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C/18/B.Sc./2nd Sem/PHSH/C3T

2018

2nd Semester

PHYSICS

PAPER—C3T

(Honours)

Full Marks : 40

Time : 2 Hours

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Illustrate the answers wherever necessary.

Group—A

Answer any *five* questions. 5×2

1. Find the expression of mutual potential energy between two coplanar dipoles.

2. If the electrostatic potential is given by $\phi = \phi_0(x^2 + y^2 + z^2)$, where ϕ_0 is constant. Find the volume density of charge.

3. A sphere of radius 'a' has uniform charge density ρ. Find the electric flux density $\vec{D}$ for $r > a$.

(Turn Over)

4. A conducting sphere of radius R is placed in a uniform electric field $\vec{E}_0$ directed along +z axis. The electric potential for outside point is given as $V = -E_0\left(1 - \frac{R^3}{r^3}\right) r\cos\theta$, where r is the distance from the centre and θ is the polar angle. Find the charge density on the surface of the sphere.

5. Evaluate $\oint_c \vec{A}\cdot\vec{dl}$ along a square loop of side L in a uniform field $\vec{A}$.

6. Prove that $\mu_r = 1 + \chi_m$ where the symbols have usual meanings.

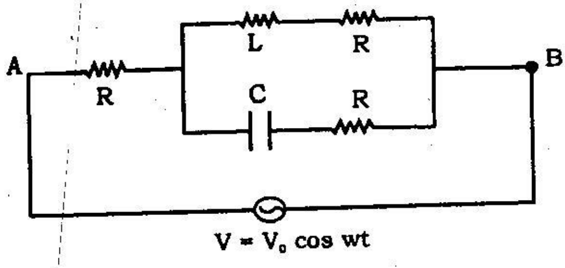
7. A capacitor (parallel plate) is being charged at a constant rate $\frac{dq}{dt} = b$. If A is the area of the plates and d is separation between them, find the displacement current.

8. Calculate the r.m.s. value of the current $i = I_0 + I_1 \cos(wt + \theta)$.

Group—B

Answer any *five* questions. 5×4

9. A complex voltage (10 + j) volt is applied to a series LR circuit of complex impedance $(\sqrt{3} + j)\Omega$. Calculate the power factor and power consumed by the circuit.

10. 

$$C = \frac{1}{wR\sqrt{3}} \quad \text{and} \quad L = \frac{R\sqrt{3}}{w}$$

Calculate the total impedance between the point A and B.

11. Consider a plane interface of two media of permeability μ_1 and μ_2. If the $\vec{B}$-fields on either side make angles θ_1 and θ_2 with the normal to the interface show that $\mu_1 \cot\theta_1 = \mu_2 \cot\theta_2$.

12. A long cylinder of radius 'a' carries a magnetization $\vec{M} = \kappa r^2 \hat{\theta}$, where κ is a constant, r is the distance from the axis. Find the magnetic field due to $\vec{M}$ both inside and outside the cylinder.

13. A long non-magnetic hollow cylinder carrying a current I. The inner and outer radii of the cylinder are a and b respectively. Find the magnetic field as a function of

radial distance (i) within the material of the conductor ($a < r < b$). (ii) outside the conductor ($r > b$).

14. Derive an expression for the force on a dipole placed in a nonuniform magnetic field.

Group—C

Answer any *one* question. 1×10

15. (a) A conducting shell of radius R is rotating about z-axis with angular velocity w in a uniform magnetic field B also in the z-direction. What is the potential difference between the pole and equator of the shell ?

(b) Show that the flux of the field vector $\vec{B}$ is continuous everywhere. Is it so for the vector $\vec{H}$? 5+5

16. (a) Three point charges q, q, -2q are located at (0, -a, a), (0,a,a) and (0,0,-a) respectively. Find the net dipole moment of this charge distribution.

(b) Find the work done is bringing a charge +q from infinity in free space to a position at a distance d in front of a semi-infinite grounded metal surface. 5+5

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