EEL713 (Microwave Theory and circuits) Major

Nov 30, 2006

Marks : 2 + 5 + 5 + 5 + 5 + 5 + 5 + 8. Time 2 hrs.

[$\varepsilon_0 = 8.8 \times 10^{-12}$, $\mu_0 = 4\pi \times 10^{-7}$ in S.I. units]

1. Under what circumstanees will a lossy transmission line be non-dispersive (i.e. propagation constant is directly proportional to frequency) ?

2. Prove that if the real part of input impedance > 0 for a one-port , then $|S_{11}| < 1$ for that one-port, for any real reference impedance level.

3. A plane wave (10 GHz) traveling in air along +z, is normally ineident on a dieleetric ($\varepsilon_r = 4$) which oceupies the region $0 < z < 3.75$ mm (rest of space is air). What is the reflection coefficient (magnitude and phase) if z=0 is taken as the reference plane ?

4. For TE_{10} mode , in a waveguide with 'a' = 20mm, at what frequeney will group velocity be half of phase velocity ? ($1 / v_g = d\beta/d\omega$)

5. Sketch the E and H fields for the dominant TM mode in a dielectric slab guide with one side metal coatcd. Show cross-sectional as well as longitudinal planes, or use a 3-D sketch.

6. Match the impedance Z = 20 – j 20 ohms, to 50 ohms , using double **short-circuited** stub matching with the eentral line length being $\lambda / 6$. Give the eleetrical lengths of the two stubs in degrees as your answer. Smith Chart may be helpful.

7. Explain how a balanced mixer gets rid of LO AM noise.

8. Show (comparing S or ABCD matrices is the easiest way) that a series capacitor, cascaded with small equal lengths of transmission lincs (choose Z_c of these lines as the reference for all S-matrices) on either side, is equivalent to a J-inverter with small J. If the line lengths are negative, how can we interpret this ?