NTK/KW/15/5759

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

102 : PHYSICS

(Electrostatics, Time Varying Fields & Electric Currents)

Paper—II

Time—Three Hours] [Maximum Marks—50

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

(2) Draw neat diagram wherever necessary.

EITHER

1. (A) State and explain Coulomb's law in vacuum. Hence show that the Coulomb's law in vector form is given by :

$$\bar{F}_{21} = \frac{1}{4\pi \epsilon_0} \frac{\rho_1 \rho_2 (\bar{r}_1 - \bar{r}_2)}{|\bar{r}_1 - \bar{r}_2|^3} \quad 5$$

(B) (i) Show that $\bar{E} = -\text{grad } V$. 3

(ii) Two equal and similar charges 3 cm apart in air repel each other with a force 1.5 kg wt. Find the charges in Coulomb. 2

OR

(C) Derive an expression for electric potential at a point due to a point charge. 2½

(D) What do you mean by conservative field ? Show that electrostatic field is conservative. 2½

(E) Define electric potential at a point. Write its SI unit and define it. 2½

(F) A thin copper wire 6 m long and 1 mm in diameter carries a net charge 5.8 μc. Calculate the electric field at a distance of 10 cm from the axis of wire

$$\left[\frac{1}{4\pi \epsilon_0} = 9 \times 10^9 \text{ SI}\right].$$ 2½

EITHER

2. (A) Show that the local electric field in a dielectric is given by $E_{LOC} = E + \frac{P}{3\epsilon_0}$ where symbols have their usual meaning. 5

(B) (i) Derive the relation $\overline{D} = \epsilon_0 \overline{E} + \overline{P}$ where symbols have their usual meaning. 3

(ii) Find the area of the paper used in the condenser of capacity 0.002 μF, if the dielectric constant of paper is 2.5 and thickness is 0.05 mm. $[\epsilon_0 = 8.85 \times 10^{-12}$ S.I.] 2

OR

(C) Define polarizability of dielectric. What are different types of Polarizability ? 2½

(D) Derive an expression for the capacity of parallel plate capacitor with air as a dielectric. 2½

(E) How are the materials classified as conductor, semiconductor or insulator on the basis of conductivity of resistivity ? Explain. 2½

(F) A potential difference of 200 V is applied across the two plates of capacitor each of area 100 π cm^2 and separated by 1 mm. Find the capacitance :

(i) When there is no dielectric between the plates.

(ii) When there is dielectric between the plates of dielectric constant K = 6. 2½

EITHER

3. (A) What is transformer ? Give the construction and theory of a transformer. 5

(B) (i) What are the requirements of an ideal transformer ? Also state the losses in a transformer. 3

(ii) The ratio of number of turns in primary to secondary is 1 : 20. It is connected to a supply of 200 V a.c. Find the voltage across secondary and find the ratio I_p/I_S. 2

OR

(C) What is electromagnetic induction ? State and explain Faraday's law of electromagnetic induction. 2½

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

(E) Establish equation for the growth of current in a circuit containing a resistance and inductance in series. Define time constant. 2½

(F) A condenser of 2 μF capacity is discharged through a 1 ohm resistance and 2 henry inductance. Calculate :

(i) The quality factor Q and

(ii) The frequency of electric vibration. 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) What is series resonance circuit ? State special feather's of series resonance. 3

(ii) An electric lamp marked 100 volts d.c. consumers a current of 10 amperes. It is connected to a 200 volts 50 cycles a.c. mains. Calculate the inductance of the required choke. 2

OR

(C) Show that the average power dissipated in an a.c. circuit is $P = E_{rms} \cdot I_{rms} \cdot \cos\theta$. 2½

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

(E) What is voltage magnification in series LCR circuit. How high voltage magnification can be obtained in the series LCR circuit ? 2½

(F) An a.c. circuit has L = 10 mH, C = 10 μF and R = 10 ohm. Calculate :

(i) Natural frequency

(ii) Resonant frequency

(iii) Impedance of the circuit at resonance. 2½

5. Attempt any **TEN** :

(i) Define SI unit of electric field intensity.

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

(iii) What is electric dipole ?

(iv) State Gauss's law of electrostatics.

(v) Define dielectric constant K.

(vi) Three capacitors each of capacity C are connected in series. Find their equivalent capacitance.

(vii) Define current and current density.

(viii) State the unit of capacitive time constant.

(ix) Current in a coil changes at the rate of 10 A/sec. It induces e.m.f. of 0.5 V in it. Find coefficient of self inductance.

(x) Write the equation of current and voltage in pure resistive a.c. circuit in terms of j-operator.

(xi) Define quality factor in terms of resonance frequency and band width.

(xii) Write the unit of reactance and impedance.

$1 \times 10 = 10$