## 2 SEM TDC PHYH (CBCS) C 3

### 2 0 2 2

( 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)* $\dfrac{Q}{3\varepsilon_0}$

   *(ii)* $\dfrac{Q}{\varepsilon_0}$

   *(iii)* $\dfrac{Q}{5\varepsilon_0}$

   *(iv)* $\dfrac{Q}{4\pi\varepsilon_0}$

*( Turn Over )*

(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) $\dfrac{1}{r^3}$

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

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

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

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

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

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

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

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

       ( Continued )

(d) The SI unit of magnetic vector potential is

  (i) T

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

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

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

(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) $\dfrac{\pi}{2}$

  (iii) $+\pi$

  (iv) $-\pi$

       ( Turn Over )

2. (a) State Gauss law in electrostatics. Derive the relation $\vec{\nabla} \cdot \vec{E} = \dfrac{\rho}{\varepsilon_0}$, where $\rho$ 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

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 $\oint_C \vec{B} \cdot \vec{dl} = \mu_0 I$. 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, $L = 0.05$H and $C = 20 \, \mu F$. An alternating potential difference of 100 V (R: 3) 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
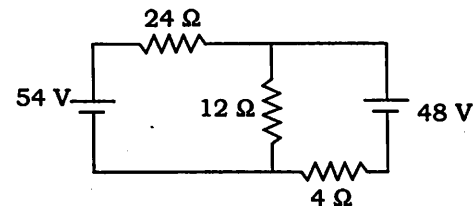
**10.** State and prove Thevenin theorem. What is the limitation of this theorem? 3+1=4

*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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