Bachelor of Science (B.Sc.) Semester—I Examination

PHYSICS (ELECTROSTATICS TIME VARYING FIELDS & ELECTRIC CURRENTS)

Optional Paper—2

Time : Three Hours] [Maximum Marks : 50

N.B. :— (1) All questions are compulsory.

(2) Draw well labelled diagrams wherever necessary.

(3) The symbols have their usual meaning unless otherwise stated.

1. **EITHER**

(A) What is electric dipole ? Obtain an expression for the electric potential and electric field at a far off point due to small electric dipole. 5

(B) (i) Prove Coulomb's law in accordance with Newton's third law of motion. 3

(ii) Two equal and opposite charges of 1μc each are placed in transformer oil at a distance of 1m. Calculate the force between them. The dielectric constant of oil is 2.2. 2

OR

(C) Show that in an electric field E, the potential difference between A and B along any path is :

$$V_B - V_A = -\int \dot{E}.\dot{d}r$$ 2½

(D) Show that :

E = – grad v 2½

(E) Explain the conservative nature of electrostatic field. 2½

(F) Calculate the Potential and field due to a dipole of dipole moment 4.5×10^{-10}c–m at a distance of 1m on perpendicular bisector. 2½

2. **EITHER**

(A) What do you understand by Lorentz local field in the dielectric ? Show that field at any point in a dielectric is :

$$\dot{E}_{local} = E + \frac{P}{3\in_o}$$ 5

(B) (i) Derive Clausius-Mosotti Equation using Lorentz local field. 3

(ii) A 10μF capacitor at 60V is connected in Parallel to an uncharged capacitor. After making the connection the common voltage on the capacitor is found to be 20V. What is the capacity of the second capacitor ? 2

OR

(C) Explain the term electric field $\vec{E}$, Polarization Vector $\vec{P}$, and displacement density vector $\vec{D}$. 2½

(D) Derive an expression for capacity of a parallel plate capacitor, when partially filled with dielectric. 2½

(E) Prove the relation $\vec{D} = \epsilon_0 \vec{E} + \vec{P}$. 2½

(F) Determine the area of a paper plate required to make a parallel plate condenser of capacity 0.004μF if the dielectric constant of paper is 2.5 and its thickness = 0.025 mm ($\varepsilon_o = 8.846 \times 10^{-12}$ F/m). 2½

3. **EITHER**

(A) Obtain an expression for decay of charge on a condenser through an inductor and a resistor. Under what condition the discharge will be oscillatory ? 5

(B) (i) Define current density and derive the continuity equation for time varying currents. 3

(ii) A capacitor of capacitance 1μF is allowed to discharge through an inductance 0.2H and a resistance of 800 ohm connected in series. Prove that the discharge is oscillatory. 2

OR

(C) State Faraday's law of electromagnetic induction. Obtain its integral and differential form using magnetic flux ϕ. 2½

(D) What are the requirements of ideal transformer and state uses of transformer. 2½

(E) Obtain an expression for the growth of charge on a condenser through resistor. What is time constant of the circuit ? 2½

(F) A transformer has 100 turns of primary and 5 turns of secondary. Calculate the secondary voltage and transformer ratio if primary voltage is 150 V. 2½

4. **EITHER**

(A) An alternating emf $E = E_o \sin wt$ is applied to series LCR circuit. Derive an expression for the alternating current in steady state. Under what condition the circuit is said to be in resonance with frequency of applied emf ? Hence write the expression for the resonance frequency. 5

(B) (i) Explain the term sharpeness of resonance. 3

(ii) In a series resonance circuit L=1mH, C = 10 μF and R = 10 ohm. Calculate the resonant frequency. 2

OR

(C) Define Inductive reactance, capacitive reactance and impedance. 2½

(D) Obtain an expression for the power consumed in an A.C. circuit. 2½

(E) How ac current and voltage are expressed in complex number form ? Explain. 2½

(F) A capacitor of 20μF is connected in series with a 25Ω resistance to a peak emf 240V, 50Hz A.C. Calculate (1) the capacitive reactance of the circuit, (2) impedance of the circuit (3) the maximum current in the circuit. 2½

5. Attempt any **ten** :

(i) Define electric field and electric field intensity.

(ii) State any two limitations of Coulomb's law.

(iii) Two protons are separated by 5×10^{-10}m, find electrostatic force between them.

(iv) Define polar and nonpolar molecules.

(v) Two capacitors each of capacity C, are connected in series and two capacitors are connected in parallel. Find equivalent capacitance of their combination.

(vi) State any two energy losses in transformer.

(vii) In a given circuit, if L = 4.0 H and C = 2μF. Find maximum value of resistance in LCR circuit so that the circuit can just oscillate.

(viii) State Faraday's law of electromagnetic induction.

(ix) Define inductive time constant, state its unit.

(x) Define Q value of series LCR circuit.

(xi) What is bandwidth of resonance ?

(xii) What is wattless current ? 1×10