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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.

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- (c) If surface charge density of an infinite thick sheet is  $\sigma$  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  $\rho$ )

(1) at an outside point

(2) on the surface

(3) at an inside point  $2+2+3=7$

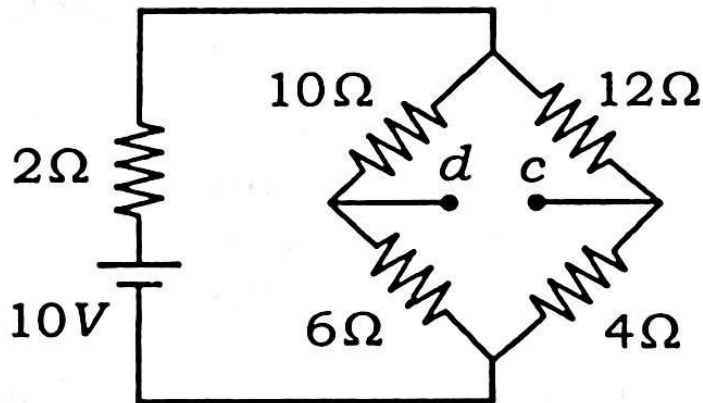
(ii) Using Gauss's law, find the electric field due to an infinite plane sheet of charge having surface charge density  $\sigma$ . 3

(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.

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