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

END OF SEMESTER EXAMINATION

SERIES: DECEMBER 2016

TIME: 2 HOURS

DATE: Pick Date Dec 2016

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. of the burgers circuit ,show the difference between edge and screw dislocations.
                                                               (6 marks)

C) Outline factors that affect slip in single crystals   (2 marks)

d) Explain the following strengthening mechanisms for single phase crystals   (6 marks)

      I   solid solution

      II Precipitate strengthening

      III Grain reduction

e) A single Zinc crystal is being pulled in tension with the normal to its basal plane (0001) at 60° to the tensile axis and the slip direction [11 $\bar{2}$ 0] at 40° 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) Polymerization

    ii) Degree of polymerization

    iii) Cross-linked   polymer

    iv) Thermosets   (8 marks)

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

c) A sample of polyethylene is found to have an average molecular weight of 25000 amu. What is the degree of polymerization, n, of the average polyethylene molecule?   (4 marks)

d) Acrylonitrile butadiene styrene (ABS) is an ideal material for making luggage bags and telephone sets. Sketch the common structure of ABS   (4 marks).

Question THREE

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

  b) State six advantages 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) Give the relative merits of the following matrices in FRP.

    i) carbon ii) glass iii) Aramid iv) Natural   (4 marks)

  e) Describe a cross-ply laminate.   (3 marks)

Question FOUR

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

    (i) Dye Penetrant test

    (ii) Radiographic test

(iii) Ultrasonic test

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 a ceramic bond. (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 a strength of 300 MPa and a fracture toughness of

3.6 MPa.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).