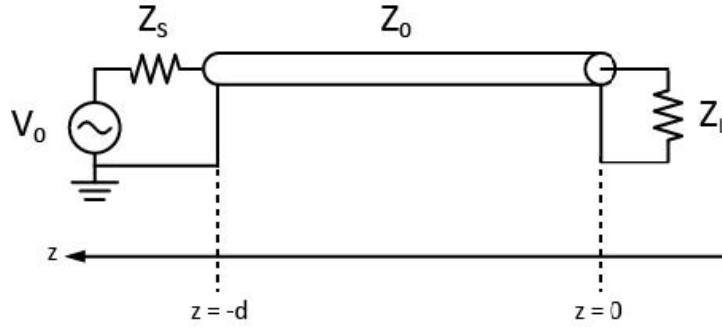


EE 142 Problem Set 3

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1 Tlines in Freq Domain



Voltage source generates 10 GHz sine with 10V amplitude.

Tline terminated with $Z_L = 80 - 40j\Omega$, and $Z_0 = 100\Omega$. $\epsilon_{eff} = 4$ and $d = 22.5$ mm.

1. Find the reflection coefficient at the load ($z = 0$) and at the source ($z = -d$)

At the load:

$$\begin{aligned}\rho_L &= \frac{Z_L - Z_0}{Z_L + Z_0} \\ \rho_L &= -0.0588 - 0.23539j \\ |\rho_L| &= 0.242\end{aligned}$$

At any point on the line, we can derive an effective generalized $\rho(z)$ which represents the ratio of the backwards and forward traveling waves at a given point on the tline.

$$\begin{aligned}V(z) &= V_0^+(e^{-j\beta z} + \rho_L e^{-j\beta z}) \\ \rho(z) &= \frac{V_0^+ \rho_L e^{j\beta z}}{V_0^+ e^{-j\beta z}} \\ \rho(z) &= \rho_L e^{2j\beta z}\end{aligned}$$

Notice that since $\beta = 2\pi/\lambda$, $\rho(z)$ repeats every $\lambda/2$ traversed along the line back to the generator. We can find c_p and λ for this line and frequency.

$$c_p = \frac{c_0}{\sqrt{\epsilon_{eff}}} \approx 1.5e8 \text{ m/s}$$

$$\lambda = \frac{c_p}{f} = 0.015 \text{ m}$$

$$d/\lambda = 1.5 = 3 \cdot \frac{1}{2} \lambda$$

So, $\rho(z)$ at $z = -d$ is $\rho_L = 0.242$.

- Find the input impedance at the source ($z = -d$) and at $z = 18.75\text{mm}$.

The general form is:

$$Z_{in}(-l) = Z_0 \frac{Z_L + jZ_0 \tan(\beta l)}{Z_0 + jZ_L \tan(\beta l)}$$

$$\beta = \frac{2\pi}{\lambda} = 418.879$$

$$Z_{in}(0) = Z_L = 100\Omega$$

$$Z_{in}(-18.75 \text{ mm}) = Z_{in}(\lambda + \lambda/4) = \frac{Z_0^2}{Z_L} = 100 + 50j$$

- Plot the magnitude of the voltage along the line. Find voltage maximum, minimum, and SWR.

We assume that $Z_S = Z_0$:

$$SWR = \frac{V_{max}}{V_{min}} = \frac{1 + |\rho_L|}{1 - |\rho_L|}$$

$$SWR = 1.64$$

$$V^+ = \frac{Z_0}{Z_0 + Z_S} = 5 \text{ V}$$

$$V_{max} = |V^+|(1 + |\rho_L|) = 6.2 \text{ V}$$

$$V_{min} = |V^+|(1 - |\rho_L|) = 3.8 \text{ V}$$

Plot of voltage magnitude along line: