KENYATTA UNIVERSITY

UNIVERSITY EXAMINATIONS 2010/2011

FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE (COMPUTER ENGINEERING)

<u>SCE 117; MATERIAL PHYSICS</u>

DATE: MONDAY, 29TH NOVEMBER 2010 TIME: 8.00 A.M. - 10.00 A.M.

Instruction : Answer question one and any other two

Use the following constants where necessary

Avogadros Number $N_A = 6.02 \times 10^{23}$ mol^{-1}
Boltzman constant $K = 8.62 \times 10^{-5}$ eV/K
Electronic charge $e = 1.6 \times 10^{-19}$C
Young modulus of Brass $E = 1.01 \times 10^5$ MPa
Poisson's ratio for Brass $\upsilon = 0.35$
Temperature coefficient of resistivity of gold α [(°C)$^{-1}$] =0.0034
Temperature coefficient of resistivity of iron α [(°C)$^{-1}$] =0.0050
Silicon electron and hole mobilities are, respectively, 0.14 and 0.048 m^2/Vs
$\varepsilon_o = 8.85 \times 10^{-12}$ F/m

Q.1 a). Relative to electrons and electron states, what doers each of the four quantum numbers specify? (4 marks)

b). (i) Write down the electronic structures of Silicon (Z=14) and Copper (Z=29) (2 marks)

(ii) Calculate the number of bonds a silicon can form. (2 marks)

c). Assume that a mental exists having a simple cubic crystal structure, that is, atoms located at the corners of a cube and touching one another along the cube edges.

(i) What is the coordination number for this crystal structure? (2 marks)
(ii) Calculate the atomic packing factor. (3 marks)

d). Define the following terms

(i) Solvent (2 mark)
(ii) Solubility limit (2 mark)

e) What is a phase diagram (2 mark)

f). (i) What is the distinction between engineering stress (σ) and true stress σ_T (1 mark)

(ii)For a specific tensile load, will σ_T be greater than or less than σ (1 mark)

g.) With regard to alloys differentiate between composition and concentration (2 marks)

h). Explain solid solution hardening (3 marks)

i). What is a (i) dipole (1 mark)
(ii) dielectric material (1 mark)

j). Phosphorous is added to high purity silicon to give a concentration of 10^{23} m^{-3} of charge carriers at room temperature. Is this material n-type or p-type (2 marks)

Q.2 a). (i) Draw a BCC structure (1 marks)

(ii) Show that the lattice parameter of BCC structure is

$a = 4R\sqrt{3}$ where R is atomic radius. (3 marks)

(iii)Determine the coordination number of BCC (2 marks)

(iv)Determine the number of atoms per unit cell in BCC structure (show your working) (2 marks)

(v)Show that the atomic packing density factor for BCC is 0.68 (3 marks)

(vi)Calculate the radius of a vanadium atom given that V has a BCC crystal structure, a density of 5.96 g/m^3, and an atomic weight of 50.9g/mole. (3 marks) b). (i) Differentiate between ionic and covalent bonding? (2 marks)

(ii) Define ionization potential. (2 mark)

(iii) Differentiate between electron affinity and electron negativity (2 marks)

Q.3 a). A hypothetical A-B alloy of composition 55 wt% B-45 wt% A, at some temperature is found to consist of mass fraction of 0.5 for both β phase is 90 wt % B-10 wt % A, what is the composition of he alpha phase (6 marks)

b). A cylindrical specimen of steel having an original diameter of 12.8 mm is tensile tested to fracture and found to have an engineering fracture strength of 460 MPa. If its cross-sectional diameter at fracture is 10.7 mm, determine

(i) ductility in terms of percent area reduction (3 marks)

(ii) the true stress at fracture (3 marks

c). For a brass alloy, the stress at which plastic deformation begins is 345 MPa and the elastic modulus is 1.03×10^5 MPa.

(i) What is the maximum load that may be applied to a specimen with a cross- sectional area of $130mm^2$ without plastic deformation? (4 marks)

(ii) If the original specimen length is 76 mm, what is the maximum length to which it may be stretched without causing plastic deformation? (4 marks)

Q.4 a). Consider a parallel –plate capacitor having an area of 6.45×10^{-4} m^2 and a plate separation of 2×10^{-3} m and across which a potential of 10 V is applied. If the material having a dielectric constant of 6.0 is positioned within the region between the plates, compute

(i) The capacitance (4 marks)

(ii) The magnitude of the charge stored in each plate (2 marks)

(iii) The dielectric displacement D (3 marks)

(iv) The polarization (3 marks)

b). Differentiate between microscopic and macroscopic composites (8 marks)

Q.5 a). (i) For an intrinsic silicon, the room temperature electrical conductivity is 4×10^{-4} (ohm-meter)$^{-1}$; the electron and hole mobilities are, respectively, 0.14 and 0.048 m^2/Vs. Compute the electron and hole concentrations at room temperature. (4 marks)\

(ii) The intrinsic electrical conductivities of a semiconductor at 20 and 100°C are 1.0 and 500 (ohm-meter)$^{-1}$, respectively. Determine the approximate band gap energy for this material. (6 marks)

b). An iron wire has a resistance of 5.90 Ω at 20.0 °C and gold wire has a resistance of 6.70 Ω at the same temperature. At what temperature do the wires have the same resistance? (5 marks)

c). Discuss briefly ferrimagnetism (5 marks)

xxxxxxxxxxxxxxxxxxxxxxxxxxx end xxxxxxxxxxxxxxxxxxxxxxxxxxxxx