53 (EC 501) ELMW

2017

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 a vector $\overline{A} = 5a_x + a_y + a_z$. Find the magnitude of the vector and the unit vector originating from the origin. Convert $\overline{A}$ in cylindrical co-ordinate and spherical co-ordinate system.

   5+5+10

2. (a) Write down Maxwell's equations for time varying electromagnetic fields, when the media is homogeneous, source-free, loss-less, 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 line charge $P_l = 50nc/m$ is located along the line $x = 2, y = 5$ in free space.

(i) Find E at $P(1, 3, -4)$

(ii) If the surface $x = 4$ contains a uniform surface charge density $P_s = 18nc/m^2$, at what point in the $z = 0$ plane is $E_{total} = 0$?

8+12

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

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

(c) State and prove the 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) State and explain Faraday's law.

(b) Derive the induced emf when a stationary loop is in the time varying B fields.

(c) Determine the magnetic field intensity at a point P due to a current carrying filamentary conductor AB carrying current I along Z axis, its upper and lower ends subtending angles α_1 and α_2 respectively. 6+6+8

7. (a) Derive an expression for the input impedance Z_{in} of a lossless transmission line, in terms of relevant parameters, when the line is terminated by 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 80MHz, a lossless transmission line has characteristic impedance of 300Ω and a wavelength of 2·5m. Find the value of L and C.

9+4+7

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