FACULTY: ENGINEERING

SEMESTER I EXAMINATIONS (FEBRUARY 2015)

2014 / 2015 **ACADEMIC SESSION**

COURSE CODE: MEE 231 GNE 231

COURSE TITLE: SCIENCE OF MATERIALS

DURATION: 2½ Hours

HOD'S SIGNATURE

INSTRUCTIONS:

1. YOU ARE TO ANSWER ANY FIVE QUESTIONS OUT OF SIX.
2. SEVERE PENALTIES APPLY FOR MISCONDUCT, CHEATING, POSSESSION OF UNAUTHORIZED MATERIALS DURING EXAM
3. YOU ARE NOT ALLOWED TO BORROW CALCULATORS AND ANY OTHER WRITING MATERIALS

4. (a) Define the following as they relates to material structures:
   i. Macrostructure
   ii. Microstructure
   (b) Briefly explain the failure mechanisms of engineering materials.
   (c) Define the following in relation to failure of engineering materials:
   i. Fatigue
   ii. Creep
   iii. Cyclic loading
   (d) List any four types of corrosion occurrences and briefly explain any two types of corrosion control measures adopted within the industrial sector.
   (e) A cylindrical specimen of a nickel allow having an elastic modulus of 205 GPa and an original diameter of 10.2 mm will experience only elastic deformation when a tensile load of 8900 N is applied. Compute the maximum length of the specimen before deformation if the maximum allowable elongation is 0.25 mm.
   (f) An aluminium bar 125 mm long and having a square cross section 16.5 mm on an edge is pulled in tension with a load of 66,700 N, and experiences elongation of 0.43 mm. Assuming that the deformation is entirely elastic, calculate the modulus of elasticity of the aluminium.

5. (a) Determine the relationship between the atomic radius and lattice parameter of BCC and FCC structures.
   (b) Calculate the packing factor for the FCC cell.
   (c) For each of the following compounds, state whether the bonding is essentially metallic, covalent, ionic, van der Waals, or hydrogen:
   i). Ni, (ii) ZrO_2, (iii) graphite, (iv) solid Kr, (v) Si, (vi) BN, (vii) SiC, (viii) Fe_2O_3, (ix) MgO, (x) W, (xi) H_2O within the molecules, (xii) H_2O between the molecules.

   b). If ionic and covalent bonds are involved in the bonding of any of the compounds listed, calculate the percentage ionic character in the compound.

6. a) State one each of the physical, mechanical, electrical and chemical properties of Stainless steel alloy.
   b) Briefly cite the main differences between ionic, covalent, and metallic bonding.

   c) Explain why covalently bonded materials are generally less dense than ionically or metallically bonded ones?
   (d) (i) What are elastic deformation and plastic deformation?
   (ii) A 10 mm diameter, 500mm long stainless steel 309 rod is subjected to a tensile load of 30 kN, what is the engineering stress experienced by the rod? Show that the rod will return to its original length after the tensile load is removed. Then determine resultant elongation of the rod. The stainless steel 309 has yield strength of 290 MPa and modulus of elasticity of 200 GPa.