Learning Objective 3.4: I can use the transmission line equation to match a load to a source using a length of transmission line.

Show your work. Write a **Documentation** line at the end (**None** if you did not collaborate). All lines are lossless, and d is the distance from the load toward the source.

1. **Admittance.**

   (a) Substitute $z = 1/y$ into $\Gamma = \frac{z-1}{z+1}$ and show that $\Gamma = \frac{1-y}{1+y}$.

   (b) Starting from the input impedance of a shorted stub and of an open stub of length ℓ_s, find the normalized admittance of each.

   (c) Explain in one sentence why a matching component that connects across the line is easier to design with admittance than with impedance.

2. **A parallel match.** The $100\ \Omega$ load from the Lesson 8 practice set terminates a $50\ \Omega$ line at 2 GHz, with $\lambda = 10$ cm in the line. Its reflection coefficient is $\Gamma = 0.333\angle 0^\circ$.

   (a) Find y_L and the two values of b at the matching points.

   y_L =

   b =

   (b) Find the phase θ_d and the distance d for each matching point.

   d_1 =

   d_2 =

   (c) Find the parallel component that completes each match, and its value.

   at d_1:

   at d_2:

3. **Stubs in place of components.** Replace each component from Question 2 with a stub of the same $50\,\Omega$ line.

   (a) At d_1 the stub must supply $b_s = -0.707$. Find the shortest shorted stub and the shortest open stub that do.

   shorted =

   open =

   (b) At d_2 the stub must supply $b_s = +0.707$. Find the shortest shorted stub and the shortest open stub that do.

   shorted =

   open =

   (c) Which line-and-stub design uses the least total line? Give its two lengths in centimeters.

4. **A match at the load.** A load $Z_L = 25 - j25\,\Omega$ terminates a $50\,\Omega$ line at 2 GHz.

   (a) Find y_L.

   y_L =

   (b) The conductance is already 1, so $d = 0$ is a matching point. Find the single parallel component, connected across the load, that matches it.

   L =

Documentation: _____