MURANG'A UNIVERSITY OF TECHNOLOGY

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

UNIVERSITY ORDINARY EXAMINATION

2023/2024 ACADEMIC YEAR

SECOND YEAR **SECOND** SEMESTER EXAMINATION FOR BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONICS ENGINEERING

EES 208 – MATERIALS SCIENCE

DURATION: 2 HOURS

INSTRUCTIONS TO CANDIDATES:

1. Answer question one and any other two questions.
2. Mobile phones are not allowed in the examination room.
3. You are not allowed to write on this examination question paper.

SECTION A: ANSWER ALL QUESTIONS IN THIS SECTION

QUESTION ONE (30 MARKS)

a. List any three properties of ionic compounds and explain these in terms of the type of atomic bonding. (4marks)
b. Sketch and label the phase equilibrium diagram between metals A and B which are completely insoluble in the solid state. Cite any two pairs of elements that show these behaviours. (4marks)
c. Given that the behaviour of a certain polymer may be modelled the Voigt-Kelvin model. Given further that at 20^{o}c, the Young's modulus is 120 Mpa, while the relaxation time is 80 days; calculate the strain in the polymer after it has been subjected to a stress of 10Mpa for 50 days. Give a schematic showing how the strain varies with time. (5marks)
d. Figure Q1 shows the low stain part of the load versus extension graph obtained when a steel reinforcement bar was tested in tension. The original diameter was 31.21 mm, while the gauge length was 140 mm. The maximum load attained was 426.e KN. When the load was 222.8 KN, the diameter was 31.197 mm. Determine the following properties of the bar.
    i. The yield stress
    ii. The ultimate tensile strength
    iii. Young's modules
    iv. Poisson's ratio. (10marks)
e. Briefly discuss how point defects in ceramics differ from those in metals; hence explain the origin of schottley and Frenkel defects. Use appropriate sketches where appropriate. (7marks)

SECTION B – ANSWER ANY TWO QUESTIONS IN THIS SECTION

QUESTION TWO (20 MARKS)

a. Explain, giving at least two examples, what is meant by the term a……. (4marks)
b. Given that magnesium has a TICP crystal structure with lattice constants a = 0.317 mm and c = 0.514 mm
    i. Sketch a unit cell of Magnesium clearly indicating the lattice constants. (2marks)
    ii. Name any two common metals with a similar crystal structure. (1mark)
    iii. Calculate the atomic packing factor of unit cell, showing clearly how you arrive at your answer. (9marks)

iv. If the atomic mass number of magnesium is 24.31, calculate the density of Magnesium. Express the result in Kg/m^3 (Note: 1 amt = 1.66×10^{-24}g)

QUESTION THREE (20 MARKS)

a. Derive an expression for the critical volume fraction in a unidirectional continuous fibre reinforced composite (UCFRC) Distinguish this and the minimum volume fraction. (11marks)

b. A UCFRC consists of 40% carbon (E = 3.5GPa) resin, calculate:
   i. The longitudinal modulus of elasticity of the composite. (2marks)
   ii. The load carried by each phase when a longitudinal load of 15 KN is applied to the composite. (2marks)
   iii. The corresponding strains in each phase given that the cross section area of the composite is 200 mm^2. (2marks)
   iv. The stress in each phase. (3marks)