

1) Calculate the actual length and width of a microstrip Rectangular Patch Antenna, which resonates at a frequency of 3 GHz. Given, the $\epsilon_r = 4.4$ height of the substrate = 1.6 mm

Given.

$$f_r = 3 \text{ GHz}$$

$$\epsilon_r = 4.4$$

$$h = 1.6 \text{ mm}$$

$$W = \frac{C}{2f_r \sqrt{\frac{\epsilon_r + 1}{2}}}$$

$$W = \frac{3 \times 10^8}{2 \times 3 \times 10^9 \sqrt{\frac{4.4 + 1}{2}}}$$

$$W = 0.030429 \text{ m}$$

$$\Sigma_{r\text{eff}} = \frac{\Sigma_r + 1}{2} + \frac{\Sigma_r - 1}{2} \left[\frac{1}{\sqrt{1 + 12 \left(\frac{h}{w} \right)}} \right]$$

$$= \frac{4.4 + 1}{2} + \frac{4.4 - 1}{2} \left[\frac{1}{\sqrt{1 + 12 \left(\frac{0.0016}{0.030429} \right)}} \right]$$

$$\Sigma_{r\text{eff}} = 4.03$$

$$L = \frac{c}{2f_r \sqrt{\Sigma_{r\text{eff}}}} - 0.824h \left[\frac{(\Sigma_{r\text{eff}} + 0.3) \left(\frac{w}{h} + 0.264 \right)}{(\Sigma_{r\text{eff}} - 0.258) \left(\frac{w}{h} + 0.8 \right)} \right]$$

$$L = \frac{3 \times 10^8}{2 \times 3 \times 10^9 \sqrt{4.03}} - 0.824 \times 0.0016 \left[\frac{(4.03 + 0.3) \left(\frac{0.030429}{0.0016} + 0.264 \right)}{(4.03 - 0.258) \left(\frac{0.030429}{0.0016} + 0.8 \right)} \right]$$

$$L = 0.0234 \text{ m}$$

2) A low loss transmission line of 100Ω characteristic impedance is connected to a load of 200Ω

Calculate the Voltage reflection Coefficient and the Standing wave ratio

$$Z_0 = 100\Omega = R_0$$

$$Z_L = 200\Omega = R_L$$

$$\Gamma = \frac{Z_L - Z_0}{Z_L + Z_0} = \frac{100}{300}$$

$$\Gamma = 0.33$$

$$\begin{aligned} \text{SWR} = S &= \frac{R_L}{R_0} = \frac{200}{100} \\ &= 2. \end{aligned}$$

3) Calculate the Standing wave Ratio and Reflection Coefficient on a line having $Z_0 = 300 \Omega$ and terminated in $Z_L = 300 + j400$

Given,
 $Z_0 = 300 \Omega$
 $Z_L = 300 + j400$

$$\Gamma = \frac{Z_L - Z_0}{Z_L + Z_0} = \frac{300 + j400 - 300}{300 + j400 + 300}$$

$$\Gamma = \frac{j400}{600 + j400} = \frac{400 \angle 90^\circ}{721.1 \angle 33.69^\circ}$$

$$X + jy$$

$$r \angle \phi$$

$$r = \sqrt{X^2 + y^2}$$

$$\phi = \tan^{-1}\left(\frac{y}{x}\right)$$

$$r = \sqrt{600^2 + 400^2}$$

$$= 721$$

$$\phi = \tan^{-1}\left(\frac{400}{600}\right)$$

$$= 33.69$$

$$= \frac{400}{721.11} \angle 90 - 33.69$$

$$\Gamma = 0.5547 \angle 56.31^\circ$$

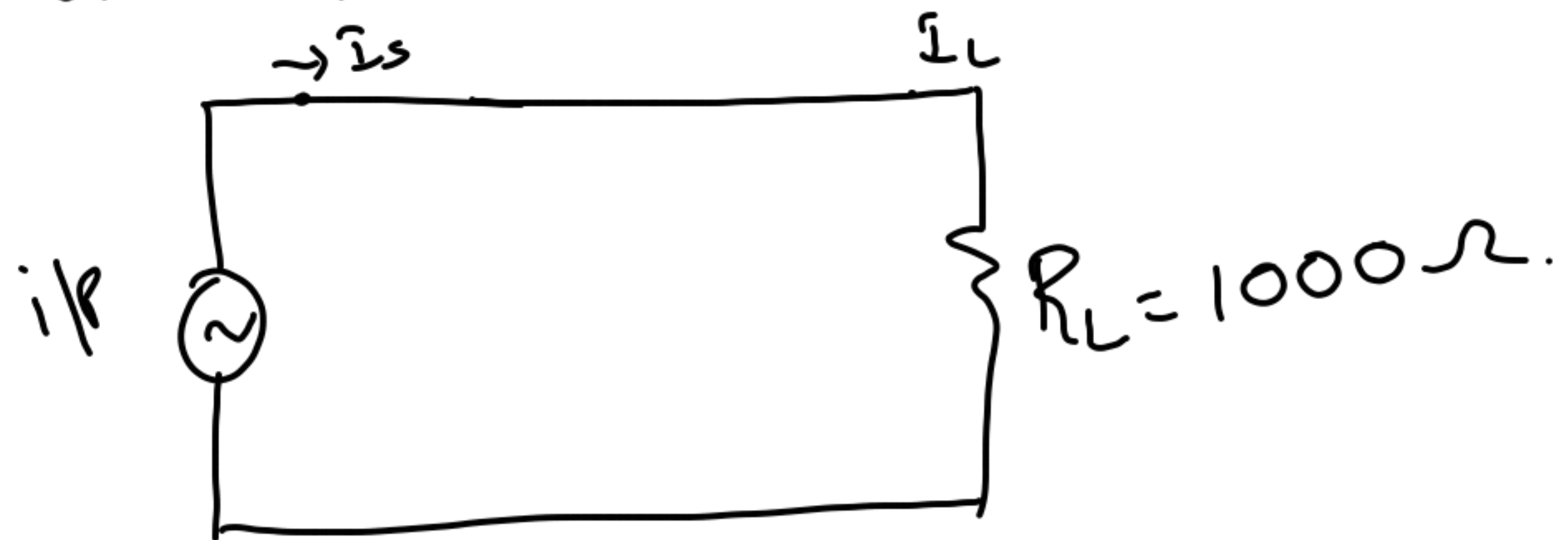
$$S = \frac{1 + |\Gamma|}{1 - |\Gamma|}$$

$$= \frac{1 + 0.5547}{1 - 0.5547}$$

$$S = 3.49$$

4) A transmission line working at RF has $L = 9 \mu\text{H}/\text{m}$ $C = 16 \text{ pF}/\text{m}$.

The line is terminated at a resistance of R_L . Find the Reflection coefficient and SWR



$$L = 9 \mu\text{H}$$

$$C = 16 \text{ pF}$$

$$Z_L = R_L = 1000 \Omega$$

$$\Gamma = ?$$

$$\text{SWR} = ?$$

$$(20)$$

$$Z_0 = \sqrt{\frac{L}{C}}$$

$$= \sqrt{\frac{9 \times 10^{-6}}{16 \times 10^{-12}}} = 750 \Omega$$

$$Z_0 =$$

$$\Gamma = \frac{Z_L - Z_0}{Z_L + Z_0} = \frac{1000 - 750}{1000 + 750} = \frac{1}{9} = 0.1428$$

$$S_{WR} = \frac{1 - |\Gamma|}{1 + |\Gamma|} = \frac{1 - 0.1428}{1 + 0.1428} = 1.33$$