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3 (Sem-2/CBCS) PHY HC 1

2022

PHYSICS

(Honours)

Paper : PHY-HC-2016

(Electricity and Magnetism)

Full Marks : 60

Time : Three hours

The figures in the margin indicate full marks for the questions.

1. Answer **any seven** questions : $1 \times 7 = 7$
- (a) Give *one* example where the electric potential is zero at a point or line but electric field is not zero.
- (b) What is conservative nature of electric field ?

Contd.

(c) If surface charge density of an infinite thick sheet is σ and $-q$ amount of charge is deposited on the sheet, then the amount of work done will be _____ .
(Fill in the blank)

(d) What is displacement current ?

(e) What is electric susceptibility ?

(f) Define Curie temperature.

(g) Define intensity of Magnetic field in Tesla.

(h) Define electric dipole moment.

(i) State Lenz's law of electromagnetic induction.

(j) What is meant by paramagnetic material ?

2. Answer **any four** questions : $2 \times 4 = 8$

(a) Distinguish between magnetic vector potential and electric potential.

(b) Mention the S.I. unit and dimension of electric flux.

(c) Show that the curl of an electric field \vec{E} is equal to zero.

(d) Show that $\mu = \mu_0(1 + \chi_m)$, where the symbols have their usual meaning.

(e) Mutual inductance of two coils is $4mH$. If the current in one coil changes from $6A$ to $1A$ in 0.1 second, find the e.m.f. induced in the other coil.

(f) An electron moving with velocity \vec{v} enters a magnetic field \vec{B} in a direction normal to it. Find an expression for the frequency of its circular motion.

(g) Find the force of attraction between two long, parallel wires at distance ' d ' apart, carrying currents I_1 and I_2 respectively.

(h) What do you mean by current sensitivity and charge sensitivity of a ballistic galvanometer ?

3. Answer **any three** questions : $5 \times 3 = 15$

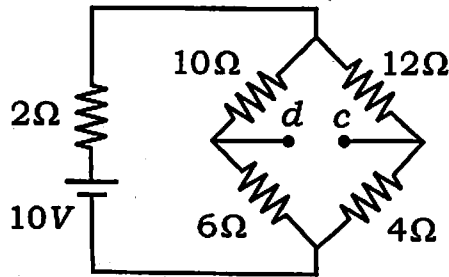
- (a) Two infinite parallel plates carry equal but opposite uniform charge densities $\pm \sigma$. Find the electric field in between the two plates and also outside the two plates.
- (b) Derive Poisson's equation. From this, write Laplace's equation. Express both the equations in Cartesian co-ordinate system.
- (c) Show that the electric field inside a charged hollow sphere is zero.
- (d) Starting from electric field intensity due to a point charge, derive the Gauss law in differential form.
- (e) Show that a small current loop is equivalent to a magnetic dipole.
- (f) Derive the expression for electric potential at any point due to an electric dipole.
- (g) Find out the vector potential at a point near a straight conductor carrying current.

(h) Obtain an expression for the torque acting on a rectangular current loop in a uniform magnetic field.

4. Answer **any three** questions : $10 \times 3 = 30$

- (a) (i) Using Gauss's law, find the expressions for electric field due to a spherical charge distribution (volume charge density ρ)
 - (1) at an outside point
 - (2) on the surface
 - (3) at an inside point $2+2+3=7$
- (ii) Using Gauss's law, find the electric field due to an infinite plane sheet of charge having surface charge density σ . 3
- (b) What is electrical image? Find out the potential, electric field and induced charge density on an earthed conductor plane.
- (c) State and prove Ampère's circuital law. Using this, find the magnetic field due to a toroid. 2+3+5=10
- (d) Find the divergence and curl of magnetic field. 5+5=10

- (e) State Thevenin and Norton theorems. Find the Thevenin's and Norton's equivalent circuit with respect to the terminals c , d in the network given below. Also find the resistance to be connected between c and d to dissipate maximum power.



- (f) (i) What do you mean by resonance in series LCR circuit? Derive the expression for resonant frequency and also draw the resonance curve. $2+2+2=6$
- (ii) Explain the terms Quality Factor and Bandwidth in case of a series LCR circuit. $2+2=4$
- (g) (i) Draw a neat labelled diagram of a moving coil ballistic galvanometer. What is logarithmic damping? $3+3=6$

- (ii) Derive the expression for the torque acting on an electric dipole placed in a uniform electric field. 4

- (h) What is hysteresis? Explain the hysteresis loop in the case of a ferromagnetic material. $2+8=10$