Name:

Enrolment No:

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, December 2022

Course: Solid State Physics **Semester : V**
Program: B.Sc. (H) Physics **Time : 03 hrs.**
Course Code: PHYS 3002 **Max. Marks: 100**

Instructions: 1) Mention your Roll No. at the top of the question paper.
2) Attempt all the parts of a question at one place only.

SECTION A
(All questions are compulsory)

S. No.		Marks	CO
Q 1	Discuss the origin of magnetism in macroscopic materials.	**4**	**CO3**
Q 2	List out some differences between soft and hard magnetic materials.	**4**	**CO1**
Q 3	Draw the fermi-energy diagram for intrinsic and extrinsic semiconductors.	**4**	**CO3**
Q 4	What are cooper pairs and how are they formed?	**4**	**CO1**
Q 5	Differentiate between the normal and anomalous dispersion.	**4**	**CO2**
	SECTION B **(All questions are compulsory)**		
Q 6	Describe how to determine the structure by powder diffraction method. What are its advantages over other methods?	**10**	**CO2**
Q 7	Derive Curie-Weiss law for ferroelectric materials.	**10**	**CO2**
Q 8	Explain the Hall effect when the charge carriers are electrons. Also derive an expression for Hall voltage.	**5+5**	**CO3**
Q 9	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.	**10**	**CO4**
	SECTION-C **(Q10 is compulsory while Q 11 has internal choice)**		
Q 10	Deduce an expression for the maximum angular frequency for the optical branch during the motion of atoms of diatomic 1D crystal.	**20**	**CO3**
Q 11	Prove that the Langevin-Debye equation in dielectrics is $$\boldsymbol{P} = NE\left\{4\pi\varepsilon_o R^3 + \frac{e^2}{\omega_o^2}\left(\frac{1}{m}+\frac{1}{M}\right) + \frac{\mu^2}{3kT}\right\}$$ where, the symbols have their usual meanings.	**20**	**CO2**

	OR Show that the relation between dielectric constant, a macroscopic parameter and polarizability, a microscopic parameter is given by $$\varepsilon_r = \frac{1 + \frac{2N\alpha}{3\varepsilon_o}}{\left(1 - \frac{N\alpha}{3\varepsilon_o}\right)}$$ where the symbols have their usual meanings.		

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, $\mu_o = 4\pi$ x 10^{-7} H/m