



TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF MECHANICAL & AUTOMOTIVE
ENGINEERING

UNIVERSITY EXAMINATION FOR:

BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

EMG 2406 : MATERIAL SCIENCE

SPECIAL SUPPLEMENTARY EXAMINATION

SERIES: AUGUST 2017

TIME: 2 HOURS

DATE: Pick Date Sep 2017

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.

Question ONE

- a) State Two effects of dislocation (2 marks)
- b) With the aid of diagrams show how an edge dislocation moves during plastic deformation in a metal. (6 marks)
- c) Outline factors that affect slip in single crystals (2 marks)
- d) Explain the following terms in terms of dislocations: (6 marks)
- I Stacking Faults
 - II Twinning
 - III Recrystallization
- e) A single Zinc crystal is being pulled in tension with the normal to its basal plane (0001) at 50° to the tensile axis and the slip direction $[11\bar{2}0]$ at 45° to the tensile axis (4 marks)

- i) Determine the resolved shear stress, τ , acting in the slip direction when a tensile stress of 0.690 MPa (100 psi) is applied?
- ii) What tensile stress is necessary to reach the critical resolved shear stress, τ_c of 0.94 MPa (136 psi)?

Question TWO

a) Distinguish the following terms:

- i) Vulcanization
- ii) viscoelastic
- iii) Cross-linked polymer
- iv) stress relaxation (8 marks)

b) Explain 'crystallinity' in Polymers giving appropriate examples (4marks)

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 blend of polyethylene and polyvinyl chloride contains 10 wt % polyvinyl chloride. What is the molecular percentage of polyvinyl chloride? (4 marks).

Question THREE

a) Explain the role of a Matrix in a Composite material (4 marks)

b) State THREE common configurations of composites. (3 marks)

c) With the aid of a diagram distinguish the mechanical strength behavior of a composite, fiber and matrix. (6 marks)

d) Calculate the elastic modulus and thermal conductivity perpendicular to continuous reinforcing fibers in an E-glass (60% vol)/polystyrene composite. (7 marks)

Question FOUR

(a) Explain the following non-destructive tests. (12 marks)

- (i) eddy currents
- (ii) acoustic emissions
- (iii) magnetic particle

b) Explain using diagrams the effect of both high and low detection rate on the probability of failure

(4 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.

(4 marks)

Question FIVE

a) Briefly describe the determination of modulus of rupture of a ceramic material
(6 marks)

b) Explain the THREE processes 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) A reaction-bonded silicon nitride has strength of 500 MPa and a fracture toughness of $5.6 \text{ MPa}\cdot\text{m}^{1/2}$, what is the largest-size internal crack that this material can support without fracturing? Given $Y = 1$ and $K_{IC} = Y\sigma_f \sqrt{\pi a}$. (4 marks)