain time equation for a standard linear solid creep test. **(10mks)**