Hayden Fuller
Fields and Waves Lab 1

$$\Gamma = \frac{V_0^-}{V_0^+} = \frac{-I_0^-}{I_0^+} \qquad \Gamma = \frac{Z_L - Z_0}{Z_L + Z_0}$$

Question 1: Calculate the reflection coefficient at the load for the case in which your load impedance is higher than Z0. Apply a sinusoidal input voltage and compare the voltage amplitude at the input of the transmission line (after the source resistor) to the voltage amplitude at the output. Can you explain these voltage amplitudes in terms of the reflection coefficient?
Γ = (ZL-Z0)/(ZL+Z0) = (150-50)/(150+50) = 0.5
VL~=VA/0.5, my actual values show Γ~=.56

Question 2: Calculate the reflection coefficient at the load for the case in which your load impedance is lower than Z0. Apply a sinusoidal input voltage and compare the voltage amplitude at the input of the transmission line (after the source resistor) to the voltage amplitude at the output. Can you explain these voltage amplitudes in terms of the reflection coefficient?
Γ = (ZL-Z0)/(ZL+Z0) = (25-50)/(25+50) = -0.33
VL~=VA/-0.33, my actual values show Γ~=1.82

Question 3: The panel to the right of the simulation defines the circuit topography. (See image above, highlighted in red.) The last line reads “c 1 7 3”. Change it to “r 50 7 3” and hit “Reset”. This will change the terminating capacitor to a 50-ohm terminating resistor. The rectangle labeled Z1 represents the transmission line and shows a graph of the voltage at different parts of the line. What do you observe?
There is no reflection.

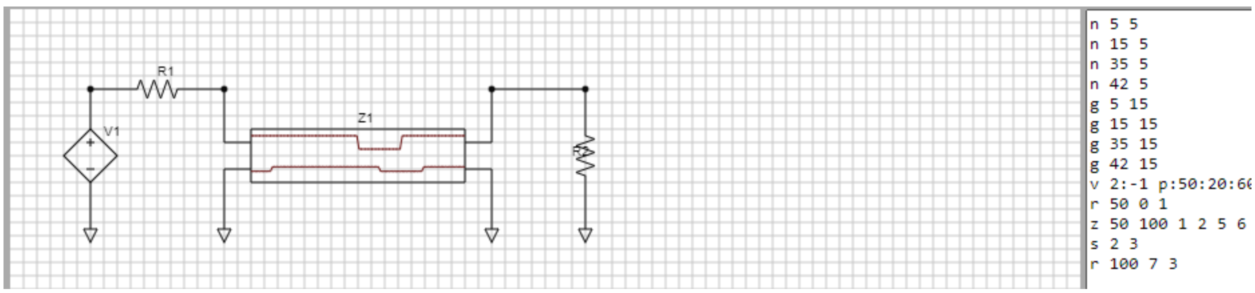
Question 4: The 11th line of code reads “z 50 100 1 2 5 6”. This defines the transmission line as having a characteristic impedance of 50 ohms and a delay of 100. Change the “100” to a different value of your choice. What do you observe? Did you make the transmission line “shorter” or “longer”?
I changed it to 50, making the line shorter.

Question 5: Since the terminating resistor and the transmission line are both set to 50 ohms, they are said to be “impedance matched”. Change the terminating resistor value to something else by changing the last line of code to “r x 7 3”, where x is a number of your choice. What do you observe? Do you see any reflection-like behavior from the terminating resistor? What about if you change the “50” in the 11th line of code to something else (i.e. changing the line’s characteristic impedance?
I changed it to 25, and there is now some slight negative reflection.
I changed it to 150, and there is more significant positive reflection.

Question 6: Change the 9th line of code to the following: “ v 2:-1 s:25:0 4 0”. The voltage source has now been modified to emit a sinusoidal voltage instead of pulses. Change the terminating resistor (last line of code) back to “r 50 7 3”. What do you observe?
Sine wave, no reflection.

Question 7: Change the value of the terminating resistor again. Start at a value that is close to 50 ohms and then observe the effect of either progressively decreasing it to 0 ohms or progressively increasing it to a very large value. What happens?
Travel speed slowed down until it became a standing wave.

Question 8: When sending pulses down the transmission line, what impact did you observe from any mismatch between the characteristic impedance of the transmission line and the terminating resistance? Did the magnitude of mismatch matter? Show a screenshot to demonstrate.
Higher impedance leads to positive reflection, lower gives negative reflection, larger mismatch leads to more reflection



Question 9: While experimenting with the transmission line, under what circumstances did you observe forward-moving waves? Under what circumstances did you observe backward-moving waves?
Forward moving waves when load impedance was low and there were negative reflected waves. The only backward wave there is is the wavefront from the initial reflection

Question 10: Under what circumstances were you able to observe standing waves? (A standing wave does not appear to move either forward or backward.) Note: D/S button allows you switch between two different views of the signal on the transmission line: one displaying separate forward- and backward-traveling waves and one displaying the sum of the forward- and backward-moving waves.
There are standing waves when impedance is 0 or infinite, leading to total reflection, and a standing wave.

Question 11: You should find that you are able to create a standing wave under two different sets of load resistor conditions, but the standing waves are not the same. What’s different about the standing waves created under those two different conditions?
0 gets you a standing wave, and infinite gets a standing wave with a negative offset

Question 12: What can you conclude about the possibility of forming standing waves from traveling waves?
A perfectly reflected wave creates a standing wave.