53 (EC 501) ELMW

2013

(December)

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. *(a)* Starting from Maxwell's equations derive the wave equation in free space. 10

   (b) If a wave of frequency $1\,MHz$ is incident on a material with $\sigma = 5 \cdot 8 \times 10^7$ and permittivity and permeability are approximately equal to the free space then find —

   (i) Attenuation constant

   (ii) Phase constant

   (iii) Phase velocity

   (iv) Depth of penetration. 10

2. *(a)* Explain the reflection of an electromagnetic wave by a perfect dielectric if the wave incident —

   (i) normally on the surface of the dielectric

   (ii) obliquely on the surface of the dielectric   14

   (b) Explain the concept of circular polarization with the help of eleptical polarization.

   6

3. *(a)* If an electromagnetic wave is allowed to pass between to parallel conducting planes in free space, then find the expression for different field components of the wave above the surface and within the conductor.

   12

   (b) A wave of frequency $15 GHz$ is propagating in free space between two parallel conducting plates placed $1 cm$ apart from each other. If the mode of propagation is TE_{10} then find —   8

   (i) Cutoff frequency

   (ii) Phase constant

   (iii) Phase velocity

   (iv) Guide wavelength

4. (a) Derive the expression for different field components of a wave travelling through an airfilled rectangular waveguide in transverse electric mode. 10

(b) Define dominant mode and degenerate modes. 4

(c) Explain why TEM mode is impossible to propagate in hollow waveguide. 6

5. (a) A wave of frequency $6GHz$ is incident on an airfilled rectangular waveguide of cross section $2 \times 1 cm^2$. Will it be propagated ? If not then what should be done to propagate the wave ? 8

(b) A wave of frequency $10GHz$ is to be propagated through an airfilled circular waveguide of radius $1cm$, in the dominant mode $(X_{np} = 1 \cdot 841)$ then find,

(i) Cutoff frequency

(ii) Phase constant

(iii) Phase velocity

(iv) Guide wavelength

(v) Wave impedance

If the waveguide is filled with a dielectric of $\in_r = 3 \cdot 9$ then what will be the cutoff frequency ? 12

6. (a) Explain the transmission analogy of a waveguide. 8

   (b) What is the difference between a waveguide and cavity resonator? 4

   (c) Define — Q-factor, coupling coefficient, critical coupling, overcoupling and undercoupling. 8

7. Write short notes on — $10 \times 2 = 20$

   (a) Semi-Circular cavity resonator

   (b) Excitation methods of various modes in waveguides.