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2 SEM TDC PHYH (CBCS) C 3

2022

(June/July)

PHYSICS

(Core)

Paper : C-3

(Electricity and Magnetism)

Full Marks : 53

Pass Marks : 21

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Choose the correct answer (any *five*) : 1×5=5

(a) The electric flux passing through a sphere enclosing $+Q$ coulomb of charge is

(i) $\frac{Q}{3\varepsilon_0}$

(ii) $\frac{Q}{\varepsilon_0}$

(iii) $\frac{Q}{5\varepsilon_0}$

(iv) $\frac{Q}{4\pi\varepsilon_0}$

(b) The magnitude of electric field intensity at any point which is at a distance r from an electric dipole is directly proportional to

(i) $\frac{1}{r^3}$

(ii) $\frac{1}{r}$

(iii) $\frac{1}{r^4}$

(iv) $\frac{1}{r^2}$

(c) Poisson's equation for a homogeneous medium is

(i) $\nabla^2 v = 0$

(ii) $\nabla^2 v = -\frac{\rho_v}{\varepsilon}$

(iii) $\nabla^2 v = \frac{\rho_v}{\varepsilon}$

(iv) $\nabla^2 v = \rho_v$

(d) The SI unit of magnetic vector potential is

(i) T

(ii) $\frac{A}{m^2}$

(iii) $\frac{Wb}{m^2}$

(iv) $\frac{Wb}{m}$

(e) An example of ferromagnetic material is

(i) zinc

(ii) manganese

(iii) cobalt

(iv) chromium

(f) Current in a circuit is wattless when the phase difference between current and voltage is

(i) zero

(ii) $\frac{\pi}{2}$

(iii) $+\pi$

(iv) $-\pi$

2. *(a)* State Gauss law in electrostatics. Derive the relation $\vec{\nabla} \cdot \vec{E} = \frac{\rho}{\varepsilon_0}$, where ρ is volume density of charge. 1+2=3

(b) If 1 coulomb charge is placed at the centre of a cube of side 10 cm, calculate the flux coming out of any face of the cube. 1

3. *(a)* Prove the relation $E = -\nabla\phi$, where the symbols have their usual meanings. What is the significance of negative sign here? 2+1=3

(b) Calculate the electric potential at a point distance r from a point charge q. 2

4. *(a)* Define capacitance. Derive an expression for the capacitance of a parallel plate capacitor. 1+3=4

(b) A point charge q is placed at a distance d from an infinite plane conductor held at zero potential. Using method of electrical image, calculate—

(i) induced surface charge density;

(ii) total induced charge;

(iii) force of attraction between the charge and the conductor. 2+2+1=5

(Continued)

5. *(a)* Derive the relationship between electric susceptibility and atomic polarizability on the basis of microscopic description of matter at atomic level. 3

(b) Why does electric field inside a dielectric medium decrease due to polarization? 1

(c) Show that $D = \varepsilon_0 \vec{E} + \vec{P}$. Also give their units. 2

Or

The capacity of a capacitor is 50 pico-farads when it is filled with a dielectric. Calculate the dielectric constant of the dielectric.

6. *(a)* State the Biot-Savart law. Find the magnetic field at a point due to straight current carrying conductor using Biot-Savart law. 1+3=4

Or

Prove that $\oint_C \vec{B} \cdot d\vec{l} = \mu_0 I$. 4

(b) Show that divergence of magnetic field is zero. 3

7. Define magnetic induction $\vec{B}$ and intensity of magnetization $\vec{M}$. Prove that $\vec{B} = \mu_0(\vec{H} + \vec{M})$. 1+2=3

8. Derive Maxwell's equations of electro-magnetic wave and write the physical significance of each equation. 4

Or

Show that Ampere's law for varying currents may be written as

$$\oint_C \vec{B} \cdot \vec{dl} = \mu_0 I + \mu_0 \varepsilon_0 \frac{d\phi}{dt}$$

9. A circuit has $R = 10$ ohm, $L = 0{\cdot}05$H and $C = 20$ μF. An alternating potential difference of 100 V (RMS) is applied across it. Calculate *(a)* resonant frequency, *(b)* current at resonance and *(c)* Q-value of the circuit. 1+1+1=3

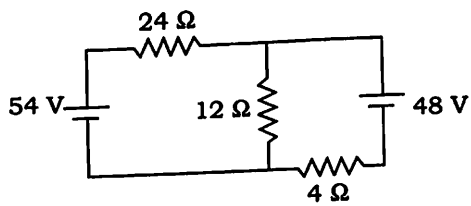
Or

A coil of self-inductance 0·7 henry is connected in series with a non-inductive resistance of 50 ohm. Calculate the wattless and power components as well as the total current when connected to a supply of 200 V at 50 Hz. 3

10. State and prove Thevenin theorem. What is the limitation of this theorem? 3+1=4

Or

In a network given below, find the current flowing through the 12 Ω resistance using the superposition theorem : 4



11. Show that the charge sensitivity is equal to $2\pi / T$ times the current sensitivity in case of the ballistic galvanometer. Under what conditions does a ballistic galvanometer become a dead beat galvanometer? 2+1=3

Or

The first three successive deflections of a ballistic galvanometer are found to be 15 cm, 14·9 cm and 14·8 cm. Calculate the first corrected deflection under damping. 3

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