

1) A low loss transmission line of 100Ω characteristics impedance is connected to a load of 200Ω . Calculate the voltage.

Reflection Coefficient and the Standing wave ratio.

Soln.

$$Z_0 = 100\Omega = R_0$$

$$Z_L = 200\Omega = R_L$$

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

$$= \frac{200 - 100}{200 + 100}$$

$$\Gamma = 0.33$$

$$S = \frac{R_L}{R_0}, \quad R_0 < R_L$$

$$S = \frac{200}{100} = 2$$

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

Soln

$$Z_0 = 300 \Omega$$

$$Z_L = 300 + j400$$

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

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

$$\Gamma = \frac{j400}{600 + j400}$$

$$(X + jY) \\ \gamma \angle \phi$$

$$\gamma = \sqrt{X^2 + Y^2} \\ \phi = \tan^{-1}\left(\frac{Y}{X}\right)$$

$$\Rightarrow 600 + j400$$

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

$$r = 721$$

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

$$\phi = 33.65^\circ$$

$$721 \angle 33.65^\circ$$

$$\Rightarrow j400 = 400 \angle 90^\circ$$

$$\Gamma = \frac{400 \angle 90^\circ}{721 \angle 33.65^\circ}$$

$$721 \angle 33.65^\circ$$

$$\Gamma = \frac{400}{721} \angle 90^\circ - 33.65^\circ$$

$$\Gamma = 0.55 \angle 56.35^\circ$$

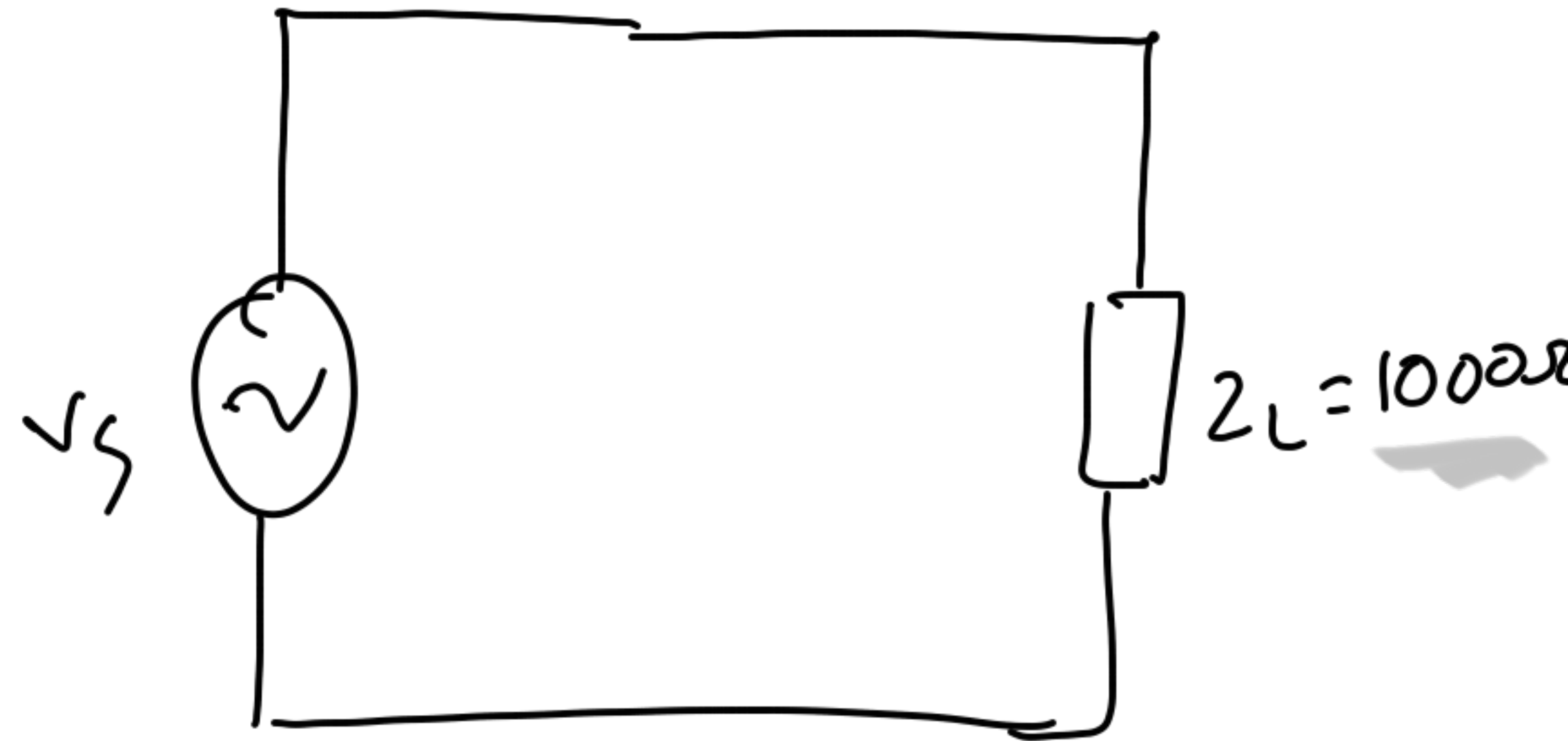
$$S = \frac{1 + |\Gamma|}{1 - |\Gamma|}$$

