SL NO of QP: 13567

a) Name of the Department	:	**Department of Physics & Astrophysics**
b) Name of Course	:	**B.Sc. Hons.__NEP___GE**
c) Semester	:	**VII- Semester**
d) Name of the Paper	:	**Solid State Physics**
e) Unique Paper Code	:	**2224002002**

Duration: 3 Hours **Maximum Marks: 90**

Instructions for Candidates

i. Write your Roll No. on top immediately on receipt of the question paper.
ii. Attempt ***five*** questions in all. Question No. 1 is compulsory.
iii. Use of scientific calculator is allowed

1. Attempt all parts. 4x5=20

(a) In 2D structures there is no centred square Bravais lattice. Give your argument to prove that the centred square is not a new lattice.

(b) Differentiate between Amorphous and Crystalline materials. Give one example of each.

(c) The Hall coefficient of a certain silicon specimen was found to be -6.24×10^{-5} m^3C^{-1} from 100 K to 400 K. Determine the nature of the semiconductor. Further, the electrical conductivity was found to be 200 $\Omega^{-1}m^{-1}$. Calculate the density and mobility of charge carriers.

(d) What do you understand by effective mass of electrons?

(e) The critical magnetic field for Aluminium is 4.5×10^5 A/m. Calculate the critical current which can flow through a long thin superconducting wire of Aluminium of diameter 10^{-4}m.

2.(a) Prove that the volume of a unit cell in the reciprocal lattice is inversely proportional to the volume of a unit cell in the direct lattice. (5)

(b) Define Brillouin Zones? Draw first two Brillouin Zones of a square lattice? (7.5)

(c) Show that for hexagonal close packed structure **c/a** $=\sqrt{8/3}$, where a and c are the lattice parameters. (5)

3(a) Derive an expression for the dispersion relation for the monoatomic linear chain of atoms and show that how it behaves as a low pass filter. (10)

(b)The dispersion relation for the vibrational modes of diatomic linear lattice having masses **m** and **M (m < M)** is

$$\omega^4 - 2\alpha\left(\frac{1}{M}+\frac{1}{m}\right)\omega^2 + \frac{4\alpha^2}{mM}sin^2\,Ka = 0$$

where the symbols have their usual meanings.

Obtain expressions for acoustical and optical curves. Also draw the dispersion curves. (7.5)

4(a) Write the assumptions taken in the formulation of Kronig-Penney model to describe the formation of energy bands in solids. Describe the argument for taking the wavefunction of electron as a Bloch function? (7.5)

(b) Show that for the free electrons, the effective mass of electron is equal to the free electron mass. (5)
(c) Calculate the number of energy states available for the electrons in a cubical box of side 1 cm lying below the energy of 1 eV. (5)

5(a) Discuss B-H curve of a ferromagnetic material using the concept of domains. How do you characterize materials as soft and hard from its B-H curve? Explain with relevant reason one practical application each of a soft and hard material. (10)
(b) A magnetic material has a magnetization of 3300 $A\text{-}m^{-1}$ and flux density of 0.0044 $Wb\text{-}m^{-2}$. Calculate the magnetizing force and the relative permeability of the material. (7.5)

6(a) what do you understand by dielectric, dipole moment, dielectric polarization, and depolarization. Show that $D = \varepsilon E + P$ where symbols have their usual meaning. (7.5)
(b) What are polar and non-polar molecules? Give examples. Also calculate the electric susceptibility for a dielectric material having dielectric constant 1.329. (5)
(c) The capacitance of a parallel capacitor increases from 0.085μF to 0.195μF when a sheet of polythene is placed between the plate. Determine the dielectric constant of polythene. (5)
7.(a) State and explain Meissner effect. Show that this law violates the classical law? (7.5)
(b) Discuss application of superconductors in power transmission and magnetic levitation. (5)
(c) A superconducting element has a critical temperature of 7.26 K at zero magnetic field and a critical field of 8×10^5 A/m at 0K. find the critical field at 5K. (5)