Homework set 4
EE 324/Phys 324
SPRING 2016

1. The following characteristics have been measured on a distortionless transmission line at 100 MHz:

$$\begin{aligned} Z_c &= 50 + j0 \quad (\Omega) \\ \alpha &= 1.15 \times 10^{-3} \quad (\text{Nep/m}) \\ \beta &= 0.8\pi \quad (\text{rad/m}) \end{aligned}$$

   Determine the per length quantities, R_0, L_0, G_0, and C_0 for the line.

2. A 2 meter lossless air-spaced transmission line having a characteristic impedance 50 (Ω) is terminated with an impedance $40 + j30$ at an operating frequency of 200 MHz. Find the input impedance.

3. A 75 Ω lossless transmission line is terminated in a load impedance $Z_L = R_L + jX_L$.

   (a) What must be the relation between R_L and X_L in order that the SWR on the line is 3?

   (b) Find X_L if $R_L = 150\ \Omega$.

   (c) Where does the voltage minimum nearest to the load occur on the line assuming Z_L as given part (b)?

4. For a lossless transmission line the normalized total impedance is given by,

$$\mathrm{z}(x) = \frac{1 + \Gamma(x)}{1 - \Gamma(x)},$$

   with $\Gamma(x) = \Gamma_0 e^{-j2\beta x}$. Similarly, the reflection coefficient can be expressed in terms of $\mathrm{z}(x)$ as,

$$\Gamma(x) = \frac{\mathrm{z}(x) - 1}{\mathrm{z}(x) + 1},$$

   where the normalized impedance can be expressed as $\mathrm{z}(x) = \mathrm{r}(x) + j\mathrm{x}(x)$.

   (a) Using Matlab, plot the real and imaginary components of $\Gamma(x)$ for $-\infty < \mathrm{x} < \infty$, for $\mathrm{r} = 0,\ 0.25,\ 0.5,\ 1.0,\ 2.0,\ 4.0$.

   (b) Repeat the above for $0 \leq \mathrm{r} < \infty$, for $\mathrm{x} = 0,\ \pm 0.25,\ \pm 0.5,\ \pm 1.0,\ \pm 2.0,\ \pm 4.0$.

5. A 2 meter lossless air-spaced transmission line having a characteristic impedance 50 (Ω) is terminated with an impedance $40 + j30$ at an operating frequency of 200 MHz. Find the input impedance.

6. The characteristic impedance of a given lossless transmission line is 75 Ω. Use a Smith chart to find the input impedance at 200 MHz of such a line that is,

   (a) 1.0 m long and open circuited,

   (b) 0.8 m long and short-circuited.

7. A load impedance of $30 - j10\ \Omega$ is connected to a lossless transmission line of length 0.101λ and characteristic impedance 50 Ω. Use the Smith chart to find:

   (a) the standing wave ratio (SWR)

   (b) the voltage reflection coefficient (Amplitude and phase angle)

   (c) the input impedance

   (d) the location of the first voltage minimum on the line

8. In a laboratory experimented conducted on a 75 Ω lossless transmission line terminated in an unknown load impedance, it is found that the SWR is 3. The successive voltage minima are 25 cm apart, with the first minimum occurring at 10 cm from the load. Find,

   (a) the unknown load impedance,

   (b) the reflection coefficient at the load.

   (c) If the load were replaced by a short, where would the first voltage minimum occur?