THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING

2015 ACADEMIC YEAR – TERM I TEST
DECEMBER 2015

MEC 2309 – PROPERTIES OF ENGINEERING MATERIALS I

TIME ALLOWED: TWO HOURS **CLOSED BOOK**
ANSWER: All Questions
Question 1 carries 50 marks while Questions 2 and 3 carry 25 marks each.

Question 1:
Copper and nickel are soluble in each other in the solid state throughout the entire range of compositions.

(a) Thermal analysis of a number of alloys of copper (Cu) and nickel (Ni) give the results in Table 1, from which you are asked to draw the binary phase diagram. Label the major features of the system. Use graph paper and draw to scale. [15 marks]

Table 1: Thermal analysis of copper (Cu) and nickel (Ni) alloys.

% Cu	100	90	80	70	60	50	40	30	20	10	0
% Ni	0	10	20	30	40	50	60	70	80	90	100
1st Arrest (°C)	1085	1150	1195	1240	1275	1320	1350	1380	1410	1435	1453
2nd Arrest (°C)	1085	1125	1160	1200	1235	1270	1305	1350	1380	1425	1453

(b) Describe transformations that take place as the following alloys are cooled slowly from 1400 °C to room temperature.
  (i) An alloy containing 50% Cu and 50% Ni. [06 marks]
  (ii) An alloy containing 100% Cu. [05 marks]

(c) For an alloy containing 35% Ni at a temperature of 1250 °C, what is the mass fraction liquid and the mass fraction solid? [06 marks]

(d) Calculate the amount of each phase present in 1 kg of a 50% Ni – 50% Cu alloy at
  (i) 1400 °C. [06 marks]
  (ii) 1300 °C. [06 marks]
  (iii) 1200 °C. [06 marks]

Question 2:

(a) Use the data in Table 2 to determine which is denser between copper and iron? [15 marks]

(b) Use a sketch to show that for the body-centred cubic crystal structure the co-ordination number is 8. [05 marks]

(c) Show that all atoms in the bcc crystal structure are lattice points. [05 marks]

Table 2: Useful data for copper, iron and molybdenum

Element	Symbol	Structure	Atomic mass (kg)	Lattice constant (nm)
Copper	Cu	fcc	1.05359×10^{-25}	0.36147
Iron	Fe	bcc	9.26028×10^{-26}	0.28664
Molybdenum	Mo	bcc	1.59048×10^{-25}	0.31468

Question 3:

The data in Figure 3 were obtained in a tensile test on a specimen of 15 mm diameter with a 60 mm gauge length. The length between gauge marks after the test was 67.30 mm and the specimen diameter after fracture was 12.65 mm.

Table 3: Tensile test data

Load(kN)	70	120	150	160	170	200	220	233	235	220
Extension(mm)	0.25	0.40	0.50	0.60	0.75	1.75	3.00	5.00	6.50	8.00

(a) Plot a force-extension curve. [15 marks]

(b) Determine:

(i) Tensile strength [02marks]

(ii) Young's Modulus [02marks]

(iii) 0.1 percent proof stress [02marks]

(iv) Percentage elongation [02marks]

(v) Percentage reduction in area [02marks]

END OF MEC 2309 TEST

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