TECHNICAL UNIVERSITY OF MOMBASA

DEPARTMENT OF MECHANICAL AND AUTOMOTIVE ENGINEERING

SPECIAL/UPPLEMENTARY UNIVERSITY EXAMINATIONS 2015/2016

FIRST YEAR SECOND SEMESTER SPECIAL/SUPPLEMENTARY EXAMINATION FOR THE DEGREE IN BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING (BSME)

EMG 2104: INTRODUCTION TO MATERIAL SCIENCE

SERIES: AUGUST 2016

TIME: 2 HOURS

INSTRUCTION TO CANDIDATES:

1. You should have the following for this examination:-
    - Answer Booklet
    - Scientific Calculator
2. This paper consists of FIVE Questions
3. All questions carry EQUAL MAXIMUM marks
4. Attempt any THREE questions
5. Use clear and neat sketches
6. All symbols have their usual meaning unless specified otherwise

QUESTION ONE: (20 Marks)

a) What do you understand by the terminology “smart (or intelligent) materials” (2 Marks)

b) List and discuss four factors which govern the selection of materials for design consideration in mechanical components (8 Marks)

c) Explain briefly the following electrical properties of metals: Resistivity, Conductivity, Temperature coefficient of resistance, Dielectric strength and Thermoelectricity (5 Marks)

d) Explain briefly the following mechanical properties of metals: Elasticity, Plasticity, Ductility, Malleability and Hardness (5 Marks)

QUESTION TWO: (20 Marks)

a) Define an element (2 Marks)

b) Define the following terms: Atom, Electron, Proton, Nucleus, Atomic number and Isobars. (6 Marks)

c) Give the comparison between ionic, covalent and metallic bonds (6 Marks)

d) Discuss briefly the general usefulness of the periodic table in reference to atomic structure (3 Marks)

e) State three (3) characteristics of molecular bonds. (3 Marks)

QUESTION THREE: (20 Marks)

a) What are point, line and surface imperfections found in solid crystals? Illustrate these imperfections with suitable sketches. (6 Marks)

b) Give comparisons between body-centered cubic, face-centered cubic and close-packed hexagonal lattices. (6 Marks)

c) What is fatigue failure? How is fatigue test carried out? (4 Marks)

d) What is creep? Draw a typical creep curve and explain the different stages of creep (4 Marks)

QUESTION FOUR: (20 Marks)

a) List the four main reasons for mechanically testing materials (8 Marks)

b) In order to evaluate various mechanical properties, a steel specimen of 12.5mm diameter and 62.5mm gauge was tested in a standard tension test. Following observations were made during the test:

Yield load = 50.0kN; Maximum load = 71.5kN; Fracture load = 50.5kN; gauge length at fracture = 79.5mm; strain at load of 20kN = 7.75×10^{-4}.

Determine:

i. Yield point stress (2 Marks)

ii. Ultimate tensile stress (2 Marks)

iii. Percentage elongation (2 Marks)

iv. Modulus of elasticity (2 Marks)

v. Fracture stress (2 Marks)

vi. Percentage reduction in area (2 Marks)

QUESTION FIVE: (20 Marks)

a) List the physical and mechanical properties of aluminum (5 Marks)

b) What are special properties of plastics that make them useful engineering materials (5 Marks)

c) Explain the Brinell hardness testing of mild steel specimen (5 Marks)

d) Explain the Vickers diamond hardness testing of mild steel specimen (5 Marks)