Q.2 a. Compare waveguides with 2 wire transmission lines. Give any four similarities & four dissimilarities.

Answer:

Similarities

1. Wave travelling in a waveguide has a phase velocity and will be attenuated as in a transmission line.
2. When the wave reaches the end of waveguide it in reflected unless the load impedance is adjusted to absorb the wave.
3. Any irregularity in a waveguide produces reflection just as in a transmission line.
4. When both incident & reflected wares are present in a waveguide, a standing wave pattern results as in a transmission line

Dissimilarities

1. Waveguide is a one conductor transmission system. Body of waveguide acts as ground.
2. The velocity of propagation of waves inside waveguide is quite different from that through free space due to multiple reflections from the walls.
3. System of propagations in waveguide in according field theory while in Transmission line circuit theory.
4. A waveguide can be made to act as cavity resonators by closing both the ends. The wave will travel back & forth. It can't be done in transmission lines.

b. A transmission line has a characteristic impedance of 50 + j 0.01Ω and is terminated in a load impedance of 73 – j 42.5 Ω
calculate
(i) the reflection coefficient
(ii) the standing wave ratio

Answer:

$\Gamma = Z_l - Z_o / Z_l + Z_o = 73 - j\,42.5 - (50 + j\,0.01)/73 - j\,42.5 + (50 + j\,0.01)$

$= 0.377 \angle - 42.7^o$

$\rho = 1 + |\Gamma| / 1 - |\Gamma| = 1 + 0.377 / 1 - 0.377 = 2.21$

Q.3 a. Derive the TM_{mn} mode field equation in rectangular waveguides and show that TM_{01} and TM_{10} modes do not exist.

Answer: 4.1.3 of Text Book.

b. A TE_{11} mode is propagating through a circular waveguide. The radius of the guide is 5 cm and guide contains an air dielectric. Find the cut off frequency. Given, for TE_{11} mode, n = 1, p = 1 and $X_{11} = 1.841 = K_c.a$ where a is the radius.

Answer:

The cutoff wave number
$K_c = 1.841 / a = 1.841 / 5 \text{ X } 10^{-2} = 36.82$

The cutoff frequency is
$f_c = K_c/2\pi\sqrt{uoEo}$ $(1/\sqrt{uoEo} = C)$

$f_c = 36.82 \text{ X } 3 \text{ X } 10^8/2\pi = 1.758 \text{ X } 10^9$ Hz

Q.4 a. What is a tee junction? Explain a magic tee. What are its applications?

Answer: 4.4.1, 4.4.2 of Text Book.

b. Determine the scattering parameters (S_{14}, S_{41}, S_{31}, S_{13}, S_{11}, S_{22}, S_{33}, S_{44}) only for a 10 dB directional coupler with given data:
Directivity D = 30 dB
Assume it is lossless.
VSWR at each port = 1.0 under matched condition. Designate ports in the main guide as 1 & 2 and in auxiliary guide as 3 and 4.

Answer:
C = -10 log $P_{1/} P_4$; C's coupling factor
Or -10 = 10 log $P_{1/} P_4$ or $10^{-1} = P_{1/} P_4 = | S_{41}^2|$
$S_{41} = \sqrt{0.1} = 0.3162$
$S_{41} = S_{14} = 0.3162$

Directivity D = 10 log $P_{4/}P_3$
$30 = 10 \log | S_{41}^2|/| S_{31}^2|$
$10^3 = | S_{41}^2|/| S_{31}^2|$

$| S_{31}^2| = (0.3162)^2/10^3$

$| S_{31}^2| = \sqrt{10}^{-4} = 0.01$

$| S_{31}^2| = | S_{13}^2| = 0.01$

S_{11} = VSWR-1/VSWR+1 = 0

$S_{11} = S_{22} = S_{33} = S_{44} = 0$

Q.5 a. Explain the principle of operation of a tunnel diode. Draw its I-V characteristics

Answer: 5.3 of Text Book.

b. Explain two valley model theory of Gunn diodes.

Answer: Page no 274-276 of Text Book.

Q.6 a. Draw a neat diagram of a two cavity Klystron amplifier. Explain the process of Bunching

Answer: 9.2.1, 9.2.2, 9.2.3 of Text Book.

b. A four cavity Klystron VA-828 has the following parameters:
Beam voltage V_0 = 14.5kV
Beam current I_0 = 1.4A
Operating frequency f = 10 GHz
dc electron charge density $\rho_0 = 10^{-6} C/m^3$
RF charge density $\rho = 10^{-8} C/m^3$
Velocity per turbation $v = 10^5 m/s$

Compute: (i) Dc electron velocity
(ii) Dc phase constant
(iii) Plasma frequency
(iv) Dc beam current density

Answer: Page no 367 of Text Book.

Q7 a. What is a magnetron Oscillator? What are its various types?

Answer: 10.1 of Text Book.

b. An X band pulsed magnetron has the following operating parameters.
Anode voltage V_0 = 26 kV
Beam current I_0 = 27 A
Magnetic flux density $B_0 = 0.336 Wb/m^2$
Radius of cathode cylinder a = 5 cm
Radius of vane edge to center b = 10 cm
Compute: (i) Cyclotron Angular frequency
(ii) Cut off voltage for a fixed B_0
(iii) Cut off magnetic flux density for a fixed V_0

Answer: Page no. 430 of Text Book.

Q8. a. Explain characteristic impedance of microstrip lines.

Answer: Page no. 477-484 of Text Book.

b. Explain quality factor of microstrip lines.

Answer: Page no. 473-474 of Text Book.

c. Explain various losses in microstrip lines.

Answer: Page no. 484-485 of Text Book.

Q9. a. List the various techniques by which monolithic microwave integrated circuits can be fabricated. Explain lithography.

Answer: 12.2.1 of Text Book.

b. A planar resistor has the following parameters:
Resistive film thickness: t = 0.1μm
Resistive film length: ℓ = 15 mm
Resistive film width w = 15 mm
Sheet Resistivity of gold film $\rho_s = 2.44\times10^{-8}\Omega$-m
Calculate the planar Resistance.

Answer:

$R=15 \text{ X } 2.44 \text{ X } 10^{-8}/15 \text{ X } 1 \text{ X } 10^{-7}$

$= 0.244\ \Omega$/square

Text Book

Microwave Devices & Circuits, Samuel Y. Liao, 3rd Edition, Prentice - Hall of India, New Delhi, 2006.