2.20 A 300-Ω lossless air transmission line is connected to a complex load composed of a resistor in series with an inductor, as shown in Fig. P2.20. At 5 MHz, determine: (a) Γ, (b) S, (c) location of voltage maximum nearest to the load, and (d) location of current maximum nearest to the load.

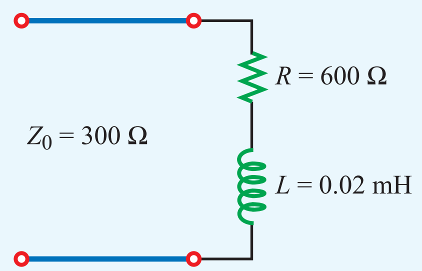

Figure P2.20 Circuit for Problem 2.20.

Solution:

(a)

$$\begin{aligned} Z_\mathrm{L} &= R + j\omega L \\ &= 600 + j2\pi \times 5 \times 10^6 \times 2 \times 10^{-5} = (600 + j628)\ \Omega. \end{aligned}$$

$$\begin{aligned} \Gamma &= \frac{Z_\mathrm{L} - Z_0}{Z_\mathrm{L} + Z_0} \\ &= \frac{600 + j628 - 300}{600 + j628 + 300} \\ &= \frac{300 + j628}{900 + j628} = 0.63e^{j29.6^\circ}. \end{aligned}$$

(b)

$$S = \frac{1 + |\Gamma|}{1 - |\Gamma|} = \frac{1 + 0.63}{1 - 0.63} = 1.67.$$

(c)

$$\begin{aligned} l_\mathrm{max} &= \frac{\theta_\mathrm{r}\lambda}{4\pi} \qquad \text{for } \theta_\mathrm{r} > 0. \\ &= \left(\frac{29.6^\circ \pi}{180^\circ}\right)\frac{60}{4\pi}, \qquad \left(\lambda = \frac{3 \times 10^8}{5 \times 10^6} = 60 \text{ m}\right) \\ &= 2.46 \text{ m} \end{aligned}$$

(d) The locations of current maxima correspond to voltage minima and vice versa. Hence, the location of current maximum nearest the load is the same as location of voltage minimum nearest the load. Thus

$$l_{\text{min}} = l_{\text{max}} + \frac{\lambda}{4}, \qquad \left(l_{\text{max}} < \frac{\lambda}{4} = 15 \text{ m}\right)$$

$$= 2.46 + 15 = 17.46 \text{ m}.$$