$$S = \frac{1 + 0.55}{1 - 0.55}$$

$$S = \frac{1.55}{0.45}$$

$$S = 3.4$$

3) A transmission line used in RF communication has an inductance (L) of $9 \mu\text{H}/\text{m}$ and capacitance of $16 \text{ pF}/\text{m}$. The line is terminated at a load impedance of Z_L . Find the reflection coefficient and SWR.



Ans.

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

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

To find characteristic impedance.

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

$$Z_0 = \sqrt{\frac{9 \times 10^{-6}}{16 \times 10^{-12}}}$$

$$Z_0 = 750 \Omega.$$

Reflection coefficient

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

$$\Gamma = \frac{1000 - 750}{1000 + 750} = 0.143$$

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

$$= \frac{1 - 0.143}{1 + 0.143}$$

$$SWR = 1.33$$

4) A transmission line with minimum dissipation has the following constants.

$R = 0.006 \Omega/m$, $L = 2.5 \mu H/m$ and $C = 4.45 pF/m$. If the line operates at $10 MHz$ Calculate the following.

a) Characteristics impedance. ✓

b) Attenuation constant ✓

c) phase constant ✓

d) velocity of propagation. ✓

Soln.

$$R = 0.006 \Omega/m.$$

$$L = 2.5 \mu H/m$$

$$C = 4.45 pF/m$$

$$f = 10 MHz.$$

a) Characteristics Impedance.

$$Z_0 = \sqrt{\frac{L}{C}} = \sqrt{\frac{2.5 \times 10^{-6}}{4.45 \times 10^{-12}}}$$

$$Z_0 = 749.53 \Omega$$

(b) Attenuation Constant.

$$\alpha = \frac{R}{2Z_0}$$

$$\alpha = \frac{0.006}{2 \times 749.53}$$

$$\alpha = 4 \times 10^{-6} \text{ Np/m}$$

c) Phase Constant

$$\beta = \omega \sqrt{LC}$$

$$\beta = 2\pi f \sqrt{LC}$$

$$= 2\pi \times 10 \times 10^6 \sqrt{2.5 \times 10^{-6} \times 4.45 \times 10^{-12}}$$

$$\beta = 0.209 \text{ rad/m}$$

d) Velocity of propagation.

$$V = \frac{\omega}{\beta} = \frac{\omega}{\omega \sqrt{LC}} = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{2.5 \times 10^{-6} \times 4.45 \times 10^{-12}}}$$
$$V = 0.3 \times 10^9 \text{ m/s}$$

