বিদ্যাসাগর বিশ্ববিদ্যালয়
VIDYASAGAR UNIVERSITY

Question Paper

B.Sc. Honours Examination 2022
(Under CBCS Pattern)
Semester - II
Subject: PHYSICS
Paper: C 3-T
Electricity and Magnetism

Full Marks : 40
Time : 2 Hours

Candidates are required to give their answers in their own words as far as practicable.
The figures in the margin indicate full marks.

Group - A

Answer any ***four*** of the following questions. 5×4=20

1. The electric field at any point within a charged sphere of radius a is $\vec{E} = Ar^3\hat{r}$. Find the volume charge density and total charge within the sphere. 3+2

2. Find the electric field produced by an infinite cylinder of radius 'a' and volume charge density $\rho(r) = 5re^{-2r}$ C/m^3 (r being the distance from the axis of the cylinder); at a point inside the cylinder. 5

3. (a) Find an expression for force per unit length between two parallel current carrying conductors.

P.T.O.

(b) A current I flows through a wire shaped in the form of a square of side L. Determine the magnetic field at the centre of the square. 2+3

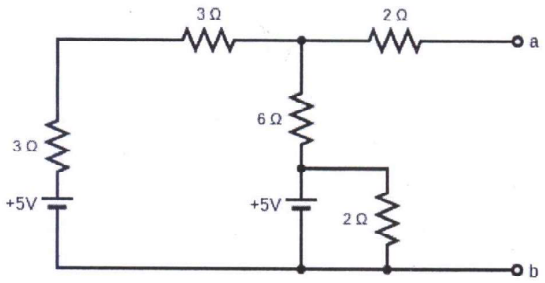
4. The distance between two parallel plates of a air capacitor is d. A dielectric slab of thickness x is introduced in the air gap. Show that the capacitance of the capacitor will be doubled if the dielectric constant of the material of the slab is $k = \frac{2x}{2x-d}$. 5

5. (a) Obtain the relation between magnetic field $\left(\vec{B}\right)$, magnetization $\left(\vec{M}\right)$ and magnetic intensity $\left(\vec{H}\right)$. Discuss qualitatively.

(b) A bar magnet made of iron has magnetic moment 2 A.m^2 and mass 5×10^{-3} kg. If the density of the iron is 6×10^{-3} kg.m^{-3}. Find the intensity of magnetization. 3+2

6. (a) Find the Thevenin and the Norton equivalent circuits between the terminals a and b for the network given below.

(b) Determine the resistance to be connected across a and b in the following figure to dissipate maximum power and calculate the maximum power. 3+2



Group - B

Answer any ***two*** of the following questions : 10×2=20

7. (a) A sphere of radius R carries a polarization $P(r) = kr$, where k is a constant and r is the vector from the center.

(i) Calculate the bound charges σ_b and ρ_b.

(ii) Find the field inside and outside the sphere.

(b) A spherical charge distribution consists of a uniform charge density ρ_1 from $r = 0$ to $a/2$, and ρ_2 from $r = a/2$ to a. Find the electric potential at $r = a/2$ and a. 5+5

8. (a) A point charge q is located at a distance a from an infinite conducting plane at zero potential. By the method of electrical image, calculate the force between the charge and the plane.

(b) Show that electric field is conservative in nature.

(c) The electric potential in a space is represented as $V = 3x + 5y - 6z$. Show that the electric field intensity is uniform everywhere in the space. 5+3+2

9. (a) Define the terms electric susceptibility and relative permittivity. Obtain the relation between them.

(b) What is Lenz's law? Show that it is in accordance with the law of conservation of energy.

(c) A proton with a kinetic energy of 1 MeV is entering a magnetic field (along north to south) of 15 T at right angles from East to West direction. Calculate the magnitude and direction of force acting on it. Given, mass of proton is $m = 1.67\times10^{-27}$ kg. 4+3+3

10. (a) Suppose an ac emf $v = V_0 \cos wt$ is applied to a circuit consisting of a pure inductor of inductance L and a capacitor of variable capacitance C in series. The capacitor is shunted by a resistance R. Find the value of C which makes the current through the coil independent of R.

(b) Starting from the expression of magnetic vector potential $\vec{A} = \frac{\mu_0 I}{4\pi}\int \frac{\vec{dl}}{r}$ obtain the expression $\vec{B} = \frac{\mu_0 I}{4\pi}\int \frac{\vec{dl}\times\vec{r}}{r^2}$, where $\vec{B} = \vec{\nabla}\times\vec{A}$. Which law does this expression represent? 5+5