

N 1159

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2004.

Sixth Semester

Electronics and Communication Engineering

EC 342 — EM WAVES AND WAVEGUIDES

Time : Three hours

Maximum : 100 marks

Answer ALL the questions.

PART A — (10 × 2 = 20 marks)

1. Give the characteristics of Uniform Plane Travelling Waves with mathematical representation.

2. Show that in good conductors the wave is attenuated greatly as it progresses through the conductor.

3. How do you account for the finite conductivity of the conductors forming waveguides?

4. Determine the reflection coefficients for an electromagnetic plane wave, incident normally from air on a sheet of copper at 1 GHz.

5. Explain why TM_{01} and TM_{10} modes in a rectangular waveguide do not exist.

6. Draw the impedance characteristics of fundamental mode in a microstrip line when the line width changes.

7. Define loaded and unloaded Q of a cavity resonator.

8. Draw electric current lines on the broad and narrow walls of a rectangular waveguide excited in dominant mode.

9. What do you understand by degenerate modes in a waveguide? Give examples of two such modes in a rectangular waveguide.

10. Explain wave impedance in rectangular waveguide.

PART B — (5 × 16 = 80 marks)

11. An air filled rectangular copper waveguide ($a = 0.9''$) × ($b = 0.4''$) is operated at 9.2 GHz in dominant mode. Find the expression for the attenuation constant due to conductor loss. Calculate the attention loss for a 20 cm length. Conductivity of copper is 5.8×10^7 mho/m.

12. (a) Establish the laws of reflection and refraction for a linearly polarized plane wave of parallel polarization incidents on a plane interface between two lossless dielectric regions 1 & 2 at an angle θ_i with respect to the normal. Obtain the expressions for reflection coefficient, Brewster angle as well as the angle of incidence for which total internal reflection occurs.

Or

(b) A uniform plane wave at 2.45 GHz is transmitted through a medium having $\sigma = 2.17$ S/m, $\epsilon = 47 \epsilon_0$, $\mu = \mu_0$. Find the complex propagation constant, phase velocity and the wave impedance of the medium. If the electric field magnitude is 10 V/m, find the time-average power flow per unit area.

13. (a) (i) Draw the physical configuration of cross section of strip and microstrip lines. What are the dominant modes in these lines? Sketch the electric and magnetic field lines in these structures when excited in dominant modes? (4)

(ii) A microstrip lines is composed of zero thickness copper conductors on the lossless substrate having $\epsilon_r = 9.0$ and thickness 3 mm. If the line width is 1 mm and operated at 9 GHz, calculate the effective dielectric constant of the medium, the characteristic impedance of the line, and guide wavelength. (12)

Or

(b) Derive the expression for minimum attenuation for the TM mode in parallel plate wave-guide filled with air dielectric. The plates are parallel to xz plane and separated by a distance b cm in y direction. Calculate its value for copper conductors placed at 5 cm apart for TM_{30} mode.

- (a) A 10 GHz signal is to be transmitted through a circular waveguide filled with air. Determine the inner diameter of the waveguide such that its lowest cutoff frequency is 20% below this original frequency. Find the bandwidth for operation of dominant mode only and corresponding wave impedance.

Or

- (b) Derive the general field components of TM mn waves in circular waveguide. Describe how using coaxial line probes excites TE₁₁ and TM₀₁ modes in these wave-guides.

- (a) Show that the expression for unloaded Q of a circular cylindrical cavity excited in TM₀₁₀ mode is $Q = 1.202 \frac{n}{[Rs(I + a/d)]}$, when $n = \sqrt{(\mu_0 / \epsilon_0)}$, Rs = Surface resistance of cavity walls, a = radius and $d = \frac{1}{l}$ the length of the cavity.

Or

- (b) (i) Explain how a cavity is formed from a rectangular wave guide ($a > b$) excited in dominant mode. Draw the electric and magnetic field configurations in the cross-section and on the planes parallel to broad walls. (8)
- (ii) Explain how a circular cylindrical cavity is excited in TM₀₁₀ mode using a wave-guide slot and coaxial loop. Describe the method of tuning of this cavity. (8)
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