

[This question paper contains 2 printed pages.]

Sr. No. of Question Paper : 2423 F-4 Your Roll No.....

Unique Paper Code : 2222501

Name of the Course : B.Sc. (Hons.)/B.Tech : Allied Course

Name of the Paper : Physics : Electricity and Magnetism

Semester : IV

Duration : 3 Hours

Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **five** questions in all including Question No. 1 which is compulsory.

1. Answer any **five** of the following questions:

- (a) State Gauss divergence theorem and Stokes theorem of vectors.
- (b) Prove: $\vec{A} \times (\vec{B} \times \vec{C}) + \vec{B} \times (\vec{C} \times \vec{A}) + \vec{C} \times (\vec{A} \times \vec{B}) = 0$.
- (c) Show that electric field can be expressed as the gradient of a scalar potential.
- (d) What are dia-, para- and ferro-magnetic materials? Give one example of each.
- (e) State Faraday's laws of electromagnetic induction.
- (f) What is Displacement current? Explain.
- (g) A coil of wire of certain radius has 600 turns and a Self Inductance of 100 mH. What will be the Self Inductance of a second similar coil with 480 turns?
(3×5=15)

2. (a) State and prove Gauss's theorem in electrostatics. Use this to determine the electric field intensity near an infinite plane charged conductor. (10)

(b) Show that the energy stored per unit volume of an electric field is $(1/2)\epsilon_0 E^2$.
(5)

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3. (a) What is an electric dipole? Derive the expressions for the electric field intensity due to an electric dipole (i) at an axial point and (ii) at an equatorial point. (10)
- (b) A parallel plate condenser consists of two plates of area 400 cm^2 each, separated by a sheet of material 0.1 mm thickness. Find the capacity in micro-farad if dielectric constant of the material is 5. (5)
4. (a) What do you mean by polarization of a dielectric material? Show that when a piece of dielectric material is polarized, there appears a charge on its surface with surface charge density $\mathbf{P} \cdot \mathbf{n}$, where \mathbf{P} is the polarization density and \mathbf{n} is the unit normal to the surface. (10)
- (b) Obtain an expression for the capacitance of a parallel plate capacitor completely filled with a dielectric material. (5)
5. (a) What is Biot-Savart's law in magnetostatics? Using this law, obtain an expression for the magnetic field \mathbf{B} at a point on the axis of a circular coil carrying a current I . (10)
- (b) An electron moves in a circular orbit of radius 0.5 \AA at a frequency of $6.8 \times 10^{15} \text{ Hz}$. Find the magnetic induction at the centre. (5)
6. (a) Define Self-inductance and Mutual Inductance. A secondary coil of 'N' turns of a wire is wound on the middle of a solenoid of length 'L', radius 'r' and number of turns per unit length 'n'. Calculate the Mutual Inductance between the coils. (10)
- (b) Prove that $M = (L_1 L_2)^{1/2}$ where the symbols have their usual meaning. (5)
7. (a) Write Maxwell's equations in free space. Use it to obtain the wave equations for \mathbf{E} and \mathbf{B} . Show that an electromagnetic wave is transverse in nature. (10)
- (b) Determine the velocity, frequency and wavelength of the electromagnetic wave given by,

$$\mathbf{E} = (10.0) \exp (i [0.8 \pi \times 10^{15} t - 0.4 \pi \times 10^7 z]) \quad (5)$$