



ST. JOSEPH'S UNIVERSITY, BENGALURU -27
B.Sc. Physics - II SEMESTER
SEMESTER EXAMINATION: APRIL 2023
 (Examination conducted in May 2023)
PH 221 - Electricity and Magnetism
(For current batch students only)

Time: 2 Hours

Max Marks: 60

This paper contains 2 printed pages and 3 parts

PART-A

Answer any FOUR questions

(4 x 8 =32)

1. (a) Derive $\mathbf{E} = -\nabla V$ where \mathbf{E} and V have their usual meaning.
 (b) Arrive at an expression for the force exerted on the unit area of a charged conductor. (3+5)
2. Show that there is always a loss of energy when two capacitors at different potentials are connected by a conducting wire. How this loss of energy is accounted for?
3. Obtain an expression for the current growth in LR circuit connected to a DC source. Define the time constant of the LR circuit and represent the growth of current graphically.
4. Derive an expression for the torque acting on a current loop kept in a magnetic field and hence arrive at the equivalence between the current loop and the magnetic dipole.
5. (a) What is the physical significance of the equation of continuity?
 (b) Explain the concept of displacement current. With usual notation show that

$$\nabla \times \vec{H} = \vec{J} + \frac{\partial \vec{D}}{\partial t} \quad (2+6)$$
6. (a) State and explain the terms i) intensity of magnetization, ii) magnetic susceptibility, iii) magnetic induction, and iv) magnetic permeability.
 (b) Give at least four differences between Dia ,para and ferro magnetic substances (4+4)

Part B

Answer any FOUR questions

(4 x 5 = 20)

7. Two charges $3 \times 10^{-6} \text{ C}$ and $-3 \times 10^{-6} \text{ C}$ are separated by a distance of 10^{-2} m . Find the magnitude and direction of the electric field intensity at a point on a line inclined at 45° to the line joining the two charges. If the point is at a distance of 0.2m from the mid-point between the charges.

8. The capacitance of a parallel plate condenser 400pF and its plates are separated by 2×10^{-3} m of air. (i) what will be the energy stored when it is charged to 1500 V? (ii) What will be the potential difference with the same charge if the plate separation is doubled? How much energy is needed to double the distance between its plates?
9. An inductance of 25 mH and a resistance of 100 Ω are connected in series to a 220 V, 50 Hz ac mains. Calculate the value and phase of the current. What is the power dissipated in the circuit?
10. A proton of energy 3.5 MeV is moving perpendicular to a uniform magnetic field of 2.5 T. What is the magnetic force on the proton? Mass of proton = 1.6×10^{-27} kg.
11. Calculate the drift velocity of free electrons in copper if the current density = 5×10^6 A/m², Avogadro No= 6×10^{23} atoms/mole, Density of copper =9000 kg/m³, atomic weight of copper = 64 gm/mole, electronic charge = 1.6×10^{-19} C
12. A plane electro-magnetic wave traveling along X-direction in an unbounded lossless dielectric medium of $\mu_r = 2$ and $\epsilon_r = 5$ has peak electric field strength of 10 V/m. Calculate (i) the Velocity of the wave (ii) the Intrinsic impedance of the medium (iii) the peak value of magnetic field strength.

Part C

Answer any FOUR questions

(4 x 2 = 8)

- 13 (a) What do you mean by lamellar and solenoidal vector fields?
- (b) Do the electric lines of force intersect each other? Give reason.
- (c) On what factors, does the polarization set up in polar and nonpolar substances depend on and why?
- (d) What is the work done by a charge moving in a direction perpendicular to the magnetic field?
- (e) What do you mean by Poynting vector? Explain.
- (f) In a circuit containing inductance and capacitance, the power consumed is zero even though a current passes through it. Explain.

