STELLA MARIS COLLEGE (AUTONOMOUS) CHENNAI – 600 086
(For candidates admitted from the academic year 2023 – 2024 and thereafter)

M.Sc. DEGREE EXAMINATION NOVEMBER 2024
PHYSICS
THIRD SEMESTER

COURSE : MAJOR CORE
PAPER : SOLID STATE PHYSICS
SUBJECT CODE: 23PH /PC/SS34
TIME : 3 HOURS **MAX. MARKS: 100**

Q. No.	SECTION A Answer ALL the Questions: (10 x 3 = 30 marks)	CO	KL
1	Define phase velocity and group velocity.	CO1	K1
2	State Hund's rule.	CO1	K1
3	Write the relation connecting the dielectric constant and dielectric susceptibility.	CO1	K1
4	How did the Einstein theory explain the failure of Dulong and Petit law?	CO2	K2
5	The conductivity of metals decreases while that of semiconductors increases with rise in temperature. Explain.	CO2	K2
6	How does the band theory lead to the concept of negative effective mass.	CO2	K2
7	Explain Bloch wall and the domain wall energy.	CO2	K2
8	How does the total polarizability depend on frequency?	CO3	K3
9	Explain how the electron-phonon interaction helps to produce the Cooper pairs.	CO3	K3
10	How does superconducting transition temperature vary with magnetic field?	CO3	K3
Q. No.	**SECTION B (30 marks)**	**CO**	**KL**
	PART A **(PROBLEM SECTION)** **Answer any TWO Questions: (2 x 5 = 10 marks)**		
11	The velocities of longitudinal and transverse waves in Aluminium are 6374 and 3111 m/s, respectively. Calculate the Debye frequency and the Debye temperature for Aluminium (Assume that there are 6.02×10^{28} atoms per m^3 in Aluminium).	CO3	K3
12	The Curie temperature of Iron is 1043 K. Assume that Iron atoms, when in metallic form have moments of 2 Bohr magneton per atom. Iron is body centered cube with lattice parameter a = 0.286 nm. Calculate the Curie constant.	CO3	K3

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13	The polarizability of NH_3 molecule is found experimentally by the measurement of dielectric constant as $2.42x10^{-39}$ Fm^2 and $1.74x10^{-39}$ Fm^2 at 309 K and 448 K respectively. Calculate for each temperature the polarizability due to permanent dipole moment and due to deformation of molecules.	**CO3**	**K3**
	PART B **Answer any FOUR Questions: (4 x 5 = 20 marks)**		
14	Discuss, qualitatively, the concept of phonons for elastic vibration in a solid. Enumerate the properties of phonons.	**CO4**	**K4**
15	Discuss the thermoelectric effects in semiconductors.	**CO4**	**K4**
16	Describe the behavior of magnetic substances with reference to their Curie points.	**CO4**	**K4**
17	Explain the polarization in dielectrics. Arrive at the relation between the dielectric constant and atomic polarizability.	**CO4**	**K4**
18	Explain Meissner effect and distinguish between type I and type II superconductors.	**CO4**	**K4**
Q. No.	**SECTION C** **Answer the following: (2 x 20 = 40 marks)**	**CO**	**KL**
19	a) List out the assumptions of Einstein's theory of specific heat capacity and estimate the specific heat capacity of a monoatomic crystalline solid. Point out its limitations.	**CO6**	**K6**
	b) Discuss the Kronig-Penney model by considering characteristic features of electron propagation in crystals.	**CO5**	**K5**
	(OR)		
	c) Discuss the condition for setting up the optical and acoustical branches based on the lattice vibrations in a linear diatomic lattice.	**CO6**	**K6**
	d) Deduce Clausius-Mosotti equation to determine the dipole moment of a polar molecule from the dielectric constant measurements.	**CO5**	**K5**
20	a) Based on the Weiss theory of ferromagnetism, obtain an expression for magnetization and illustrate its variations with temperature with necessary plots.	**CO6**	**K6**
	b) With suitable diagrams, discuss Hall effect in semiconductors and highlight the significance of Hall coefficient.	**CO5**	**K5**
	(OR)		
	c) Describe Langevin's theory for a paramagnetic gas and its limitations. Obtain paramagnetic susceptibility of a free electron gas employing quantum statistics.	**CO6**	**K6**
	d) Explain London's theory with London penetration length and coherence length.	**CO5**	**K5**

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