



B.Sc. (Semester – V) Examination, October/November 2018
PHYSICS (Paper – IV)
Electromagnetic Theory – I

Duration : 2 Hours

Max. Marks : 80

Instructions : 1) **All questions are compulsory. Internal choices are available.**

2) **Figures to the right indicate full marks.**

3) **Symbols have their usual meaning, unless otherwise stated.**

4) **Use of calculator is allowed.**

Given : Permittivity of free space, $\epsilon_0 = 8.854 \times 10^{-12} \text{ C}^2/\text{Nm}^2$.

1. Answer **any four** of the following : **(4×4=16)**

- Given a vector function $\vec{A} = \sin x \hat{i} + \cos y \hat{j} - z \hat{k}$, find its i) divergence and ii) curl.
- State the integral form of Gauss' law for the continuous distribution of charge and hence obtain its differential form.
- Write Laplace's equation with one independent variable in spherical coordinates and obtain its solution.
- A thin dielectric rod of cross section A extends along the z-axis. The polarization of the rod along z-axis is given by $P_z = 3z^2 + 2$. Find its volume charge density.
- What are polar and non-polar dielectrics ? What is induced dipole ?
- Calculate the energy density of a medium of dielectric constant 3 placed in uniform electric field of 4 V/m.

2. Answer **any four** of the following : **(4×4=16)**

- State i) Gauss' divergence theorem and ii) Stoke's curl theorem.
- Two point charges $30 \mu\text{C}$ and $-200 \mu\text{C}$ are located at distance of 50 cm from each other. Calculate the magnitude of force between them.
- State the first and second theorems of properties of solution of Laplace's equation.
- What is a dielectric material ? When is the dielectric said to be polarized ?
- What are permanent dipoles ? Define curie point.
- Calculate the capacitance of the capacitor that can store 1000 J energy at 100 V.



3. A) State and prove Green's theorem in the second form. 6

OR

A) Show that $\vec{\nabla} \cdot (\phi \vec{A}) = (\vec{\nabla} \phi) \cdot \vec{A} + \phi (\vec{\nabla} \cdot \vec{A})$. 6

B) Show that $\nabla^2 r^n = n(n+1)r^{n-2}$, where r is the magnitude of the position vector. 6

4. A) A point charge q is kept at a distance d from the center of the grounded conducting sphere of radius a . Use method of images to obtain equations which specifies the location and magnitude of the image charge. 6

OR

A) A point charge q is kept near infinite grounded conducting plane. Use method of images to find the expression for potential and induced charge. 6

B) Derive an expression for electric potential due to a dipole. 6

5. A) Deduce boundary conditions to be satisfied by the electric field vector and magnetic field vectors at the interface of two different media. 6

OR

A) Apply Gauss' law to a region containing charges embedded in a dielectric medium and derive integral form of Gauss' law in dielectric in terms of electric displacement. 6

B) A point charge q is situated in a dielectric medium of dielectric constant k . Derive expression for electric displacement and polarisation 6

6. A) Derive Clausius-Mossotti equation for the molecular polarisability of non-polar molecules. 6

OR

A) Derive Langevin formula for effective dipole moment of polar molecules. 6

B) Obtain an expression for the electrostatic energy of group of point charges. 6