53 (EC 501) ELMW

2018

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.*

1. Given point $P(-2,6,3)$ and a Vector $A = ya_x + (x+z)a_y$, express P and A in cylindrical and spherical co-ordinates. Evaluate A at P in the Cartesian and Spherical systems. 20

2. *(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 centre of the sphere.

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

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

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

(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. 9+11

3. (a) What is meant by the Uniform Plane Wave? Derive the wave equation in terms of electric and magnetic fields.

(b) Derive Poynting theorem and explain clearly every terms. Calculate power flow for a plane wave. 3+7+4+6

4. (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 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 2·5*m*. Find the value of L and C. 8+5+7

5. (a) What does a lossless and distortionless line mean?

(b) Derive the necessary condition for a transmission line to become distortionless line.

(c) Prove that a distortion line is not necessarily a lossless line but a lossless line is a distortionless line.

(d) An air line has characteristic impedance of 70Ω and phase constant 3 *rad/m* at 100*MHz*. Calculate the inductance per meter and the capacitance per meter of the line. 4+8+3+5

6. (a) Establish the boundary conditions for electric and magnetic field intensities and the interference between to 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 ($\epsilon_r = 5$), if the electric field intensity in region 1 ($\epsilon_r = 1$) is $\vec{E}_1 = (4\hat{u}_x + 1{\cdot}5\hat{u}_y - 2\hat{u}_z) V/m$.

7+6+7

7. Write short notes on : ***(any four)*** 4×5=20

(i) Skin depth

(ii) Ampere's Circuital law

(iii) Smith chart

(iv) Poynting theorem

(v) Conduction and Convection current.
