



Avinashilingam Institute for Home Science and Higher Education for Women

Deemed to be University Estd. u/s 3 of UGC Act 1956, Category A by MHRD (now MoE)

Re-accredited with A++ Grade by NAAC. CGPA 3.65/4, Category I by UGC

Coimbatore - 641 043, Tamil Nadu, India

Master's Degree Examination – May 2025

II Semester

Class : I P.G.
Major : Physics

Time: 3 Hours
Max. Marks: 100

23MPHC09 Advanced Condensed Matter Physics

Course Outcomes:

CO1: Analyse free electron theory

CO2: Distinguish conductors and semiconductors on the basis of Band theory.

CO3: Explain the effect of macroscopic electric field on dielectric material and learn about superconductivity

CO4: Describe about Dia and Para magnetism in detail.

CO5: Discuss Ferro and Antiferro magnetism in detail.

Part A

10 x 1 = 10

Choose the Correct Answer

1. Which of the following factors primarily affects the electrical conductivity of metals? CO1K1
 - a. Temperature
 - b. Magnetic field
 - c. Atomic number of the metal
 - d. Pressure

2. Fermi-Dirac statistics applies to which type of particles? CO1K1
 - a. Photons
 - b. Bosons
 - c. Fermions
 - d. Neutrons

3. Which of the following statements is true for an intrinsic semiconductor? CO2K1
 - a. The number of free electrons is greater than the number of holes.
 - b. The number of free electrons is equal to the number of holes.
 - c. It requires doping to conduct electricity effectively.
 - d. It has a very high concentration of charge carriers at room temperature.

4. What does the Hall Effect describe? CO2K1
 - a. The voltage difference across a conductor in a magnetic field
 - b. The current flow in a magnetic field
 - c. The magnetic field produced by a current
 - d. The interaction between electric and magnetic fields

5. What is the primary property of a dielectric material? CO3K1
 - a. It allows free movement of electrons
 - b. It can conduct electricity
 - c. It does not conduct electricity but can support an electric field
 - d. It generates electric fields

6. In the Meissner effect, a superconductor: CO3K3
 - a. Becomes a perfect insulator
 - b. Expels all magnetic fields from its interior
 - c. Absorbs the magnetic field completely
 - d. Does not interact with magnetic fields at all

7. According to Langevin's theory of diamagnetism, the magnetic susceptibility (χ) of a diamagnetic material is: CO4K2
- Directly proportional to the temperature
 - Inversely proportional to the temperature
 - Zero at absolute zero temperature
 - Independent of temperature
8. What is the characteristic behaviour of a paramagnetic material when placed in a magnetic field? CO4K1
- It becomes magnetized and retains its magnetism even after the field is removed
 - It becomes magnetized in the opposite direction of the magnetic field
 - It becomes weakly magnetized in the direction of the applied magnetic field
 - It does not become magnetized
9. In ferromagnetic materials, the magnetic domains are: CO5K3
- Randomly oriented
 - Aligned in the opposite direction to the applied magnetic field
 - Always at zero magnetization
 - Aligned in the same direction
10. At what temperature does an antiferromagnetic material lose its anti ferromagnetic order? CO5K3
- Curie temperature
 - Néel temperature
 - Bohr temperature
 - Fermi temperature

Part B

5 x 6 = 30

Answer ALL questions

Each answer should not exceed 400 words or two pages

- 11.a. Explain the origin of band gap. CO1K2
- (or)
- 11.b. Derive an expression for thermal conductivity in metals. CO1K3
- 12.a. Derive the expression for the intrinsic carrier concentration in a semiconductor. CO2K3
- (or)
- 12.b. Explain how the Hall Effect can be used to determine the mobility of charge carriers in a semiconductor. CO2K4
- 13.a. Explain Meissner effect. CO3K2
- (or)
- 13.b. Differentiate Type I and Type II superconductors. CO3K3
- 14.a. Explain the basic principle of Langevin's classical theory of diamagnetism. CO4K2
- (or)
- 14.b. Discuss the quantum theory of paramagnetism. CO4K1
- 15.a. Describe the assumptions made in the classical theory of ferromagnetism. CO5K1
- (or)
- 15.b. What happens to the magnetic susceptibility of antiferromagnetic materials below the Néel temperature? CO5K1

Part C

5 x 12 = 60

Answer ALL questions

Each answer should not exceed 800 words or four pages

- 16.a. Explain the free electron gas in three dimensions. CO1K3
- (or)
- 16.b. Derive the expression for the probability of an energy state being occupied in the Fermi-Dirac distribution. CO1K5

- 17.a. How does the density of states influence the carrier concentration in a semiconductor? CO2K1
(or)
- 17.b. Describe the characteristics of n-type and p-type semiconductors with suitable diagrams. CO2K2
- 18.a. Show how the Clausius-Mossotti relation can be used to determine the polarizability of molecules from the macroscopic dielectric constant of the material. CO3K3
(or)
- 18.b. Explain AC Josephson effect. CO3K2
- 19.a. Derive the Curie Law for paramagnetic materials at high temperatures. CO4K4
(or)
- 19.b. Using Weiss' Theory, show that the magnetic susceptibility (χ) of a paramagnetic material follows the Curie-Weiss law at high temperatures. CO4K3
- 20.a. Compare the soft and hard magnetic materials. CO5K5
(or)
- 20.b. Explain molecular field theory of anti-ferromagnetism. CO5K3
