

Problem 2.35 For the lossless transmission line circuit shown in Fig. P2.35, determine the equivalent series lumped-element circuit at 400 MHz at the input to the line. The line has a characteristic impedance of $50\ \Omega$ and the insulating layer has $\epsilon_r = 2.25$.

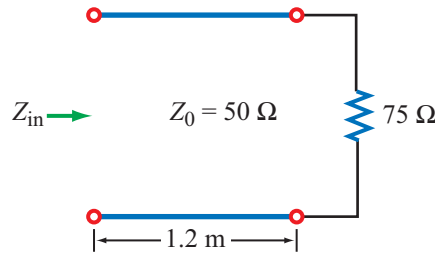


Figure P2.35: Circuit for Problem 2.35.

Solution: At 400 MHz,

$$\lambda = \frac{u_p}{f} = \frac{c}{f\sqrt{\epsilon_r}} = \frac{3 \times 10^8}{4 \times 10^8 \sqrt{2.25}} = 0.5\text{ m}.$$

$$\beta l = \frac{2\pi}{\lambda} l = \frac{2\pi}{0.5} \times 1.2 = 4.8\pi.$$

Subtracting multiples of 2π , the remainder is:

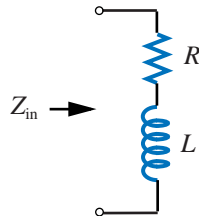
$$\beta l = 0.8\pi\text{ rad}.$$

Using (2.79),

$$Z_{in} = Z_0 \left(\frac{Z_L + jZ_0 \tan \beta l}{Z_0 + jZ_L \tan \beta l} \right)$$

$$= 50 \left(\frac{75 + j50 \tan 0.8\pi}{50 + j75 \tan 0.8\pi} \right) = (52.38 + j20.75)\ \Omega.$$

Z_{in} is equivalent to a series RL circuit with



$$R = 52.38 \, \Omega$$
$$\omega L = 2\pi fL = 20.75 \, \Omega$$

or

$$L = \frac{20.75}{2\pi \times 4 \times 10^8} = 8.3 \times 10^{-9} \, \text{H},$$

which is a very small inductor.
