53 (EC 501) ELWV

2016

ELECTROMAGNETIC WAVES

Paper : EC 501

Full Marks : 100

Time : Three hours

The figures in the margin indicate full marks for the questions.

Answer ***any five*** *questions.* 5×20=100

1. *(a)* State and prove Divergence theorem in electrostatics.

   (b) Write down the physical significance of divergence and curl.

   (c) Given point P (–2, 6, 3) and vector $A = y a_x + (x + z) a_y$. Express P and A in cylindrical and spherical co-ordinate. Evaluate A at P in the Cartesian cylindrical and spherical system. 5+5+10

2. (a) Write down Maxwell's equations for time varying electromagnetic fields : when the media is homogeneous, source free, lossless, isotropic and linear.

(b) Obtain an expression of wave equation of a conducting medium.

(c) What do you mean by perfect conductor?

(d) Explain Maxwell's fourth equation of modified Ampere's circuital law. What is displacement current? 5+6+2+7

3. (a) Prove that the electric field at a point $(r > a)$ due to a uniformly charged sphere of radius 'a' is the same as the whole charge is located at the center of the sphere.

(b) A circular disc of radius 'a' uniformly charged with $\rho_s c/m^2$. If the desk lies on the $Z = 0$ plane with its axis along the Z axis

(i) Show that at point $(0, 0, h)$

$$E = \frac{\rho_s}{2\epsilon_0}\left\{1 - \frac{h}{\left[h^2 + a^2\right]^{1/2}}\right\} a_Z$$

(ii) From this, derive the E field due to an infinite sheet of charge on the $Z = 0$ plane.

(iii) If $a << h$ show that E is similar to the field due to a point charge. 8+12

4. (a) Establish the relation $\nabla \times H = J + \frac{\partial D}{\partial t}$, where the symbols have their usual meanings.

(b) Explain the concept of skin depth and find out an expression for that.

(c) State and prove uniqueness theorem. 5+5+10

5. (a) Derive the expressions of the electric and magnetic fields of an electromagnetic wave propagating in a lossy dielectric medium.

(b) What do you understand by the term loss tangent and what is its physical significance?

(c) Obtain the Poynting theorem for the conservation of energy in an electromagnetic field and discuss the physical significance of each term in resulting equation. 9+3+8

6. (a) Establish the boundary conditions for electric and magnetic field intensities and the interference between two dielectric media.

(b) Explain how these conditions will be modified, if one of the media is a perfect conductor.

(c) If $x<0$ defines region 1 and $x>0$ defines region 2, then find the electric field intensity in region 2 $(\in r_2 = 5)$, if electric field intensity in region 1$(\in r = 1)$ is $\vec{E} = (4\hat{u}_x + 1\cdot 5\hat{u}_y - 2\hat{u}_z)V/m$. 8+4+8

7. (a) Derive an expression for the input impedance Z_{in} of a lossless transmission line, interms of relevant parameters, when the line is terminated into impedance Z_L.

(b) Show that for a lossless transmission line the input impedance of a line repeat over every $\lambda/2$ distance.

(c) At a frequency of 80*MHz*, a lossless transmission line has a characteristic impedance of 300Ω and a wavelength of $2\cdot 5m$. Find the value of L and C. 9+4+7
