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ELECTRONICS ENGINEERING

Objective Practice Sets

Microwave Engineering

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CHAPTER

Introduction

Q.1 A square waveguide carries TE_{11} mode whose axial magnetic field is given by

$$H_z = H_0 \cos\frac{\pi x}{\sqrt{8}} \cos\frac{\pi y}{\sqrt{8}} \text{ A/m}$$

Where the waveguide dimensions are in centimeters. What is the cut-off frequency of the mode?
(a) 5 GHz
(b) 7.5 GHz
(c) 6.5 GHz
(d) 8 GHz

Q.2 Match **List-I** (Transmission system) with **List-II** (Mode) and select the correct answer using the codes given below the lists:

List-I	List-II
A. Rectangular waveguide	**1.** TE/TM
B. Circular waveguide	**2.** TEM
C. Coaxial Line	**3.** Quasi-TEM
D. Microstrip Line	

Codes :

	A	B	C	D
(a)	1	1	2	3
(b)	1	2	2	3
(c)	2	2	3	3
(d)	3	1	2	2

Q.3 In a hollow rectangular waveguide, the phase velocity
(a) Increases with increasing frequency.
(b) Decreases with decreasing frequency.
(c) Decreases with increasing frequency.
(d) Is independent of frequency.

Q.4 A rectangular or a circular waveguide is
(a) A resonant circuit
(b) High-pass filter
(c) Low pass filter
(d) None of the above

Q.5 Typical microwave oven work on the frequency
(a) 1.225 GHz
(b) 2.45 GHz
(c) 4.90 GHz
(d) 9.80 GHz

Q.6 An air-filled rectangular waveguide of inside dimensions 7×3.5 cm operates in the dominant TE_{10} mode as shown in figure.
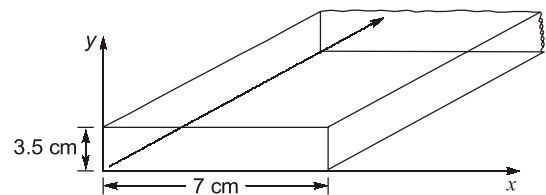
1. Find the cutoff frequency.
2. Determine the phase velocity of the wave in the guide at a frequency of 3.5 GHz
(a) 1.07 GHz, 3.78×10^8 m/s
(b) 2.14 GHz, 1.89×10^8 m/s
(c) 2.14 GHZ, 3.78×10^8 m/s
(d) 1.07 GHz, 1.89×10^8 m/s

Direction for Q. 7, 8 and 9
A lossless line has a characterize tic impedance of 50 Ω and is terminated in a load resistance of 75 Ω. The line is energized by a generator which has an output impedance of 50 Ω and an open-circuit output voltage of 30 V(rms). The line is assumed to be 2.25 wavelengths long. Determine

Q.7 The input impedance
(a) 100 Ω
(b) 33.33 Ω
(c) 66.67 Ω
(d) 50 Ω

Q.8 The magnitude of the instantaneous load voltage.
(a) 0 V
(b) 18 V
(c) 36 V
(d) 42 V

Q.9 The instantaneous power delivered to the load is
(a) $\left(30\sqrt{2}\right)^2$
(b) $\dfrac{(36)^2}{75}$
(c) $\dfrac{(18)^2}{75}$
(d) $\dfrac{(42)^2}{75}$

Q.10 Consider the following statements about smith chart
1. The constant r and constant x circles all pass through the point ($G_r = 1$, $G_i = 0$).
2. The distance around the smith chart once is one-half wavelength ($\lambda/2$).

Q.36 When phase velocities of an EMW depends on frequency in any medium, the phenomenon is
(a) Scattering (b) Absorption
(c) Polarisation (d) Dispersion

Q.37 For low attenuation, the best transmission medium is
(a) Flexible waveguide
(b) Ridged waveguide
(c) Rectangular waveguide
(d) Coaxial line

Q.38 In order to reduce cross sectional dimensions, the waveguide to use it
(a) Circular (b) Ridged
(c) Rectangular (d) Flexible

Q.39 Which transmission line is ideal for handling high powers?
(a) Coaxial line (b) Microstrip
(c) Stripline (d) Rectangular

Q.40 Microwave energies propagate the length of the waveguide by .... its side walls
(a) Reflection of (b) Refraction of
(c) Moving of (d) Absorbing

Q.41 If the receiving antenna is polarised at 90° with respect to transmitting antenna it will receive
(a) No signal (b) Maximum signal
(c) Minimum signal (d) None of these

Q.42 The velocity propagation in a coaxial waveguide is
(a) $v = \dfrac{c}{\alpha}$ (b) $v = \dfrac{c^2}{\alpha}$
(c) $v = \dfrac{c}{\alpha^2}$ (d) None of these

Q.43 Waveguides are generally not used for
(a) < 1 GHz (b) < 10 GHz
(c) < 50 GHz (d) < 150 GHz

Q.44 Wave guide are generally not made of
(a) Copper (b) Aluminium
(c) Bronze (d) All

