Name: **Enrolment No:**	UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
Online End Semester Examination, November/December 2021

Course: Solid State Physics **Semester: V**
Program: B.Sc Physics (H) **Time: 3 Hrs**
Course Code: PHYS 3002 **Max. Marks: 100**

Section A
All questions are compulsory. Each question carries 4 marks.

S.No.	Question	CO
Q1	(i) The ferroelectric Curie temperature (θ_c) of a ferroelectric material is the temperature above which the ……. polarization vanishes. (ii) …… is the property of all electrical non-conductors that causes them to change their shape under the application of an electric field. (iii) Piezoelectric effect can be used to measure (a) Force (b) Strain (c) Acceleration (d) All of the above (iv) ……..polarization exists in all types of dielectrics.	**CO1**
Q2	(i) The points in a reciprocal space correspond to …… in real space. (a) Points (b) Planes (c) Lines (ii) The coordination number of the central atom on the hexagonal face (HCP lattice) is **…** (a) 8 (b) 12 (c) 6 (d) 4 (iii) The Miller indices of the plane parallel to the x and y-axes are (a) (1 0 0) (b) (0 1 0) (c) (0 0 1) (d) (1 1 1) (iv) In an FCC lattice, in which of the following planes there is no Bragg reflection. (a) (1 1 2) (b) (2 2 0) (c) (1 1 5) (d) (1 1 1)	**CO1**
Q3	If A and B are two isotopes of a superconducting element where the number of neutrons is more in isotope B. Predict which of the two isotope would be having a higher critical temperature? Please also provide the reason behind.	**CO3**
Q4	Draw the fermi level diagram in case of N-type and P-type semiconductor clearly showing the various bands and levels.	**CO2**
Q5	Differentiate between the acoustical and optical phonons.	**CO1**

Section B
All questions are compulsory. Each question carries 10 marks.

Q6	Show that the spontaneous magnetization in a ferromagnetic material exists for temperatures below the Curie point T_c.	**CO2**
Q7	The London penetration depths for Pb at 3 K and 7.1 K are respectively 39.6 nm and 173 nm. Calculate its transition temperature as well as penetration depth at 0 K.	**CO4**

Q8	Show that for the Einstein's model of a solid, the molar specific heat at constant volume C_v is given by $$C_V = 3Nk\left(\frac{\hbar\omega}{kT}\right)^2 \frac{e^{\hbar\omega/kT}}{\left(e^{\hbar\omega/kT}-1\right)^2}$$ where the symbols have their usual meanings.	**CO3**
Q9	Explain how the Kronig-Penney model predicts the presence of energy gaps in crystals.	**CO4**
Section C **All questions are compulsory. Each question carries 20 marks. Question 11 has internal choice.**		
Q10	(a) Calculate the current produced in a Germanium crystal having cross sectional area 2 cm^3 and length 0.4 mm when a potential difference of 1.5 V is applied. Given: concentration of free electrons in Germanium crystal is 2 x 10^{19} m^{-3} and the mobilities of electron and hole are 0.36 and 0.17 $m^2.V^{-1}.s^{-1}$ respectively. **[10]** (b) Show that the nearest neighbor distance in case of a body centered cubic is 0.866*a*, where '*a*' is the edge length. **[10]**	**CO3**
Q11	What do you mean by local field in a solid dielectric? Deduce an expression for the local field for structures possessing cubic symmetry. OR What is dielectric strength? Deduce the Clausius-Mosotti equation relating the macroscopic dielectric constant with microscopic polarization.	**CO2**

Values of some physical constants:

Planck's constant, h = 6.6 x 10^{-34} J.s
Boltzmann's constant, k = 1.38 x 10^{-23} J/K
Mass of electron, m_e = 9.1 x 10^{-31} Kg
Mass of proton, m_p = 1.67 x 10^{-27} Kg
Velocity of light, c = 3 x 10^8 m/s
Rydberg Constant, R = 1.097 x 10^7 m^{-1}
Avogadro's number = 6.023 x 10^{23}
Permittivity of free space, ε_o = 8.85 x 10^{-12} F/m
Permeability of free space, μ_o = 4π x 10^{-7} H/m