MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

MAIN CAMPUS

UNIVERSITY EXAMINATIONS

2023/2024 ACADEMIC YEAR

SECOND YEAR SECOND SEMESTER EXAMINATIONS

FOR THE DEGREE

OF

BACHELOR OF SCIENCE IN ELECTRICAL AND COMMUNICATIONS ENGINEERING

COURSE CODE: ECE 204

COURSE TITLE: MATERIAL SCIENCE FOR ELECTRICAL ENGINEERS

DATE: 15/4/2024 **TIME:** 8.00-10.00am

INSTRUCTIONS TO CANDIDATES

1. This paper consists of **FOUR** questions
2. Answer Question **ONE (Compulsory)** and any other **TWO** Questions
3. All symbols have their usual meaning

TIME: 2 Hours

MMUST observes ZERO tolerance to examination cheating

This Paper Consists of **4** Printed Pages. Please Turn Over

QUESTION 1   (30 MARKS)

a) Miller indices are derived from planes and directions in crystalline materials, why should an engineer be taught miller indices of planes and directions

               (2 Marks)

b) (i) Draw the following miller indices inside a cubic unit cell $[011]$ and $[110]$ (2 Marks)

   (ii)Inside one unit cell draw $(10\bar{1})$ and $(\bar{1}\,\bar{1}\,1)$ planes hence determine the miller indices of direction that is common to both planes.

               (6 Marks)

c) Show that the packing factor of an FCC material is 0.741

               (5 Marks)

d) Number of atoms per square meter for each of the following planes $(1\,1\,1)$ and $(\bar{1}\,\bar{1}\,0)$ for Al atom. Take the lattice parameter of Aluminum as 4.05Å.

               (6 Marks)

e) i) Define the term polymerization

               (1mk)

   ii) Describe the following forms of polymerization: additional polymerization and condensational polymerization

               (5 Marks)

F) Mention any THREE useful additives for the manufacture of polymeric materials (3 Marks)

QUESTION 2   (15 Marks)

The following data are for two metals A and B

   Pure metal A melts at 960°C,

   Pure metal B melts at 1083°C,

   Eutectic Composition 28 % metal B

   Metal B can dissolve a maximum of 8 % metal A at 800°C

   Metal A can dissolve a maximum of 9% metal B at 800°C

   Denote solid solution of B in A as α

   Denote solid solution of A in B as β

   At 0°C both metals A and B dissolve 2% of each other.

Eutectic Temp 800.

a) Using the information given , draw the phase diagram for the two metals A and B

               (4 marks)

   By selecting an alloy containing 15% Solid A,

b) At what temperature will the first solid appear?

               (1 marks)

c) What is the composition and percentage proportions of constituents formed at 850°C(3 marks)

d) At what temperature will solidification be complete?

               (1 marks)

e) Determine the maximum primary constituent and the percentage of β in the eutectic microstructure for this alloy with 15%A

               (3 marks)

ii)

Question 3   (20 Marks) ✓

a) With the aid of sketches where possible differentiate between   (8Marks)
- I)   Equi-axed grains and Dendritic grain
- II)   Interstitial solid solution and substitution solid solution
- III)   Frenkel defect and Schottky defect
- IV)   Solid solution and compound

b) Describe giving relevant examples the Hume Rothery factors for substitution solid solution formation

Question 4   (20 Marks) ✓

a) Define the terms(i) ceramic ii) Composites   (4 marks)

b) Mention any TWO ceramics that are used in the following areas   (6 marks)
- i)   Insulators: Refractories - Thermal insulators
  White clay - earthing
- ii)   Passive components ← Electric porcelain - clay
- iii)   Piezo electric ceramics - advanced ceramics

c) i)   State any FOUR forms of composites   (4 marks)

     ii)   State the function of the matrix and that of fibers in a composite

d) Describe by the aid of a diagram the PrePreg method of manufacturing composites (6mks)