ECE 391: Transmission Lines

Spring Term 2020

Homework Assignment #4
due Friday, May 22

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1. The following data are specified at $f = 200$KHz for a given transmission line.

$$\begin{aligned} Z_0 &= (52 - j0.4)\Omega \\ \alpha &= 5 \times 10^{-3}\text{dB/m} \\ \beta &= 8.3776 \times 10^{-3}\text{rad/m} \end{aligned}$$

   Determine the per-unit-length R, L, G, C transmission line parameters, wavelength, and phase velocity.

2. (a) The voltage amplitude of a sinusoidal wave at the input of a 200m long transmission line is $V_{in} = 5$V. The far end of the line is matched (no reflected waves are excited) and the voltage is measured as $V_{out} = 3$V. What is the attenuation in (i) dB/m, (ii) Np/m? (b) A coaxial cable has a specified attenuation constant of $\alpha = 0.05$dB/m. Specify the attenuation constant in (i) dB/cm, (ii) Np/m, (iii) dB/100ft. How much is the voltage amplitude of a single traveling sinusoidal wave attenuated after 100 meters? Give your answer in %, dB, and nepers.

3. A lossless 50Ω transmission line of length $z_r = 50$m ($v_p = 30$cm/ns) is terminated in (a) $Z_T = Z_0/4$, (b) $Z_T = 4Z_0$, (c) $L = 398$nH, (d) $C = 79.6$pF. Using Matlab, plot the voltage and current standing-wave patterns on the line for $f = 7.5$MHz and specify the voltage standing-wave ratio for each of the cases (a)-(d). The amplitude of the incident wave is 10V. Use one graph for all voltage plots and one for current plots.

4. A lossless 50Ω coax of length $z_r = 5$m ($\epsilon_r = 2.25$) is terminated in an impedance $Z_T = (70 - j30)\Omega$. (a) What is the standing-wave ratio on the line? (b) Using Matlab, plot the voltage and current standing-wave patterns on the line for $f_0 = 10$ MHz. (c) Determine the input impedance of the line if the operating frequency is (i) $f_0 = 10$ MHz, (ii) $f_0 = 20$ MHz, (iii) $f_0 = 30$ MHz.

5. A lossless transmission line with characteristic impedance $Z_0 = 50\Omega$ is terminated in a resistive load $R_L > Z_0$. A portion of the voltage standing-wave plot is shown below (dashed curve). (a) What is the standing-wave ratio on the line for the resistive termination (dashed curve)? (b) Determine R_L. (c) Determine the voltage magnitude of the incident wave, $|V_0^+|$. (d) Determine the wavelength on the line.

   Now, the resistive load is replaced with unknown load impedance Z_T and the new standing-wave pattern is obtained (solid curve above). e) Determine the standing-wave ratio on the line terminated in unknown load impedance $Z_T = R_T + jX_T$ (solid curve). (f) Determine the unknown terminating impedance $Z_T = R_T + jX_T$.