



# TECHNICAL UNIVERSITY OF MOMBASA

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FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL & AUTOMOTIVE ENGINEERING

**UNIVERSITY EXAMINATION FOR:**

BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

BACHELOR OF SCIENCE IN MEDICAL ENGINEERING

EMG 2406 : MATERIAL SCIENCE

EME 4212 MATERIAL SCIENCE II

SPECIAL/SUPPLEMENTARY EXAMINATION

**SERIES: SEPTEMBER 2018**

TIME: 2 HOURS

**DATE:** Pick Date Sep 2018

## **Instructions to Candidates**

You should have the following for this examination

*-Answer Booklet, examination pass and student ID*

This paper consists of five questions. Attempt any THREE questions.

**Do not write on the question paper.**

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## **Question ONE**

- a) Explain the burgers vector. (2 marks)
- b) With the aid of diagrams show how an edge dislocation moves during plastic deformation in a metal. (4 marks)
- C) Outline factors that affect slip in single crystals (2 marks)
- d) Explain the following in terms of dislocations: (6 marks)
- I Stacking Faults
  - II Twinning
  - III Recrystallization

e) The yield strength of a polycrystalline material increases from  $115 \text{ MNm}^{-2}$  to  $215 \text{ MNm}^{-2}$  on decreasing the grain diameter from 0.04 mm to 0.01 mm. Find the yield strength of the material when grain size ASTM 9 for which the grain diameter is 0.016. (6 marks)

### Question TWO

a) Distinguish the following terms:

i) Vulcanization

ii) viscoelastic

iii) Cross-linked polymer

(6 marks)

b) Illustrate the formation of polyethylene by the process of chain growth

(6 marks)

c) Sketch graphs of strength versus temperature showing variation of Modulus of elasticity with temperature for increasing levels of crosslinking in a polymer (4 marks)

d) A small uniaxial stress of 1Mpa (145psi) is applied to a rod of high-density polyethylene. Determine the resulting strain. Take  $E = 830 \text{ Mpa}$  (4 marks)

### Question THREE

a) Explain the main characteristics of Composite materials

(4 marks)

b) State THREE common classifications of composites based on reinforcements

(3 marks)

c) With the aid of a diagram distinguish the mechanical strength behavior of a composite,

fiber and matrix.

(6 marks)

d) Determine the volume ratio of Aluminium and Boron in Aluminium-boron composite which can have the same Young's modulus equal to that of iron.  $E_{Al} = 71 \text{ GN/m}^2$ ,  $E_{Fe} = 210 \text{ GN/m}^2$ ,  $E_B = 440 \text{ GN/m}^2$

(7 marks)

### Question FOUR

(a) Explain the following non-destructive tests.

(12 marks)

(i) Leak testing

(ii) Dye liquid penetrant

(iii) Ultra-sonic

b) Explain using diagrams the probability of detection using ultrasonic detection.

(2 marks)

c) A cylindrical nuclear pressure vessel has an external diameter of 2 m and a wall thickness of 150 mm. The working internal pressure of the vessel is 40 MPa. A semi-circular crack of depth,  $a = 50$  mm has been detected in the pressure vessel. Describe an appropriate NDT method to locate and size the crack. Discuss any problems which may be encountered and give an estimate of the uncertainty in the crack size.

(6 marks)

### Question FIVE

a) Briefly describe the determination of modulus of rupture of a ceramic material

(4 marks)

b) Explain the THREE steps in processes involved in ceramic manufacture (6 marks)

c) With the aid of a diagram show how strength of a ceramic is affected by defects.

State the sources of defects.

(4 marks)

d) Calculate the composition (in weight percent) of a glass-ceramic composed entirely

of  $\beta$ -spodumene.  $\beta$ -spodumene is  $\text{LiO} \cdot \text{Al}_2\text{O}_3 \cdot 4\text{SiO}_2$  and Li, O, Al, Si have atomic

weights of 6.94, 16.00, 26.98 and 28.09 respectively.

(6 marks)