

ELECTRICITY AND MAGNETISM - C

(Re-appear April - 2012)

Time : Three Hours]

[Maximum Marks : 75

Note : Attempt *one* question each from Section A, B, C and D carrying 15 marks each, and *five* questions from Section E consisting of *eight* short answer type questions carrying 3 marks each.

SECTION : A

1. (a) What do you understand by divergence of a vector field? Find its expression in Cartesian coordinates. Give its physical significance. 12

(b) Prove that $\nabla \left(\frac{1}{r^4} \right) = -4 \frac{\vec{r}}{r^6}$.

2. (a) State and prove Gauss's Law. Find the electric field intensity due to a live charge at any point using Gauss's law. 12
(b) Two charges $-25 \mu\text{C}$ are placed 10 cm apart. Calculate the intensity of electric field at a distance of 5 cm from $-25 \mu\text{C}$ charge toward other charge. 3

Section : B

3. (a) Find electric potential at any point due to arbitrary charge distribution and define Multiple moment. 10
(b) Show that in electrostatics, $\text{curl } \vec{E} = 0$. 5

4. (a) Find electric potential due to a linear quadrupole. 8
 (b) Derive Poisson's and Laplace's equation starting from differential form of Gauss's law. 7
- Section : C**
5. (a) Define Current and Current density. Derive the equation of continuity $\frac{\partial \rho}{\partial t} + \nabla \cdot \vec{J} = 0$, where ρ , \vec{J} are charge and current densities respectively. Show that it implies conservation of charges. 8
 (b) Explain Ohm's Law from atomic point of view. Give its limitations. Derive the relation $\vec{J} = \sigma \vec{E}$. 7
6. (a) Define \vec{M} and \vec{H} . How are they related with free and bound currents? 7
 (b) Give *four* basic differences between dia, para and ferromagnetic materials. 8
- Section : D**
7. (a) State and explain Ampere's circuital law. Find the magnetic field inside the long straight solenoid using this law. 8
 (b) Prove the relation $\nabla \cdot \vec{B} = 0$. 7
8. Discuss LCR series circuit. Derive relations for impedance and resonance frequency. Find phase relationship between current and voltage. 15
- Section : E**
9. Attempt any *five* in short :
- (a) What do you understand by Conservative field ?
 (b) Explain the concept of point charge in electrostatics.
 (c) What is an equipotential surface ? Show that work done in moving a test charge from one point another on equipotential surface is zero.
 (d) Two charges $4 \times 10^{-6} \mu\text{C}$ and placed 1 \AA apart. Find the electric field at a point 3 cm from the centre of a dipole at 60° with axial line.
 (e) Explain domains in ferromagnetic materials.
 (f) What are Ferrites ?
 (g) Calculate the self inductance of 2 m long solenoid having 1000 turns and 10 cm diameter.
 (h) Write down Maxwell's equations. Explain the physical significance any *one*. (3×5=15)