Standing Waves

1. A lossless, 50 meter, 50Ω transmission line with \(v_p = 30\,cm/ns\) is terminated in four different loads listed below. The line is driven with an incident wave with a 10V amplitude at \(f_0 = 7.5\,MHz\). Using pencil and paper, plot the voltage and current standing-wave patterns on the line and specify the voltage standing-wave ratio for each case. Use one graph for all the different loads.
   (a) \(Z_0/4\)
   (b) \(4Z_0\)
   (c) 398nH
   (d) 79.6pF

2. A lossless 5 meter length of 50Ω coax (\(\epsilon_r = 2.25\)) is terminated in an impedance \(Z_t = (70 - j30)\Omega\).
   (a) What is the standing-wave ratio on the line?
   (b) Using pencil and paper, 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 \(f_0\) is 10 MHz, 20 MHz, and 30 MHz.

3. An unknown load impedance \(Z_t\) is connected to a lossless coaxial transmission line with characteristic impedance \(Z_0 = 50\Omega\). The standing-wave pattern of the voltage has been measured and is shown in figure 1. In order to obtain a reference position, the load has been replaced by a short circuit. The corresponding standing-wave pattern is also shown in figure 1. Determine:
   (a) the voltage standing-wave ratio when the line is terminated in impedance \(Z_t\).
   (b) the wavelength
   (c) the unknown load impedance \(Z_t\)
   (d) Plot the corresponding current versus position \(z\) for impedance \(Z_t\)
4. A 2 meter long, lossless, air-spaced transmission line having characteristic impedance $Z_0 = 50\Omega$ is terminated in impedance $Z_t = (40 + j50)\Omega$ at an operating frequency of 200 MHz.
   (a) Determine the input impedance at the operating frequency
   (b) Determine the input impedance if the frequency is changed to 300 MHz (assuming the $Z_t$ is unchanged)

5. A lossless 600$\Omega$ open-wire transmission line of length $z_r = 500m$, and $(\epsilon_r = 2.25)$ is terminated in an impedance $Z_t = (400 - j300)\Omega$. The circuit is operated at $f_0 = 1$MHz.
   (a) What is the standing-wave ratio on the line
   (b) Plot the voltage and current standing-wave patterns (magnitude) on the line
   (c) Determine the input impedance of the line
6. For the circuit below, find:

a) $|\Gamma_L|$

b) $\Gamma_L$

c) $\Theta_L$ (degrees)

d) $V_{max}$

e) $V_{min}$

f) $VSWR$

g) The location in meters to the first (as measured from the load) voltage minimum

7. A high-powered transmitter operating at 450Mhz is connected to the end of a lossless 75Ω coaxial transmission line with non-zero R and G parameters. The cable has $v_p = 0.7c$ and is terminated with a 200Ω load.

a) If overheating due to excessive conductor current was taking place, where along the line (in meters) would you first see damage? This measurement is taken starting from the load.

b) If dielectric breakdown was taking place, where along the line (in meters) would you first see damage? This measurement is taken starting from the load.

c) For damage occurring either from over-current or over-voltage conditions, once a damaged location is found on the cable, at what interval (in meters) would you look for another damaged area?