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UNIVERSITY EXAMINATIONS 2024/2025

SECOND YEAR FIRST SEMESTER EXAMINATION FOR DEGREE OF BACHELOR OF EDUCATION TECHNOLOGY IN MECHANICAL ENGINEERING

EMT 3150: MATERIALS SCIENCE

DATE: JANUARY 2025 **TIME: 2 HOURS**

INSTRUCTIONS: Answer Question ONE and any other TWO questions.

QUESTION ONE (30 MARKS)

a) Describe the following crystallographic terms:

i. Lattice (2 Marks)

ii. Crystal structure (2 Marks)

iii. Coordination number (2 Marks)

iv. Unit cell (2 Marks)

v. Atomic packing factor (2 Marks)

b) Briefly outline four different types of heat treatments for steel. (8 Marks)

c) Using a suitable example, explain the term "binary isomorphous system" as applied to phase diagrams. (3 Marks)

d) Outline any six types of nondestructive testing techniques. (6 Marks)

e) Using a neat sketch, explain the process of spinning as applied to sheet metal work. (3 marks)

QUESTION TWO (15 MARKS)

a) Define the following mechanical properties:

i. Ductility (1 Mark)

ii. Tensile toughness (1 Mark)

iii. Stiffness (1 Mark)

iv. Yield strength (1 Mark)

b) Describe the three main steps involved in the production of primary steel. (3 Marks)

c) Outline three classes of steel based on their carbon content. (6 Marks)

d) Explain the difference between true stress and engineering stress. (2marks)

QUESTION THREE (15 MARKS)

a) Using neat sketches illustrate the difference between line defects and point defects and give two examples of each. (5marks)

b) Using figure Q3(b), and assuming equilibrium cooling, explain the activities that take place at points a,b,c,d and e and the associated microstructures at each point(10marks)

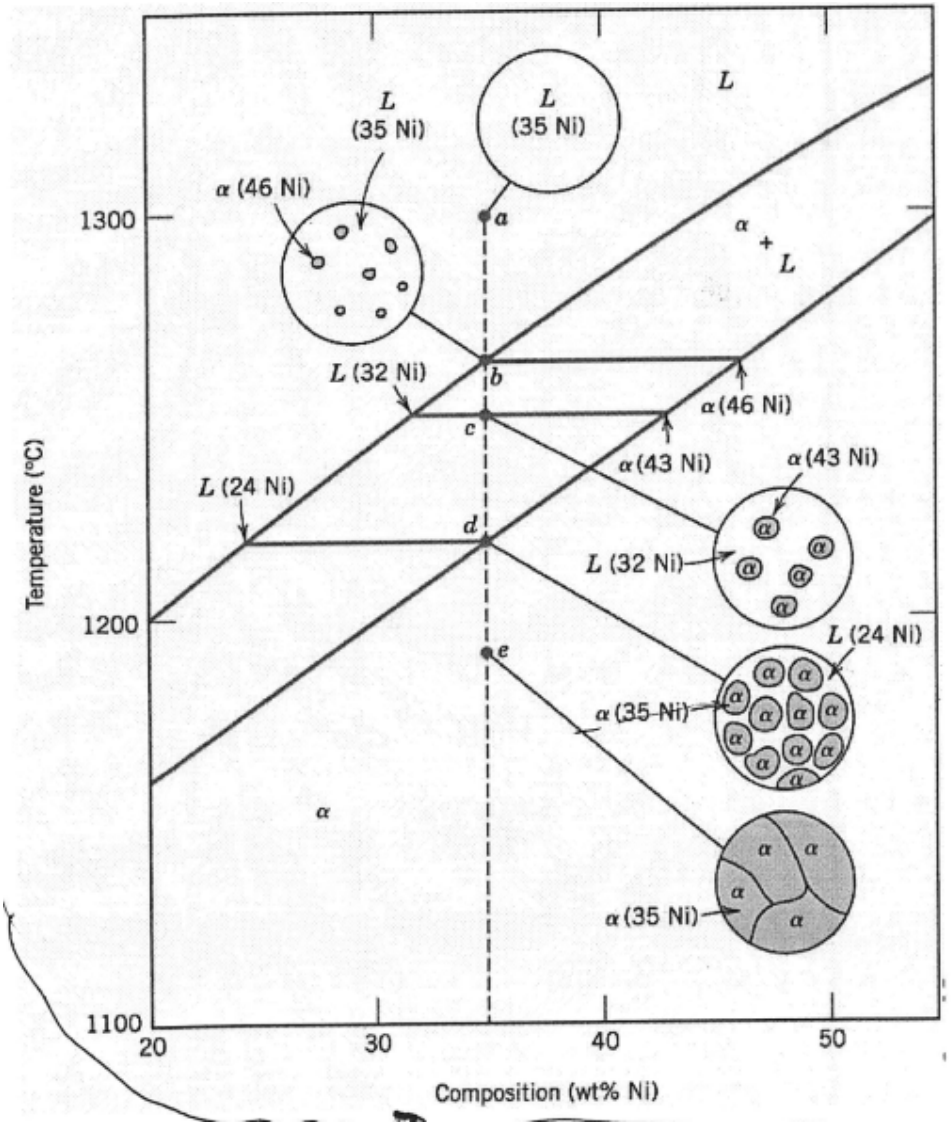

Figure Q3(b)

QUESTION FOUR (15 MARKS)

a) Define the term phase and state three characteristics of a phase. (4 Marks)

b) Using a well labelled diagram show that the atomic packing factor for a face centred cubic (FCC) unit cell is 74%. (6marks)

c) Outline five corrosion control methods. (5 marks)

QUESTION FIVE (15 MARKS)

a) With the aid of neat diagrams, describe the slip casting method used in the production of ceramic products. (4Marks)

b) Briefly explain the difference between the Charpy and Izod impact tests. (4 marks)

c) A company based at Makutano-Meru that recently started a new production line for turning shafts using mild steel has received complaints from its clients that the shafts are too hard and are causing abnormal wear on bushes normally fitted on the shafts. An internal investigation has concluded that the shafts need to be heat treated. Consequently, the company wishes to engage a materials Engineer conversant with heat treatment process. Using neat diagrams, explain the heat treatment required and explain how it will solve the identified problem. (7 marks)