Name:

Enrolment No:

UPES

End Semester Examination, May 2025

Course: Condensed Matter Physics | **Semester: II**

Program: M.Sc. Physics | **Time: 03 hrs.**

Course Code: PHYS 7033 | **Max. Marks: 100**

Instructions:

1) All questions are compulsory with an internal choice in Q9 and Q11.
2) Non-programmable scientific calculators are allowed during examination.

SECTION A
(5Qx4M=20Marks)

S. No.		Marks	CO
Q1	How will you distinguish between polycrystalline, single crystalline and amorphous materials experimentally?	**4**	**CO1**
Q2	What do you understand by molecular field theory in case of magnetism?	**4**	**CO1**
Q3	Explain magneto-crystalline anisotropy with proper example.	**4**	**CO2**
Q4	Differentiate between classical and quantum phase transition.	**4**	**CO2**
Q5	The superconducting critical temperature of the H_3S superconductor is 205 K, with a mass of 35.09 u. Calculate the critical temperature for its isotope D_3S, which has a mass of 38.1 u.	**4**	**CO4**

SECTION B
(4Qx10M= 40 Marks)

Q6	(a) Discuss the role of vacancies in structural and physical properties in condensed matter physics. (b) The first-order diffraction is found to occur at a glancing angle of 12º. Calculate the wavelength of X-ray and the glancing angle for second order diffraction if the spacing between the adjacent plane is 2.4 Å.	**5** **5**	**CO4**
Q7	Elaborate crystal electric field splitting for free *d*-electrons in octahedral and tetrahedral environments.	**10**	**CO2**
Q8	(a) Discuss magnetization process of a ferromagnet based on domain structure. (b) Magnetic susceptibility for a diamagnetic material is found to be, $\chi = -4.5 \times 10^{-2}$ μ_B/Oe at an applied field magnetic field of 1000 Oe at room temperature. What will be the value of magnetic susceptibility at 4.2 K and under magnetic field of 500 Oe?	**5** **5**	**CO4**

Q9	Explain the Integral Quantum Hall effect with the aid of an appropriate diagram. Also, compare it with the Fractional Quantum Hall effect. **OR** Establish a relation between electrical and thermal conductivity considering free electron theory.	**10** **10**	**CO1**
SECTION-C **(2Qx20M=40 Marks)**			
Q10	(a) What is the Hall effect? Derive the expressions for longitudinal and transverse resistivity, demonstrating that one of them is independent of the applied magnetic field. (b) Using the free electron model, calculate the Hall coefficient of sodium, assuming a body-centered cubic (BCC) structure with a unit cell side length of 4.28 Å.	**15** **5**	**CO3**
Q11	(a) Write a brief note on the BCS theory of superconductivity. (b) The critical temperature of mercury is 4.2 K and the penetration depth is 62 nm at 3.2 K. Determine the penetration depth in mercury at 0 K. (c) Explain how a superconductor is different from a perfect conductor? **OR** (a) Derive London's equations for superconductivity. (b) Determine the superconducting critical temperature of aluminum if the penetration depth for aluminum is 16 nm and 96 nm at 2.18 K and 8.1 K, respectively. (c) Discuss salient features of type-II superconductor explaining their phase diagram.	**10** **5** **5** **10** **5** **5**	**CO3**