3 (Sem–2/CBCS) PHY HC 1

2025

PHYSICS

(Honours Core)

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 the following questions :   1×7=7

    (a) What is the S.I. unit of electric flux ?

    (b) The dielectric constant for metal is _____ .

    (c) The magnetic field at a distance R from a long straight wire carrying steady current I is proportional to

    (i) IR

    (ii) I/R^2

(iii) I^2/R^2

(iv) I/R

(d) The unit of magnetic dipole moment is _____.

(e) Why is a.c. more dangerous than d.c. for same voltage ?

(f) What is a loop ?

(g) What is logarithmic decrement ?

2. Answer the following questions : 2×4=8

(a) Derive the relation $\bar{E} = -\bar{\nabla}\cdot V$

(b) What is the physical significance of magnetic vector potential ?

(c) Instantaneous current from ac source is $I = 6\sin(100\pi t + \phi)$. What is r.m.s. value of the current ?

(d) Mention few applications of ballistic galvanometer.

3. Answer *any three* questions : 5×3=15

(a) State Gauss' law in differential form. Hence derive Poisson's equation and Laplace's equation in electrostatic.
1+4=5

(b) State Ampere's circuital law of the magnetic field and show that $\bar{\nabla} \times \bar{B} = \mu_0 \bar{J}$ and discuss *one* limitation of the equation. 4+1=5

(c) (i) Distinguish between conduction current and the displacement current. 3

(ii) Two coils have mutual inductance of 2.5 henry. Find the average e.m.f. in the secondary coil if the current in the primary coil builds up to 10 A in 0.05 s after the circuit is closed. 2

(d) State and explain Norton's theorem.

(e) Derive the expression of magnetic field at a point on the axis of current carrying in circular loop.

4. Answer *any three* questions : 10×3=30

(a) (i) What is principle of 'method of electrical images' ? A point charge (Q) is placed in front of an earthed conducting sphere of radius (R). Calculate the potential and field at an external point $P(r, \theta)$.
1+4=5

(ii) What is electric dipole ? Derive an expression for electric potential at a point due to an electric dipole.

1+4=5

(b) (i) What do you understand by the polarization of dielectric ? 2

(ii) Show that,

$$K = 1 + \chi_e$$

where K is dielectric constant and χ_e is electric susceptibility. 8

(c) (i) Explain Biot-Savart law. 5

(ii) Find the magnetic field due to long straight conductor using Biot-Savart law. 5

(d) (i) What is self-inductance ? Show that the co-efficient of self-inductance of a circuit is equal to twice the workdone in establishing the magnetic flux per unit current in a circuit.

1+6=7

(ii) A magnetic field of 30 tesla act right angle to coil of area 10 sq metre with 40 turns. The coil is removed from the field in 1/10 s.

Find (i) the magnetic flux linked with the coil, (ii) change of magnetic flux, and (iii) induced e.m.f.

1+1+1=3

(e) Explain the terms sharpness of resonance, bandwidth and quality factor in L.C.R (series) circuit. How does sharpness vary with quality factor ?

3+3+3+1=10

(f) What is hysteresis ? Derive an expression for workdone per unit volume during cycles of magnetisation. What are the factors on which hysteresis loss depends ? Draw hysteresis curves for the material suitable for its use

(i) in a transformer, and

(ii) as a permanent magnet.

2+4+2+2=10