



B.Sc. (Semester – V) Examination, October/November 2016
PHYSICS (Paper – IV)
Electromagnetic Theory – I

Duration : 2 Hours

Total Marks : 80

- Instructions:** i) **All questions are compulsory.**
ii) **Symbols have their usual meaning unless specified.**
iii) **Figures to the right indicate full marks.**
iv) **Use of log table and calculator is allowed.**
v) **Given $\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{N/m}^2$.**

1. Answer any four of the following :

(4×4=16)

- i) If $\phi = x^2 - y^2 + 2z$ find $\text{grad}\phi$.
- ii) Define the term Vector field.
- i) What is meant by volume charge density ?
- ii) State differential form of Gauss's law.
- Write Laplacian in spherical coordinates. Obtain its solution in one dimension.
- Define : i) Electric Polarization.
ii) Electric Susceptibility.
- What are ferroelectric materials ? Ferroelectric slab may serve as basic element of memory device. Explain.
- The presence of dielectric in the capacitor enhances its capacity. Justify.

2. Answer any four of the following :

(4×4=16)

- Show that a vector field whose divergence is everywhere zero can be expressed as curl of some other suitable vector field.
- A Gaussian surface encloses no net charge. Does it mean $E = 0$ on its surface ? Justify your answer with illustration.
- Prove uniqueness theorem related to the solution of Laplace's equation.
- i) State the boundary conditions on the field vectors.
ii) Deduce Poisson's equation in dielectrics.
- Using the concept of molecular field, obtain the condition for a permanent polarization.
- A charge Q is placed on a spherical conductor of radius R . Calculate the energy density at a distance greater than radius of sphere.



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3. A) State and prove Stoke's theorem. 6

OR

A) State and prove Green's theorem. 6

B) Show that the electric potential due to an arbitrary charge distribution may be considered as the sum of potential of monopole, dipole, quadrupole and higher order multipoles. 6

4. A) Determine the potential energy and torque acting on a dipole placed in an external uniform electric field. 6

OR

A) Two concentric conducting spherical shells of radii a_1 and a_2 ($a_2 > a_1$) are charged to a potential ϕ_1 and ϕ_2 respectively. Determine the electric potential and field in the region between the shells. 6

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

5. A) For a point charge in dielectric, show that the electric field is reduced by factor K from its value in free space. Also find expression for polarization P . 6

OR

A) A dielectric material is placed in an uniform electric field, then show that the relation between electric susceptibility and atomic polarizability is given by

$$\chi_e = \frac{N\alpha}{\left(\epsilon_0 - \frac{N\alpha}{3}\right)}$$

B) State and prove Gauss's law in dielectrics. 6

6. A) Obtain Langevin formulae for effective dipole moment of polar molecules. Explain it with suitable plot. 6

OR

A) What is a parallel plate capacitor? Find its capacitance when the space between two plates is filled with two different materials having dielectric constants K_1 and K_2 and thicknesses d_1 and d_2 respectively. 6

B) Obtain an expression for electrostatic potential energy of an arbitrary charge distribution in terms of volume charge and surface charge densities. 6