

**PHYSICS Paper-C**

**(Electricity and Magnetism-II)**

**Time Allowed : 3 Hours**

**Maximum Marks : 45**

- Note :**
- (i) Attempt five questions in all, selecting two questions from each of Units I and II.
  - (ii) Unit III is compulsory.
  - (iii) Use of non-programmable scientific calculator is allowed.

## UNIT-I

- Drive the equation of Continuity  $\vec{\nabla} \cdot \vec{J} + \frac{\partial \rho}{\partial t} = 0$  where  $\rho$  and  $\vec{J}$  are charge and current densities respectively. What form will it take for steady currents ?
  - Calculate the average time between collisions for an electron of electron gas colliding with positive ion of Copper wire having  $10^{29}$  electrons  $m^{-3}$ . Given resistivity of Copper is  $1.7 \times 10^{-8}$  ohm m. 5, 4
- Derive an expression for the electric field of a point charge moving with constant velocity. How does it differ from the field due to a stationary charge ? Illustrate with diagrams. 9
- Explain Langevin Theory of Diamagnetism.
  - Find the percent increase in magnetic induction when the space with a current carrying toroid is filled with magnesium. Given that the susceptibility of Magnesium is  $1.2 \times 10^{-5}$ . 6, 3

## UNIT-II

- State and prove the reciprocity theorem of Mutual Induction.
  - What is Hall Effect ? Show that the Hall coefficient  $R_H = 1/ne$ . 6, 3
- Drive Gauss's Law in Magnetism.
  - Explain the term surface current density. Give its application.
  - Show that the magnetic field at a point inside the toroid varies inversely as its distance from the centre. 3, 3, 3
- Define vector potential and derive an expression for it.
  - Show that the energy stored per unit volume in the magnetic field 'B' set up in a solenoid is  $B^2/2\mu_0$ . 5, 4

## UNIT-III

7. Attempt any six parts :

- In a certain material the drift velocity is a quadratic function of electric field. Will the material be ohmic or non-ohmic ?
- Can a free electron show diamagnetic effect ? Explain.
- Is the electric field due to a moving charge conservative ?
- Show that the magnetic scalar potential satisfies Laplace's equation.

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- (v) What is the value of  $\vec{\nabla} \cdot \vec{B}$  and  $\vec{\nabla} \times \vec{B}$  for points inside the current loop ?
- (vi) Define displacement current. What is its cause ?
- (vii) The magnetic flux linked with a close loop changes with time as  $\phi = At^2 + Bt^2$ . What are the Units of A and B ?  $6 \times 10^{1/2} = 9$