



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

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

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)