

ANNA UNIVERSITY :: CHENNAI – 600 025

MODEL QUESTION PAPER

VI SEMESTER

B.E. ELECTRONICS AND COMMUNICATION ENGINEERING

EC342 - ELECTROMAGNETIC WAVES AND WAVE GUIDES

Time: Three Hours

Maximum : 100 Marks

Answer All The Questions

PART – A (10 x 2 = 20 Marks)

1. Consider a parallel plate waveguide formed by conductors covering the planes $y = 0$ and $y = b$. Show that the field $E_x = E_0 \sin(n\pi y/b)e^{-\gamma z}$, $n = 1, 2, 3$ defines a set of TE_n modes.
2. Show that a uniform plane wave passing in any direction does not have any component at that direction.
3. Define velocity of propagation of energy and show that for a uniform plane traveling wave it is equal to its phase velocity.
4. Plane traveling wave reflected by dielectric on imperfectly conducting boundaries will result in partial standing waves with SWR's between one and infinity. Justify.
5. Show that in lossy matter, a traveling wave is attenuated in the direction of travel and H is no longer in phase with E.
6. Define clearly dominant and degenerate modes with examples.
7. Sketch the cross-sectional rectangular waveguide mode pattern for TE₁₀, TE₁₁ and TM₁₁ modes with explanation and indicate the methods of excitation.
8. Explain why TEM wave is not possible in a hollow waveguide.
9. Obtain the general expression for the mode chart equation for a cylindrical cavity. What is its usefulness?
10. Show that for metals
 $\eta = R_s(1+j)$, $k = 1/\delta (1-j)$ and $R_s = 1/\sigma\delta$
where R_s is the surface resistance, δ is the skin depth and σ is the conductivity.

PART – B (5 x 16 = 80 Marks)

11. Derive the general expressions for all the field components existing in TE wave in a rectangular waveguide ($a > b$) and explain that it behaves like a high pass filter.
- 12.a) Explain different polarizations of electromagnetic waves and express them in terms of mathematical models.

(OR)

- 12.b) Derive the expression for reflection Co-efficient for vertical polarization when a wave is incident on a plane dielectric interface between two media. What phenomenon is of particular interest for this case.
- 13.a) Show that the Q factor of a rectangular waveguide cavity ($a \times b \times d$) excited in dominant mode is given by :

$$Q = \frac{(k_0 a d)^3 b Z_0}{2\pi^2 R_s (2a^3 b + 2d^3 b + a^3 d + d^3 a)}$$

where k_0 is the free-space propagation constant, R_s is the surface resistance of metal walls.

(OR)

- 13.b) Determine the range of radius of a circular waveguide filled with air so that only dominant mode can be propagated at 10 GHz. Draw the field configuration of dominant mode and explain how such is excited.
- 14.a) The electric field strength of a uniform plane waves in free space is 1 V/m; at 300 MHz. If a very large thick flat copper plate is placed normal to the direction of wave propagation, determine.
- (i) E and H at the surface of the plate
 - (ii) skin depth
 - (iii) the conduction current density at the surface
 - (iv) the power loss per square meter of surface area.

(OR)

- 14.b) Take a parallel plate waveguide with ϵ_1, μ_1 for $Z < 0$ and ϵ_2, μ_2 for $Z > 0$ Show that there is no reflected wave for a TM mode incident from $Z < 0$ when

$$\frac{f}{fc_1} = \sqrt{\frac{\mu_1(\epsilon_1^2 - \epsilon_2^2)}{\epsilon_2(\epsilon_1 \mu_2 - \epsilon_2 \mu_1)}}$$

15.a)i) What that the attenuation constant due to conductor losses in rectangular wave guide is given by

$$\alpha_c = \frac{R_s}{b\eta\sqrt{1-(f_c/f)^2}} [1 + (2b/a)(f_c/f)^2]$$

ii) Select with justification the proper wave function for a coaxial wave guide of inner and outer radii a and b respectively.

(OR)

15.b)i) Show that the instantaneous pointing vector is given by

$$\mathbf{S} = \text{Re} (\mathbf{S} + \mathbf{E} \times \mathbf{H} e^{j2\omega t}) \text{ why is } \mathbf{S} \text{ not related to } \mathbf{S} \text{ by usual way.}$$

ii) Suppose a filament of z – directed electric current $I^i = 10$ is impressed along

\hat{z}

the z – axis from $z = 0$ to $z = 1$. If $\mathbf{E} = U\hat{z}(1+j)$, determine the complex power and the average power supplied by this source.
