

1590/MP3

MAY 2008

Paper III — ELECTROMAGNETIC THEORY

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

1. (a) State and explain Gauss's law in electrostatics. Arrive coulomb's law from Gauss's law. Write down Poisson's and Laplace equations and explain their significance. Obtain the solution to Laplace equation in Spherical polar coordinates. (20)

Or

(b) (i) Explain the method of images with an illustration. (8)

(ii) Prove that the potential due to an arbitrary charge distribution can always be expressed as the sum of multipole potentials. (12)

2. (a) Define polarization and displacement vector. Obtain a relation between them. Deduce an expression for the electric field in the case of a dielectric sphere in a uniform electric field. Explain electric susceptibility. (20)

Or

(b) Explain the concept of energy density in an electrostatic field. Obtain expression for the energy of a system of charged conductors. (20)

3. (a) State and explain Ampere's circuital law. Show that the magnetic induction is solenoidal. Calculate the force between two long wires based on Biot-Savart's law. (20)

Or

(b) Deduce the non-homogeneous wave equations for scalar and vector potentials. Explain in detail the plasma oscillations and measurements. (20)

4. (a) (i) Explain the propagation of electromagnetic waves in a conducting media and arrive an expression for the skin depth. (14)

(ii) Discuss normal incidence and oblique incidence. (6)

Or

(b) Explain in detail:

(i) Wave guides. (15)

(ii) Cavity resonators. (5)

5. (a) (i) What is an oscillating electric dipole? Obtain an expression for the average power radiated by an oscillating electric dipole and hence find an expression for the radiation resistance. (15)

(ii) Show that the Hertz potential π for an electric dipole of moment \vec{P} is given by $\pi = \frac{1}{4\pi\epsilon_0} \frac{[\vec{P}]}{r}$. (5)

Or

(b) (i) Deduce the Lorentz Transformation of a four vector. (10)

(ii) Obtain covariant form of electromagnetic wave equations. (10)