TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MEDICAL ENGINEERING

UNIVERSITY EXAMINATION FOR:

BACHELOR OF SCIENCE MEDICAL ENGINEERING

BACHELOR OF TECHNOLOGY IN MECHANICAL ENGINEERING

BACHELOR OF TECHNOLOGY IN MARINE ENGINEERING

BACHELOR OF SCIENCE IN ELECTRICAL ENGINEERING

EME4105 : MATERIAL SCIENCE I

TMC 4213 MATERIAL SCIENCE & ENGINEERING

EMC 4311 MATERIAL SCIENCE

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.

Question ONE

I. Describe the enabling materials property of each of the following and why it is so:
   (a) aluminum for airplane bodies
   (b) polyurethane for teeth aligners (invisible braces);
   (c) steel for the ball bearings in a bicycle's wheel hub;
   (d) polyethylene terephthalate for water bottles; and
   (e) glass for wine bottles

II. a) Explain Five ways of classifying materials.

b) state factors that determine the properties of materials.

Question TWO

(a) Draw neat sketches of unit cells of BCC, hcp and FCC crystal structures.

(ii) In each case a (i) calculate the number of atoms   (6 marks)

(b) Show that the atomic packing factor of FCC crystal is 0.74.   (6 marks)

(c) Explain the following terms.

(i) Unit Cell

(ii) Coordination number

(iii) Packing Factor   (3 marks)

(d) Draw (121) plane and <121> direction in a cubic lattice   (5 marks)

Question TWO

In order to evaluate various mechanical properties, a steel specimen of 15 mm diameter and 72.5 mm gauge was tested in a standard tension test. The following observations were made during the test:

Yield Load = 60 KN

Maximum Load = 71.5 KN

Fracture Load = 50.5 KN

Gauge length of fracture = 79.5 mm

Strain at Load of 20 KN = 7.75×10^{-4}

Determine

(a) Yield point stress
(b) Ultimate tensile strength
(c) Percentage elongation
(d) Modulus of elasticity
(e) Modulus of resilience
(f) Fracture stress
(g) Percentage reduction in area
(h) Modulus of toughness   (20 Marks)

Question THREE

(a) Describe **THREE** types of crystal defects   (3 marks)

(b) Outline the corrosion mechanisms.   (5 Marks)

(c) State **THREE** methods to prevent corrosion.   (3 Marks)

(d) Explain   i) proof stress

                   ii) strain hardening   (4 marks)

(e) Assuming first order reflection, calculate the interplanar spacing when a beam of x-ray of wavelength 1.54 A is directed towards the crystal at an angle 20.3˚ to the atomic plane.
           (5 marks)

Question FOUR

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

     (i) Dye Penetrant test

     (ii) Radiographic test

     (iii) Ultrasonic test

(b) State the THREE advantages of a (i) and a (ii) above.   (6 marks)

(c) State **TWO** types of destructive tests.   (2 marks)

Question FIVE

(a) Sketch the Fe-C phase equilibrium diagram for compositions up to 2.5% C and insert the approximate temperature ranges for the following heat treatment processes for steel (0.3 – 1.2% C)

     (i) Normalising

     (ii) Full annealing

     (iii) Spheroidising

     iv) Stress relief annealing   (12 marks)

(b) Sketch the continuous cooling curve for eutectoid steel, label the various regions.
           (8 marks)