PHYSICS PAPER–C

(Electricity and Magnetism-I)

Time Allowed : Three Hours **[Maximum Marks : 22**

Note : (1) Attempt **five** questions in all, selecting **two** questions each from of Unit I and Unit II.

(2) **Unit III (Q. No. 7) is compulsory.**

(3) Use of non-programmable scientific calculator is allowed.

(4) Log tables may be asked for, if needed.

2. (a) Derive an expression for electric field due to uniformly charged infinite wire at a point on a line perpendicular to the wire.

(b) An electric dipole of dipole moment 5×10^{-7} cm is located at the origin and is aligned along x-axis. What is electric field due to dipole at the point (0, 0.3, 0.4)m ? 3, 1

3. (a) Show that potential at a point due to electric dipole is $\frac{\vec{P}}{4\pi\varepsilon_0} \text{grad}\left(\frac{1}{r}\right)$

where $\vec{P}$ is the electric dipole moment.

(b) Show that Coulomb's force between stationary charges satisfies Newton's Third Law of Motion. 3, 1

Unit-II

4. (a) What is Electrical Image ? Find the potential energy of a point charge placed near conducting sheet at zero potential.

(b) What is Laplace's equation ? Show that function $V = x^2 - y^2 - z$ satisfies Laplace's equation. 3, 1

5. (a) What is Atomic Polarizability ? Derive an expression for it in terms of dielectric constant.

(b) Show that the energy stored in a parallel plate capacitor per unit volume of capacitor is $\frac{1}{2}\frac{q^2}{c}$ where q be the charge on capacitor and c be the capacitance. 3, 1

6. (a) Discuss the effect of introducing a dielectric between plates of capacitor. Hence establish the relation $\kappa = 1 + \chi e$.

(b) Two molecules are 3 mm apart. One molecule has one excess electron and the other has deficiency of one electron. Find the force between these molecules if they are in water. Given dielectric constant of water is 80. 3, 1

Unit-III

7. Attempt any six parts :

(i) What is charge on electron moving with velocity 0.8 c?

(ii) If vector field is divergenceless, can it be expressed as curl of another vector field ?

(iii) Prove that the vector field $\vec{A} = xy^2\hat{i} + x^3y\hat{\partial}$ is non-conservative.

(iv) Define Electric Susceptibility.

(v) Define curl of vector field.

(vi) What are equipotential surfaces ?

(vii) What is effect of polarization on a given volume of dielectric material?

$6 \times 1 = 6$