FACULTY OF INFORMATION TECHNOLOGY AND ELECTRICAL ENGINEERING

DEGREE PROGRAMME IN ELECTRONICS (MASTER’S)

Course Name: Radio Engineering 1
Homework #3

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Answer-1:-

Given,

Coupling Power = 20 dB

Impedance, $Z_0 = 75\,\Omega$.

Frequency, $f_0 = 10$ GHz.

Dielectric constant, $\varepsilon_r = 2.2$

Ground plane Spacing. $b = 0.32$ cm $= 3.2$ mm.

Voltage coupling co-efficient, $C_v = 10^{-20/20} = 0.1$ | $C_{dB} = 20$ dB.

Now, for single section coupled line coupler, the impedance must satisfy:-

$$C_v = \frac{Z_e - Z_0}{Z_e + Z_0} \quad \& \quad Z_0 = \sqrt{Z_e Z_0}.$$

$$Z_{0e} = 75 \times \sqrt{\frac{1+C}{1-C}} = 82.9\,\Omega.$$

$$Z_{00} = 75 \times \sqrt{\frac{1-C}{1+C}} = 67.8\,\Omega.$$

For stripline, effective permitivity is approximitly $= \varepsilon_r$.

$$\sqrt{\varepsilon_r}\, Z_{0e} = \sqrt{2.2} \times 82.9 = 122.9.$$

$$\& \; \sqrt{\varepsilon_r}\, Z_{0e} = \sqrt{2.2} \times 67.8 = 100.56.$$

Now, using fig 7.29 from Pozar,

$W/b \approx 0.42 \Rightarrow W = (0.42 \times 0.32)$ cm $= 0.134$ cm

$\boxed{W = 1.34 \text{ mm}}$

Strip width.

$S/b \approx 0.48 \Rightarrow S = (0.48 \times 0.32)$ cm $= 0.15$

$\boxed{S = 1.5 \text{ mm}}$

Strip separation.

Answer-2:

Given, $P_2/P_3 = 2$. $Z_0 = 50\Omega$ (source impedance).

~~Standard~~ We know, $K^2 = \frac{P_3}{P_2}$

$$\therefore K = \sqrt{\frac{P_3}{P_2}} = \sqrt{\frac{1}{2}} = 0.707.$$

Port 2 will get twice power with respect to port 3.

$$Z_{03} = Z_0 \cdot \sqrt{\frac{1+K^2}{K^3}} = 50 \times \sqrt{\frac{1+0.5}{0.354}} \simeq 103$$

$$Z_{02} = Z_0\sqrt{K(1+K^2)} = K^2 \cdot \times Z_{03} = 0.5 \times 103 \approx 51.5.$$

Now, using the $\lambda/4$ transform, we can calculate the isolated resistor R and load resistances.

$$R = Z_0\left(K + 1/K\right) = 50\left(0.707 + \frac{1}{0.707}\right) \approx 106\Omega$$

$$R_2 = Z_0 \cdot K = 50 \times 0.707 = 35.4\Omega.$$

$$R_3 = \frac{Z_0}{K} = \frac{50}{0.707} \approx 70.7\Omega.$$

So, to get the actual split & match, then circuit port 2 need to see 35.4Ω and 70.7Ω at port 3 side.

Matching all external ports to 50Ω.

→ Port 1 is 50Ω.

→ Port 2 & 3, required matching.

So, $Z_{\lambda/4}, (2) = \sqrt{Z_0 \cdot R_2} = \sqrt{50 \times 35.4} = 42\Omega.$

$Z_{\lambda/4}, (3) = \sqrt{Z_0 \cdot R_3} = \sqrt{50 \times 70.7} = 59.5\Omega.$