1) A two-wire transmission line consists of two perfectly-conducting wires of diameter 2 mm with a center-to-center spacing of 5 mm. If the insulation had an effective dielectric permittivity of \(2.2\varepsilon_0\), find \(L\), \(C\), \(Z_0\), and the phase velocity. At a frequency of 890 MHz, what are the phase constant and wavelength?

\[
Z_0 = 2\text{mm} \\
d = 5\text{mm}
\]

From Table 11.1,

\[
L = \frac{\mu_0}{\pi} \cosh^{-1}\left(\frac{d}{2a}\right)
\]

\[
C = \frac{\pi \varepsilon}{\cosh^{-1}\left(\frac{d}{2a}\right)}
\]

\[
L = \frac{\mu_0}{\pi} \cosh^{-1}\left(\frac{5\text{mm}}{2\text{mm}}\right) = \frac{4\pi \times 10^{-7}}{\pi} \cosh^{-1}(2.5)
\]

\[
L = 6.267 \times 10^{-7} \frac{\text{H}}{\text{m}} = 626.7 \frac{\mu\text{H}}{\text{m}}
\]

\[
C = \frac{\pi (2.2) 8.854 \times 10^{-12}}{\cosh^{-1}(2.5)}
\]

\[
C = 3.906 \times 10^{-11} \frac{\text{F}}{\text{m}} = 39.057 \frac{\mu\text{F}}{\text{m}}
\]

(11.21c) \(Z_0 = \sqrt{\frac{L}{C}} = \sqrt{\frac{6.267 \times 10^{-7}}{3.906 \times 10^{-11}}} = 126.67 \Omega\)

(11.21b) \(U = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{6.267 \times 10^{-7} (3.906 \times 10^{-11})}} = 2.021 \times 10^8 \frac{\text{V}}{\text{m}}\)

(11.21b) \(\beta = \frac{\omega}{U} = \frac{\frac{2\pi (890 \times 10^6)}{2.021 \times 10^8}} = 27.67 \text{ rad/m}\)

(11.13) or (11.14) \(\lambda = \frac{\omega}{\beta} = \frac{2\pi}{27.67} = 0.2271 \text{ m}\)
A 50\,\Omega coaxial cable feeds a 75+j20\,\Omega dipole antenna. Find \( \Gamma \) and \( S \).

Assume coaxial cable is lossless (SWR or VSWR doesn't make much sense for lossy trans. lines)

\[
\Gamma_L = \frac{Z_L - Z_0}{Z_L + Z_0} = \frac{(75+j20) - 50}{(75+j20) + 50} = \Gamma
\]

\[
\Gamma_L = 0.2529 \angle 29.57^\circ
\]

\[
|\Gamma_L| = 1|\Gamma_L| = 0.2529
\]

\[
S = \frac{1 + |\Gamma_L|}{1 - |\Gamma_L|} = \frac{1 + 0.2529}{1 - 0.2529}
\]

\[
S = 1.677
\]