NATIONAL OPEN UNIVERSITY OF NIGERIA
PLOT 91, CADASTRAL ZONE, NNAMDI AZIKIWE EXPRESSWAY, JABI - ABUJA
FACULTY OF SCIENCES

DEPARTMENT OF PURE AND APPLIED SCIENCE

2021_2 EXAMINATIONS

COURSE CODE: **PHY 307**

COURSE TITLE: **SOLID STATE PHYSICS I**
CREDIT UNIT: **2**
TIME ALLOWED: **(2 HRS)**

INSTRUCTION: ***Answer question 1 and any other three questions***

QUESTION 1

(a) Write down the Fermi-Dirac function (2 Marks)

(b) Sketch the Fermi-Dirac function (4 Marks)

(c) What are the important simple structures? (1½ Marks)

(d) For uniform deformation, what are the strain components of displacement in u, v and w (3 Marks)

(e) Write down the equation of motion in the y and z direction in terms of stress components (4½ Marks)

(f) (i) What is the physics principle behind the reason why the origin of repulsive energy is similar in all solids. (ii) State the principle. (2 Marks)

(g) What are the principal numbers of regularities in the appearance of superconductivity? (7 Marks)

(h) Define superconductivity (1 Mark)

QUESTION 2

(a) Define crystal binding.(2 Marks)

(b) State the various bonding types in an atom.(4 Marks)

(c) Use diagram to illustrate a typical curve for the potential energy representing the interactions between two atoms.(9 Marks)

QUESTION 3

(a) State the Cauchy relation. (1 Mark)

(b) State where Cauchy relation does not work well and where it is moderately well satisfied. (2 Marks)

(c) What are the conditions for the validity of the Cauchy relations? (3 Marks)

(d) Show that the velocity of a longitudinal wave in the [111] direction of a cubic crystal is given by

$$v_s = \left[\frac{1}{3}(C_{11} + 2C_{12} + 4C_{44})/\rho\right]^{\frac{1}{2}}$$ (9 Marks)

QUESTION 4

(a) What is the condition holding for a harmonic approximation? (1 Mark)
(b) State the force exerted on nth atom in a lattice.(3 Marks)

(c) What are the important properties in the dispersion relation in the 1-D mono-atomic lattice?(3 Marks)

(d) Sketch the dispersion curve of a 1-D mono-atomic lattice representing the first Brillouin zone.(8 Marks)

QUESTION 5

(a) State the allowed energy level equation for a harmonic oscillator. (4 Marks)

(b) Why is it that a phonon does not carry real physical momentum? (2 Marks)

(c) Consider a harmonic oscillator in a thermal bath. The probability to find this oscillator in an excited state, which is characterized by a particular energy E_n is given by the Boltzmann distribution.

(i) Write down the average excitation number. (ii) Derive the Planck's distribution function

(9 Marks)