



KIBABII UNIVERSITY

**UNIVERSITY EXAMINATIONS
2021/2022 ACADEMIC YEAR**

**SECOND YEAR SECOND SEMESTER
MAIN EXAMINATIONS**

**FOR THE DEGREE OF BACHELOR OF SCIENCE IN RENEWABLE
ENERGY AND BIO FUELS TECHNOLOGY**

COURSE CODE: REN 222

COURSE TITLE: MATERIALS SCIENCE

DURATION: 2 HOURS

DATE: 5/10/2021

TIME: 8:00-10:00AM

INSTRUCTIONS TO CANDIDATES

- Answer **QUESTION ONE** (Compulsory) and any other two (2) Questions.
- Indicate **answered questions** on the front cover.
- Start every question on a new page and make sure question's number is written on each page.

This paper consists of printed pages. Please Turn Over



KIBU observes ZERO tolerance to examination cheating

SECTION A : COMPULSORY (30 MARKS)

QUESTION ONE (20 MARKS)

(a) State **four** characteristics of Schrodinger's three dimensional wave equation.

(5 marks)

(b) Define the term **allotropy** with reference to iron and state three allotropic elements

(5 marks)

(c) Illustrate the following lattice directions:

(i) [110]

(ii) [100]

(iii) [112]

(iv) [111]

(v) [0001]

(5 marks)

(d) Using a sketch, explain the Equilibrium transformation of the following Carbon steels when cooled from the Upper critical temperature:

(i) 1.2%

(ii) 0.8%

(10 marks)

(e) With the aid of sketches, explain the effects of adding the following elements to carbon steels with reference to polymorphic transformation:

(i) Nickel

(ii) Chromium

(5 marks)

SECTION B: ATTEMPT ANY TWO QUESTIONS FROM THIS SECTION (40 MARKS)

QUESTION TWO (20 MARKS)

(a) State five **disadvantages** and five **advantages** of cold working in metals

(10 marks)

(b)(i) An annealed metal rod has an initial diameter of 10mm. It is drawn down to 8mm. Determine the percentage of cold work.

(ii) If the annealed metal rod was first reduced to 8.9mm before the final diameter of 8.0mm was achieved through the same process, determine the amount of cold work and state your observation.

(7 marks)

(c) State TWO methods of altering mechanical properties of metals

(3 marks)

QUESTION THREE (20 MARKS)

(a) Highlight TWO effects of adding the following elements in carbon steels:

(i) Sulphur

(ii) Phosphorous

(iii) Manganese

(iv) Silicon

(8 marks)

(b) With the aid of sketches describe the **martensitic** transformation of a steel heated to austenitizing temperature

(12 marks)

QUESTION FOUR (20 MARKS)

(a) Illustrate the following crystal imperfections found in metals

(i) vacancy

(ii) Interstitial

(5 marks)

(b) Describe the production of the following malleable Cast Irons

(i) Ferritic

(ii) Pearlitic

(10 marks)

(c) (i) Define the term Packing factor as it is applied to atom lattice

(ii) Show that for a BCC lattice, the relationship between the lattice parameter (distance between the atoms), 'a', and the diameter of the atoms, 'd', is given by $\frac{a}{d} = 1.155$

(5 marks)

QUESTION FIVE (20 MARKS)

(a)(i) Describe the term "Recrystallization" as it is applied in crystallography

(ii) Explain the industrial application of a(i)

(5 marks)

(b)(i) State the main constituents of the THREE stainless steels

(ii) State THREE applications of the stainless steels in b(i)

(10 marks)

(c) State FOUR tool steel materials

(ii) State FOUR requirements of tool steels in c(i)

(5 marks)