

## U.G. 3rd Semester Examination-2025

## PHYSICS

[MINOR]

Course Code : PHY-MI-T-03

(Electricity and Magnetism)

[NEP-2020]

Full Marks : 30

Time : 2 Hours

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

Symbols have their usual meaning.

## GROUP-A

1. Answer any five questions: 2×5=10
- a) Obtain an expression for the mutual inductance between the primary and the secondary of a standard solenoid.
  - b) State the differential form of Gauss's Law in electrostatics.
  - c) Calculate the torque on a current loop, with area A and carrying current I in a uniform magnetic field B.

*[Turn over]*

- d) Find the electrostatic energy stored in a capacitor of capacitance  $C$ , charged to a voltage  $V$ .
- e) Distinguish between conduction current and displacement current.
- f) What does imply? When a coil is said to have a self-inductance of 1 Henry?
- g) A point charge  $Q$  is kept at the centre of a cube. Calculate the electric flux through one face of the cube.
- h) Can the vector  $k(x+y)$  be treated as an electric field, a magnetic field, or neither? ( $k$  is a constant).

#### GROUP-B

2. Answer any two questions:  $5 \times 2 = 10$

- a) Define capacitance. How is it related to the diameter of a spherical capacitor? Find the capacitance of a cylindrical capacitor of length  $l$ , internal and external radii  $a$  and  $b$  respectively with the space being filled up by a medium of dielectric constant  $k$ .  $1+1+3$

- b) Write down the differential form of Gauss's law.  
Using the differential form of Gauss's law, find the volume charge density  $\rho$  for an electric field. Find the corresponding potential. 1+4
- c) State Ampere's circuital law. Apply this law to find the magnetic field inside a long solenoid. 1+4
- d) Compare dia, para and ferromagnetic materials. 5

### GROUP-C

3. Answer any one question: 10×1=10
- a) i) Show that, if two coils having coefficients of self-inductance  $L_1$  and  $L_2$  are mutually coupled, then the coefficient of the mutual inductance can be obtained as,  $M = K\sqrt{(L_1 L_2)}$ . What is K? 4+1
- ii) What is hysteresis? Discuss the concept of remanence and coercivity of a magnetic material. 1+2+2
- b) i) State Maxwell's equations in electromagnetic (EM) theory. Show, by mathematical treatment, that EM waves are transverse in nature. 2+3

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ii) If x and y components of electric vector of an electromagnetic wave are

$$E_x = a \sin(\omega t); E_y = b \sin(\omega t + \delta)$$

With the actual meaning of the symbol, show that for  $\delta=2m\pi$  and  $\delta=(2m+1)\pi$  the EM are linearly and elliptically polarized, respectively. Here  $m=1,2,3,\dots$   $2\frac{1}{2}+2\frac{1}{2}$

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