[This question paper contains 5 printed pages.]

1213 *Your Roll No.* .....

B.Sc. (Hons.)/I **A**

PHYSICS – Paper III

(Electricity and Magnetism)

Time : 3 Hours *Maximum Marks : 38*

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt **Five** *questions in all.*
Question No. **1** *is compulsory.*
Attempt **one** *question from each Section.*

1. Attempt any **Five** of the following :

(a) Show that for external points, a spherical symmetric charge distribution behaves as if the entire charge were concentrated at the centre.

(b) An electric dipole is placed in non-uniform electric field. Calculate the force acting on it.

(c) Prove div $\vec{B} = 0$ and explain its significance.

(d) State & prove Reciprocity Theorem for Mutual Inductance.

P.T.O.

(e) A.C. bridges need simultaneous adjustment of two balance conditions. Explain why ?

(f) State and explain Norton's Theorem. (2×5)

SECTION – A

2. (a) Show that the potential due to a uniformly charged circular disc falls off from the centre to the edge of the disc, derive necessary expressions. Also find the electric field at the centre of the disc.

(b) Find the potential of a uniformly charged spherical shell of radius (R) for points (a) inside (b) outside it using Gauss's law. (5,2)

3. Explain the 'Method of Electrical Images'. A point charge (q) is placed in front of a conducting plane of infinite long maintained at zero potential. Calculate

(i) the potential & the electric field at any point.

(ii) the surface density of induced charge, on the conducting plane. What is the total induced charge on it. (7)

SECTION – B

4. (a) Obtain the generalized form of Gauss's law in a dielectric medium both in integral & differential forms. Discuss the boundary conditions for $\vec{D}$ & $\vec{E}$ across the interface between two media having surface charge density σ.

(b) Two dielectrics of thicknesses d_1 & d_2 having dielectric coefficients K_1 & K_2 respectively are placed between a pair of oppositely charged parallel plates. Find the ratio of electric intensities in the two dielectrics. (5,2)

5. (a) Show that the potential energy of a system of charges can be calculated from electric field by assigning an amount of energy $(\frac{1}{2}) \epsilon_0 E^2 d\tau$ to every volume element $d\tau$ and integrating over entire space.

(b) Distance between the plates of a parallel plate capacitor is (d). A dielectric slab of thickness (x) is introduced in the air gap. Show that the capacitance of capacitor will be doubled if the dielectric constant of the slab $K = 2x/(2x-d)$.

(4,3)

SECTION – C

6. (a) Derive expression for magnetic field, at a point on its axis of symmetry of a circular coil carrying current. Use it to prove that magnetic field at the ends of a long solenoid is one-half of that at the centre.

(b) An electron circulates around a nucleus in an orbit of radius 5.1×10^{-11} m with constant speed 0.7×10^{-2} C. Calculate (B) at the centre of orbit. ($\mu_0 = 4\pi \times 10^{-7}$ H/m, $e = 1.6 \times 10^{-19}$ Coulomb, $C = 2.998 \times 10^8$ m/sec). (5,2)

7. (a) Draw Hysteresis curves for the material suitable for its use in (i) in a transformer (ii) as a permanent magnet. Explain how the curve shows that the material is suitable for the purpose indicated.

(b) Show that the area enclosed by B-H loop denotes the energy dissipated per unit volume of the material during each cycle of magnetisation.

(c) The mean length of a Rowland ring is 50 cm & its cross-sectional area 4 cm^2. Find the value of current needed to establish a flux of 4×10^{-4} Webers in the ring. (permeability of material of the ring is 65×10^{-4} H/m & number of turns wound on the ring is 200). (2,3½,1½)

SECTION – D

8. (a) Show that Faraday's law of electromagnetic induction holds good for a conducting loop moving through non-uniform magnetic field (Magnetic field varies in both direction and magnitude from place to place).

(b) A long co-axil cable of length 'l' carries a current 'I'. Find the energy stored in it when the current flows down the surface of inner cylinder of radius 'a' and back along the outer cylinder of radius 'b'. (4½,2½)

9. (a) An alternating source of e.m.f is connected to a circuit having inductance L, resistance R and capacitance C in series. Obtain expression for instantaneous current & impedance. Also obtain the condition of resonance & explain sharpness of resonance.

(b) State & explain Thevenin's theorem. Draw Thevenin's equivalent circuit for the following network (4½,2½)