NKT/KS/17/5044

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

PHYSICS

(Electrostatics Time Varying Fields and Electric Currents)

Compulsory Paper—2

Time : Three Hours] [Maximum Marks : 50

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

(2) Draw neat diagrams wherever necessary.

EITHER

1. (A) Define electric dipole and dipole moment. Obtain an expression for electric field intensity at a point due to an electric dipole having polar co-ordinates (r, θ). 5

(B) (i) Define Electric potential at a point and derive an expression for the potential at a point due to a point charge. 3

(ii) Four point charges $q_1 = 2 \times 10^{-8}$ C, $q_2 = 3 \times 10^{-8}$ C, $q_3 = -2 \times 10^{-8}$ C $q_4 = 1 \times 10^{-8}$ C are placed at four corners of a square of side 1 m. Find the potential at its centre. $\left(\frac{1}{4\pi\in_o} = 9\times10^9 \text{ Nm}^2/\text{C}^2\right)$ 2

OR

(C) Explain Coulomb's law between two point charges in terms of their position vectors. 2½

(D) Define electric field and intensity of electric field. Write the unit and dimensional formula of electric field intensity. 2½

(E) What is a conservative field ? Show that electrostatic field $\overline{E}$ is conservative. 2½

(F) Calculate the electric field on the surface of a Uranium nucleus ($Z = q_2$). Its nuclear radius is 7×10^{-15} m and $e = 1.6 \times 10^{-19}$ C. 2½

EITHER

2. (A) What do you understand by local field in a dielectric ? Show that the local electric field in a dielectric is given by

$$E_{loc} = E + \frac{P}{3\in_o}$$

where the symbols have their usual meaning. 5

(B) (i) Obtain an expression for capacity of a parallel plate capacitor filled with air as dielectric medium. 3

(ii) The plates of a parallel plate capacitor are separated by 1.5 mm. What must be the plate area if the capacitance is to be 1 F ?

Assuming that the parallel plates are filled with air. ($\in_o$ = 8.9 × 10^{-12} $coul^2/\mu m^2$) 2

OR

(C) Explain the classification of materials as conductors, semiconductors and insulators on the basis of conductivity. 2½

(D) Explain the term 'electric displacement D'. Hence, show that $D = \in E$. 2½

(E) Explain polar and non-polar molecules with examples. 2½

(F) Two parallel plates having equal but opposite charges are separated by a dielectric slab 2 cm thick, with dielectric constant 3. If the electric field strength between the plates is 10^6 V/m, calculate the displacement vector and polarisation vector. 2½

EITHER

3. (A) What is Electromagnetic induction ? State and explain Faraday's law and Lenz's law of electromagnetic induction. Write down integral and differential form of Faraday's law. 5

(B) (i) Under what condition in LCR series circuit, will the discharge be dead beat, critical damped and damped oscillatory ? Hence draw curve of discharge of capacitor through L and R. 3

(ii) An experiment had coil of 3 mH. Find the value of capacitor in order to have oscillating frequency of 10^3 kHz. Neglect resistance in the circuit. 2

OR

(C) Derive the equation of continuity $\vec{\nabla}.\vec{J} + \frac{\partial \rho}{\partial t} = 0$ where symbols have their usual meaning. 2½

(D) State the explain Kirchhoff's laws in electric network with circuit diagram. 2½

(E) Obtain an expression for decay of electric current in a circuit with resistor and inductor in series. Hence define inductive time constant. 2½

(F) The current in an LR-circuit rises to half of its final value in 4 sec. Find the time constant of the circuit. 2½

EITHER

4. (A) Using J-operator method, obtain an expression for reactance and phase in each case when sinusoidal e.m.f. is applied to :

(i) pure inductance

(ii) pure capacitance. 5

(B) (i) Obtain an expression for the power consumed in ac circuit and define power factor. 3

(ii) An alternating emf of 10 V and 100 Hz is applied to a 5 H choke coil of resistance 200 ohm. Find the power factor and power absorbed. 2

OR

(C) What is resonance in series LCR circuit and find condition for sharp resonance. 2½

(D) How a.c. current and voltage are expressed in complex number form ? Explain. 2½

(E) Obtain an expression for current in AC circuit containing resistor and capacitor connected in series using j-operator method. 2½

(F) A resistance of 10 Ω is in series with inductance of 0.5 H. What capacity should be kept in series with the combination to set maximum current ? The current is supplied at 50 Hz. 2½

5. Attempt any **TEN** questions :—

(i) What is Charge ? State its unit.

(ii) What are the limitations of Coulomb's law ?

(iii) Calculate the acceleration of an electron of mass 9.1×10^{-31} kg due to a force of magnitude 4.8×10^{-15} N exerted on it.

(iv) Define 'relative permittivity'.

(v) Define Current density.

(vi) Three capacitors are connected in parallel and two are connected in series and these sets of capacitors are connected in parallel combination. If the capacitance of each is C, find the capacitance of the combination.

(vii) State the principle of Transformer.

(viii) The current in the primary coil of a transformer changes at the rate of 10 A/sec and the mutual inductance is 0.05 H. Find the induced e.m.f. in the secondary coil.

(ix) State the unit of capacitive time constant.

(x) What is wattless current ?

(xi) Write the unit of reactance and impedance.

(xii) Calculate the reactance of a capacitor of capacity 1 μf when it is connected across a source of frequency 1 kHz. 1×10=10