



**Avinashilingam Institute for Home Science and Higher Education for Women**  
(Deemed to be University under Category 'A' by MHRD, Estd. u/s 3 of UGC Act 1956)  
Re-accredited with 'A+' Grade by NAAC. Recognised by UGC Under Section 12B  
Coimbatore - 641 043, Tamil Nadu, India

**Master's Degree Examination – June / July 2021**  
**II Semester**

**Class : I PG**  
**Major : Physics**

**Time : 3 Hours**  
**Max. Marks: 100**

**20MPHC09 Advanced Condensed Matter Physics**  
**Part A**

**10 x 1 = 10**

**Choose the Correct Answer**

- If  $\lambda$  is the mean free path of the electron moving with velocity  $v$ , then the time  $\tau$  between two successive collisions is defined by the equation -----.  
a.  $\tau = v \lambda$       b.  $\tau = \frac{\lambda}{v}$       c.  $\tau = \frac{v}{\lambda}$       d.  $\tau = \sqrt{\frac{v}{\lambda}}$  CO1K1
- The Fermi function attains a value '1/2' when  $E$  and  $E_F$  are associated as below.  
a.  $E < E_F$       b.  $E > E_F$       c.  $E = E_F$       d.  $E = \frac{E_F}{2}$   
CO1K2
- Indicate the position of the Fermi level in an n-type semiconductor at 0 K CO1K2  
a. lies below the donor level  
b. lies half way between the conduction band and donor level  
c. coincides with the intrinsic Fermi level  
d. is absent
- Mobility is defined as the ----- acquired by the current carrying particles per unit electric field. CO1K1  
a. displacement      b. velocity      c. acceleration      d. voltage
- On comparing, it is observed that in ----- substances, the non-polar state is more stable at high temperatures. CO2K2  
a. ferroelectric      b. piezoelectric  
c. superconducting      d. semiconducting
- Infer which of the below causes Superconductivity/ CO2K2  
a. crystal structure having infinite atomic vibrations at 0 K  
b. crystal structure having no atomic vibrations at 0 K  
c. all electrons interacting in the superconducting state  
d. all electrons having Fermi energy at 0 K
- When the atoms and ions are acted upon individually with no mutual interaction between them, the effect is defined as ----- CO3K1  
a. diamagnetism      b. ferromagnetism  
c. anti-ferromagnetism      d. paramagnetism
- Each ferromagnetic material has a characteristic temperature above which its properties are very different from those below it. This is defined as ----- temperature. CO3K1  
a. Curie      b. Demagnetisation  
c. Transition      d. Faraday
- Express the maximum value of spontaneous magnetisation. CO3K2  
a.  $\frac{Ng}{J\mu_B}$       b.  $NgJ\mu_B$       c.  $\frac{N}{J\mu_B}$       d.  $\frac{Ng}{\mu_B}$
- Select the most characteristic property of a polycrystalline antiferromagnetic substance which shows a maximum as a function of temperature. CO3K1  
a. permeability      b. permittivity  
c. susceptibility      d. magnetic field

**Part B****5 x 6 = 30****Answer ALL questions****Each answer should not exceed 400 words or two pages**

- 11.a. Show that the electrical conductivity of metals depends on the number of free electrons. Also compute the expression for thermal conductivity and obtain the Wiedemann Franz ratio. CO1K3
- (or)
- 11.b. Calculate the average drift velocity of electrons in a copper conductor with a cross-sectional area of  $10^{-6} m^2$  carrying a current of 4 A. The atomic weight of copper is 63.6 and the density is  $8.9 \text{ gm/cm}^3$ . Take Avogadro number  $N_A = 6.02 \times 10^{23}$ . CO1K3
- 12.a. Explain effective mass of an electron. CO1K2
- (or)
- 12.b. Compute the intrinsic concentration of charge carriers in Germanium at 300 K.  $E_g$  for germanium is 0.67 eV. Given  $\frac{m_e^*}{m_0} = 0.12$  and  $\frac{m_p^*}{m_0} = 0.28$ . CO1K3
- 13.a. Explain polarization catastrophe. CO2K2
- (or)
- 13.b. Distinguish between Type I and Type II superconductors. CO2K2
- 14.a. Explain the term susceptibility. Derive the Langevin formula for the susceptibility of a diamagnetic material. CO3K2
- (or)
- 14.b. Discuss the theory of cooling by adiabatic demagnetization and obtain an expression for the resulting change in entropy. CO3K2
- 15.a. Explain the temperature dependence of spontaneous magnetisation in ferromagnetic materials. CO3K2
- (or)
- 15.b. Explain Anisotropy energy. CO3K2

**Part C****5 x 12 = 60****Answer ALL questions****Each answer should not exceed 800 words or four pages**

- 16.a. (i) Explain the theory of free electron gas in three dimensions. Show that the Fermi energy depends on the electron concentration.  
(ii) For lithium, the Fermi energy is 4.7 eV and the density of electrons is  $4.6 \times 10^{28}/m^3$ . Compute the electron density for a metal with Fermi energy 2.35 eV. CO1K3
- (or)
- 16.b. Compute the expression for Fermi Dirac distribution. Show that the Fermi function is given by the expression  $F(E) = \frac{1}{\exp\left[\frac{(E-E_F)}{K_B T}\right] + 1}$ . CO1K3
- 17.a. Determine the expressions for the densities of free electrons and holes in an Intrinsic semiconductor. CO1K2
- (or)
- 17.b. Explain Hall effect. Compute the expression for the Hall coefficient. How is it experimentally determined? CO1K3
- 18.a. Compute the expression for Lorentz field in a dielectric and hence determine the Clausius - Mossotti equation. CO2K3
- (or)
- 18.b. Compute the London equations. Explain the term coherence length. CO2K3
- 19.a. Explain the quantum theory of paramagnetism. Relate how this theory explains the behaviour of rare earth ions. CO3K2
- (or)
- 19.b. Distinguish between hard and soft magnetic materials. CO3K2
- 20.a. Explain the domain structure in ferromagnetic materials. Explain the reason for the strong ferromagnetic property found in iron, cobalt and nickel. CO3K3
- (or)
- 20.b. Explain in detail the phenomenon of anti-ferromagnetism. Explain its variation with Neel temperature. CO3K2