Q.45 Wave guides are considered superior to coaxial lines in the range
(a) 30 MHz - 1 GHz (b) 1 GHz - 3 GHz
(c) 3 GHz - 100 GHz (d) 100 GHz - 150 GHz

■■■■

Answers	Introduction							
1. (b)	2. (a)	3. (c)	4. (b)	5. (b)	6. (c)	7. (b)	8. (c)	9. (b)
10. (d)	11. (a)	12. (c)	13. (c)	14. (b)	15. (c)	16. (b)	17. (a)	18. (c)
19. (c)	20. (b)	21. (d)	22. (a)	23. (d)	24. (a)	25. (a)	26. (c)	27. (c)
28. (b)	29. (b)	30. (b)	31. (c)	32. (a)	33. (a)	34. (b)	35. (d)	36. (c)
37. (c)	38. (b)	39. (d)	40. (a)	41. (a)	42. (b)	43. (a)	44. (a)	45. (c)

Explanations | **Introduction**

1. **(b)**

$$\lambda_c = \frac{2a}{\sqrt{m^2 + n^2}}$$

$$= \frac{2a}{\sqrt{\left(\frac{1}{\sqrt{8}}\right)^2 + \left(\frac{1}{\sqrt{8}}\right)^2}} = 4 \text{ cm}$$

$$\therefore \qquad f_c = \frac{c}{\lambda_c} = \frac{3 \times 10^8}{4 \times 10^{-2}} = 7.5 \text{ GHz}$$

2. **(a)**

Microstrip line $\rightarrow$ Quasi-TEM
Coaxial line $\rightarrow$ TEM

3. **(c)**

Phase velocity $= \dfrac{c}{\sqrt{1 - \left(\dfrac{f}{f_c}\right)^2}} = \dfrac{c}{\sqrt{1 - \left(\dfrac{\lambda_c}{\lambda}\right)^2}}$

4. **(b)**

RWG : below certain cutoff frequencies it doesn't work, so we can say it acts like high pass filter.

5. **(b)**

Microwave oven : 2.45 GHz

6. **(c)**

$$f_c = \frac{c}{2a} = \frac{3 \times 10^8}{2 \times 7 \times 10^{-2}} = 2.14 \text{ GHz}$$

$$V_p = \frac{c}{\sqrt{1 - \left(\dfrac{f_c}{f}\right)^2}} = \frac{3 \times 10^8}{\sqrt{1 - \left(\dfrac{2.14}{3.5}\right)^2}}$$

$$= 3.78 \times 10^8 \text{ m/sec}$$

7. **(b)**

$$z_{\text{in}} = \frac{(50)^2}{75} = 33.33 \ \Omega$$

8. **(c)**

Reflection coefficient $\Gamma = \dfrac{z_L - z_0}{z_L + z_0} = \dfrac{75 - 50}{75 + 50}$

then the instantaneous voltage at load

$$V = V^+ e^{-j\beta l}(1 + \Gamma) \ (\because l = 0)$$
$$= 30(1 + 0.2) = 36 \text{ V}$$

9. **(b)**

Instantaneous power delivered to load is

$$P = \frac{(36)^2}{75} = 17.28 \text{ W}$$

11. **(a)**

$$\frac{1}{\lambda^2} = \frac{1}{\lambda_g^2} + \frac{1}{\lambda_c^2}$$

12. **(c)**

$$\text{VSWR} = 3 = \frac{1 + |\Gamma|}{1 - |\Gamma|}$$

$$\Rightarrow \qquad |\Gamma| = 0.5 = \frac{z_L - z_0}{z_L + z_0} \quad z_0 = 75 \ \Omega$$

$$\therefore \qquad z_L = 225 \ \Omega$$

13. **(c)**

when $m = 1$, $\lambda = \dfrac{2 \times 6}{1} = 12$ cm ✓

when $m = 2$, $\lambda = \dfrac{2 \times 6}{2} = 6$ cm ✓

when $m = 3$, $\lambda = \dfrac{2 \times 6}{3} = 4$ cm ✓

when $m = 4$, $\lambda = \dfrac{2 \times 6}{4} = 3$ cm ✗

for 10 GHz $\lambda = \dfrac{3 \times 10^8}{10 \times 10^9} = 3$ cm

$\therefore m = 4$ is not allowed

14. **(b)**

$$\lambda_g = \frac{\lambda}{\sqrt{1 - \left(\dfrac{\lambda}{\lambda_c}\right)^2}} = \frac{3}{\sqrt{1 - \left(\dfrac{3}{4}\right)^2}} = 4.54 \text{ cm}$$

15. **(c)**

For aspect ratio 2 : 1 $\Rightarrow b = a/2$

$$\therefore \qquad \lambda_0 = \frac{2}{\sqrt{\left(\dfrac{m}{a}\right)^2 + \left(\dfrac{n}{b}\right)^2}} = \frac{2a}{\sqrt{m^2 + 4n^2}}$$

here $m = n = 1$

$$\therefore \qquad \lambda_0 = \frac{2a}{\sqrt{5}} = 0.894 \ a$$