KIBABII UNIVERSITY

SUPPLIMENTARY/ SPECIAL UNIVERSITY EXAMINATIONS

ACADEMIC YEAR 2021/2022

FOURTH YEAR FIRST SEMESTER EXAMINATIONS

BACHELOR OF SCIENCE

COURSE CODE: SPH 417

COURSE TITLE: SOLID STATE PHYSICS

DATE: 22/11/2022 **TIME: 11:00AM-1:00PM**

INSTRUCTIONS TO CANDIDATES

Answer question ONE and any TWO of the remaining.

Time: 2 hours

KIBU observes ZERO tolerance to examination cheating

QUESTION ONE (30 MARKS)

a) State any two states of matter (2 marks)
b) Differentiate between crystalline and amorphous solids (2 marks)
c) Define the following terms crystals:

(i) Lattice
(ii) Basis (2 marks).
(iii) Unit cell (2 marks)
(2 marks)

d) What is an ionic bond (2 marks)
e) What is a lattice vibration and how does it occur (3 marks)
f) Name any three forces in which metallic bonds depends (3 marks)
g) Calculate the distance between two lattice planes which give first order diffraction at an angle of 26.42° with molybdenum of X-rays of wavelength 0.71Å? (3 marks)
h) Using a well labelled diagram, define a face-centred cubic (bcc) unit cell. (2 marks)
i) What is an atomic scattering factor? (3 marks)
j) State Bragg's law in mathematical form (2 marks)
k) Apply Miller indices to sketch (1 0 0) plane (2 marks)

QUESTION TWO (20 MARKS)

(a) Derive the relationship between phase velocity and group velocity (12 marks)
(b) Discuss the important properties of metal crystals (8marks)

QUESTION THREE (20 MARKS)

(a) State the Bloch theorem and show how it can be expressed in one dimension (12 marks)
(b) A bcc crystal is issued to measure the wavelength of some X-rays. The Bragg angle for the first order reflection from (100- planes is 20.2°. What is the wavelength? (Take lattice parameter of the crystal as 3.15 Å (8 marks)

QUESTION FOUR (20 MARKS)

(a) Discuss any five assumptions of classical free electron model (10 marks)
(b) A sample of silicon is doped with 10^{17} phosphorus atoms per cm^3. What is the resistivity and the expected Hall voltage in a sample of 200μm thickness if the current density is 1 A/cm^2 and magnetic field of 1×10^{-5} Wb/cm^2 is applied perpendicular to the direction of current flow. Given mobility = 600 cm^2/volt-sec) (10 marks)

QUESTION FIVE (20 MARKS)

(a) What is Hall effect? An n-type semi-conductor (Ge) has a donor density of $10^{15}/cm^3$. It is arranged in a Hall effect experiment where magnetic field $B_Z = 0.5$ Wb/m^2 is applied and a current density of $j_x = 500A/m^2$ results. What will be the Hall voltage if the specimen is 4 mm thick? (8 marks)

(b) Calculate the extent of energy range between $f(\epsilon) = 0.9$ and $f(\epsilon) = 0.1$ at temperature T= 200K and express it as a function of $\epsilon_f = 3$ eV. (12 marks)