25PHP104/22PHP102N

PSG COLLEGE OF ARTS & SCIENCE
(AUTONOMOUS)

MSc DEGREE EXAMINATION DECEMBER 2025
(First Semester)

Branch – **PHYSICS**

SOLID STATE PHYSICS

Time: Three Hours Maximum: 75 Marks

SECTION-A (10 Marks)

Answer **ALL** questions

ALL questions carry **EQUAL** marks (10 × 1 = 10)

Module No.	Question No.	Question	K Level	CO
1	1	In a one-dimensional well, the allowed energy levels of an electron are a) Continuous b) Discrete c) Zero d) Negative	K1	CO1
	2	Mean free path (λ) of an electron is related to relaxation time as a) $\lambda = v\tau$ b) $\lambda = \frac{\tau}{v}$ c) $\lambda = \tau^2 v$ d) $\lambda = \frac{\tau}{v^2}$	K2	CO1
2	3	The Einstein Model of the specific heat assumes atoms in a solid as a) Free particles b) Independent harmonic oscillators c) Classical particles d) Rotating dipoles	K1	CO2
	4	The Kroning-Penney model the occurrence of energy bands is due to a) Free electron motion without potential b) Periodic potential of ions in a crystal lattice c) Random scattering of electrons d) Temperature vibrations of atoms	K2	CO1
3	5	The unit of dipole moment is a) Coulomb b) Coulomb meter c) Joule d) Volt	K1	CO3
	6	Piezoelectric effect refers to a) Electric polarization produced by magnetic filed b) Electric polarization produced by mechanical stress c) Magnetic field produced by temperature change d) Spontaneous polarization below Curie temperature	K2	CO3
4	7	Which of the following substance shows weak repulsion when placed in a magnetic field? a) Ferromagnetic b) Paramagnetic c) Diamagnetic d) Ferrimagnetic	K1	CO4
	8	The easy axis in a magnetic material is the direction in which a) Maximum anisotropy energy is required to magnetize b) Minimum anisotropy energy is required to magnetize c) Magnetization is not possible d) Magnetic susceptibility is zero	K2	CO4
5	9	The sources of superconductivity in a material are a) Electron pairing b) Magnetic impurities c) Crystal defects d) High temperature only	K1	CO5
	10	The coherence length decreases as temperature approaches a) Zero Kelvin b) Critical temperature c) Room temperature d) None of the above	K2	CO5

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SECTION - B (35 Marks)

Answer **ALL** questions

ALL questions carry **EQUAL** Marks (5 × 7 = 35)

Module No.	Question No.	Question	K Level	CO
1	11.a.	Explain the energy quantization in a three-dimensional infinite potential well. Derive the expression for the energy levels of a particle confined in a cubic box of side *a*.	K2	CO1
		(OR)		
	11.b.	Describe the role of free electrons in contributing to the electric specific heat of metals and also derive its expression.		
2	12.a.	Apply the Einstein model to calculate the specific heat of a solid at high and low temperatures.	K3	CO2
		(OR)		
	12.b.	Illustrate the application of Bloch's theorem in explaining the motion of electrons in a periodic potential.		
3	13.a.	Apply the concept of dipole moment and polarization to derive the expression for the electric field of a dipole.	K3	CO3
		(OR)		
	13.b.	Differentiate and explain the piezoelectric, pyroelectric and ferroelectric properties of crystals and highlight their practical applications.		
4	14.a.	Explain the response of substance to external magnetic field and the atomic theory of magnetism.	K5	CO4
		(OR)		
	14.b.	Evaluate how spontaneous magnetization in ferromagnetic materials varies with temperature.		
5	15.a.	Explain the different sources that can lead to superconductivity in materials.	K5	CO5
		(OR)		
	15.b.	Derive the London equation and explain its significance in understanding the electromagnetic response of superconductors.		

SECTION -C (30 Marks)

Answer **ANY THREE** questions

ALL questions carry **EQUAL** Marks (3 × 10 = 30)

Module No.	Question No.	Question	K Level	CO
1	16	Apply the particle in a box model to calculate the allowed energy levels of an electron confined in a one-dimensional box of length *a*. Show how quantization arises for varies n values with diagram.	K3	CO1
2	17	Evaluate the significance of the Debye temperature and explain how it determines the behavior of specific heat in different materials.	K4	CO2
3	18	Describe the concept of the local electric field inside a dielectric and derive the expression for depolarization field, Lorentz field and field of diploes inside cavity for an atom.	K2	CO3
4	19	Derive and evaluate the Langevin's classical theory of diamagnetism.	K5	CO4
5	20	Describe the concept of phonon-mediated electron pairing in BCS theory and its importance in the formation of the superconducting state.	K5	CO5

Z-Z-Z END