Name:

Enrolment No:

UPES

End Semester Examination, December 2024

Course: Solid State Physics **Semester: V**

Program: B.Sc. Physics (H) **Time : 03 hrs.**

Course Code: PHYS 3021 **Max. Marks: 100**

Instructions: All questions are compulsory. Use of Scientific calculator is allowed.

SECTION A

All questions are compulsory.

S. No.		Marks	CO
Q 1	Determine the nearest-neighbor distance for a Face-Centered Cubic (FCC) crystal structure.	**4**	**CO2**
Q 2	Explain how an external magnetic field affects ferromagnetic domains.	**4**	**CO3**
Q 3	Draw the fermi-energy diagram for intrinsic and extrinsic semiconductors.	**4**	**CO2**
Q 4	Write a note on Ferrimagnetic materials.	**4**	**CO1**
Q 5	Draw a neat and labelled polarization vs Electric field curve for ferroelectric materials.	**4**	**CO2**

SECTION B

All questions are compulsory. Question 9 has internal choice.

Q 6	Explain Bragg's law and derive its expression.	**10**	**CO1**
Q 7	Starting from the expressions for Einstein's specific heat equation and Debye's specific heat equation, demonstrate that both equations converge to Dulong and Petit's law at high temperatures.	**10**	**CO2**
Q 8	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**	**CO3**
Q 9	What do you mean by the London penetration depth? Show that the London penetration depth is given by the expression $\lambda = \left(\frac{m}{\mu_o e^2 n_s}\right)^{1/2}$ where, the symbols have their usual meanings. **OR**	**10**	**CO2**

	What is pyroelectricity? Explain with the help of an example.		
SECTION-C **All questions are compulsory. Question 11 has internal choice.**			
Q 10	(a) Calculate the critical magnetic field for Tin at 1.5K and 2.5K. The following data for Tin are given T_c = 3.72K and H_c = 30.5 x 10^{-3} T at 0K. (b) The polarizability of ammonia molecule is found by measuring the dielectric constant approximately as 2.42 x 10^{-39} C^2m/N at 309K and 1.74 x 10^{-39} C^2m/N at 448 K. Calculate the orientational polarizability of ammonia molecule at 309 and 448 K.	**10** **10**	**CO4**
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. **OR** Prove that the local field for structures possessing cubic symmetry is given by $$\boldsymbol{E_L} = \boldsymbol{E} + \frac{\boldsymbol{P}}{3\varepsilon_o}$$ where, the symbols have their usual meanings.	**20**	**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
Charge on an electron, e = 1.6 x 10^{-19} C
Mass of proton, m_p = 1.67 x 10^{-27} Kg
Speed 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