Learning Objective: Transmission Line

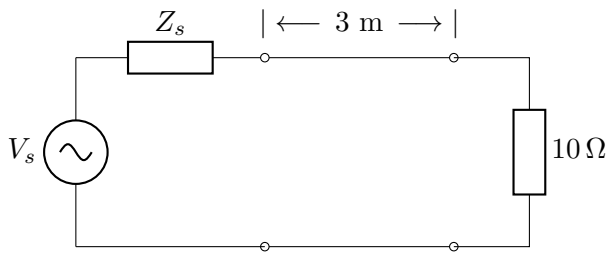
Problem 1. Consider a voltage of an electromagnetic wave traveling on a lossless transmission line is given by $\tilde{V} = V_o \exp(-j20\pi z)$, where $|V_o| = 5\exp(-\alpha z)$, and z is the distance from the generator in meters. The phase shift of V_o is 0, and angular frequency is $\omega_o = 4\pi \times 10^9$ rad/s.

(a) Determine the expression of time-domain voltage wave $v(z, t)$ using a sin function.

(b) Determine the frequency, wavelength, and phase velocity of the wave.

(c) At $z = 2$ m, the amplitude of the wave is 5 V. Determine α.

Problem 2. Consider a 3-m section of lossless RG-59 coaxial transmission line, is driven by a voltage source of $V_s = \cos(2\pi \times 10^6 t)$ V as shown in the schematic below. The coaxial line uses insulating material with a relative permittivity of $\epsilon_r = 4$, a conductance of $\sigma_s = 10^{-5}$ S/m, and a outer-to-inner radius ratio of $r_b/r_a = 2.7182$. Assume $R' << \omega L'$ and $G' << \omega C'$.

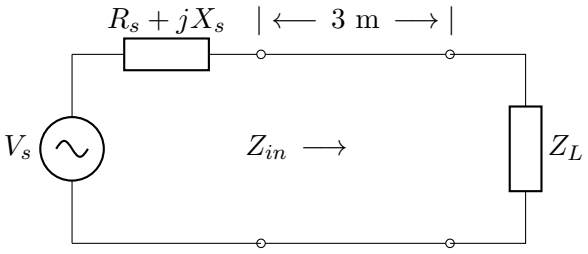


(a) Determine the characteristic impedance Z_0 of the transmission line.

(b) Determine the propagation constant γ of the transmission line.

(c) Determine the reflection coefficient Γ at the transmission line.

Problem 3. Consider a 3-m section of 100-Ω lossless RG-59 coaxial transmission line is terminated by a 300-Ω load Z_L, is driven by a voltage source of $V_s = \cos(2\pi \times 25 \times 10^6 t)$ V with a source resistance $R_s = 50\ \Omega$. The coaxial line uses insulating material with a relative permittivity of $\epsilon_r = 4$.



(a) Determine the standing wave ratio at the load Z_L.

(b) Determine the input impedance Z_{in} of the transmission line.

(c) Suppose the input impedance $Z_{in} = 50 + j25\ \Omega$, determine the jX_s component and its value for a single series reactance matching network at the input.