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

PHYSICS-102

Compulsory Paper—II

(Electrostatics, Time Varying Fields and Electric Currents)

Time : Three Hours] [Maximum Marks : 50

N.B. :— (1) **ALL** questions are compulsory.

(2) Draw neat diagrams wherever necessary.

EITHER

1. (A) Define electric field intensity and electric potential difference. Obtain an expression for electric potential at a point due to point charge. 2+3

(B) (i) Derive an expression for electric field at a point due to a short dipole. 3

(ii) Calculate the potential due to a short dipole of dipole moment 3×10^{-26} C-m at a point at a distance 3 cm from its center on its axis.

[Given : $\frac{1}{4\pi\epsilon_0} = 9 \times 10^9$ N-m^2/C^2] 2

OR

(C) For a conservative electrostatic field show that electric field at a point is negative gradient of electric potential at that point. 2½

(D) State and explain Coulomb's law of electrostatics in vector form. 2½

(E) The potential at a certain distance from a point charge is 600 V and electric field is 200 N/C. Find :

(i) Distance of point charge and

(ii) The magnitude of point charge. 2½

(F) Express work-done on a charge in an electric field as a line integral of electric field. 2½

EITHER

2. (A) Define electric field intensity ($\vec{E}$), Displacement density ($\vec{D}$) and Polarization ($\vec{P}$) and derive the relation between them. 5

(B) (i) Explain with examples polar and non-polar dielectrics. 3 3.

(ii) If the Helium (He) gas is placed in an electric field of 600 V/cm, find out induced dipole moment per unit volume of Helium.

(The atomic polarizability of He is 0.18×10^{-40} F-m^2 and density of He is 2.6×10^{25} atoms/m^3). 2

OR

(C) If the local field in an isotropic dielectric is given by $E_{loc} = E_0 + \frac{3P}{\epsilon_0}$, derive Clausius-Mosotti equation. 2½

(D) Define electric polarizability and give its S.I. unit. State different types of polarizability. 2½

(E) Obtain an expression for the capacity of a parallel plate capacitor filled completely by dielectric substance. 2½

(F) The plates of a parallel plate capacitor of capacitance 1 μf are separated by 1 mm. Calculate the plate area, assuming that air is filled between the plates. 2½

EITHER

3. (A) Describe the construction and theory of transformer with neat labelled diagram. 5

(B) (i) Derive an expression of discharging of current in CR circuit. 3

(ii) A LCR circuit consist of L = 0.24, a capacitor of C = 0.0012 μF and a resistor. Calculate the maximum value of resistor, which will oscillate the circuit. 2

OR

(C) Derive Faraday's laws of electromagnetic induction in integral form. 2½

(D) Derive an expression for growth of current in an LR circuit applied with a d.c. source. 2½

(E) Explain different types of losses in transformer. 2½

(F) The time constant of an inductive coil is 2.5×10^{-3} sec when 80 Ω resistance is added in series, the time constant reduces to 0.5×10^{-3} sec. Find the inductance and resistance. 2½

EITHER

4. (A) Using j-operator method, derive an expression of current in a series LCR circuit when ac source is applied to it and hence discuss the phase relationship between alternating emf and current for three different cases. 5

(B) (i) Define capacitive reactance. Explain the phase relationship between the current and voltage when ac source is applied to a CR circuit. 3

(ii) An alternating voltage of 120 V and 50 cycles is applied to a circuit containing a capacitor of capacitance 20 μf and resistance of 10 Ω. Determine impedance and phase angle between alternating voltage and current. 2

OR

(C) When an ac source of peak value 0.1 V is applied to series LCR circuit having, L = 300 μH, C = 20 pf, and R = kΩ, calculate :

(i) Resonance frequency

(ii) The current at resonance

(iii) Power factor at resonance. 2½

(D) Derive an expression of power consumed in an ac circuit. 2½

(E) Define quality factor. For a series LCR ac circuit prove that quality factor is given by $Q = \frac{1}{R}\sqrt{\frac{L}{C}}$. 2½

(F) Obtain an expression of current in LR circuit, when ac source is applied to it. 2½

5. Attempt any *ten* (1 mark each) :

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

(ii) Define conservative field.

(iii) Electric potential in a region is $V = 4x^2 - 3y^2 - 9z^2$, find the electric field at a point, P(3, 4, 5).

(iv) Define dielectric constant of a material.

(v) What will happen to the capacity of a parallel plate capacitor if a metal plate is inserted between its plates ?

(vi) What is the relation between electric displacement ($\vec{D}$) and electric field intensity ($\vec{E}$) in free space ?

(vii) Give the statements of Kirchoff's current and voltage law.

(viii) A transformer is used to glow a 140 W – 240 V bulb at 240 V ac. If the current in the primary coil is 0.7 A, calculate the efficiency of the transformer.

(ix) Define capacitive time constant in case of decay of charge in CR circuit.

(x) State any two applications of series resonant circuit.

(xi) In series resonant circuit, L = 1 mH, C = 10 μf and R = 10 Ω calculate quality factor of the circuit.

(xii) Define voltage magnification. 1×10