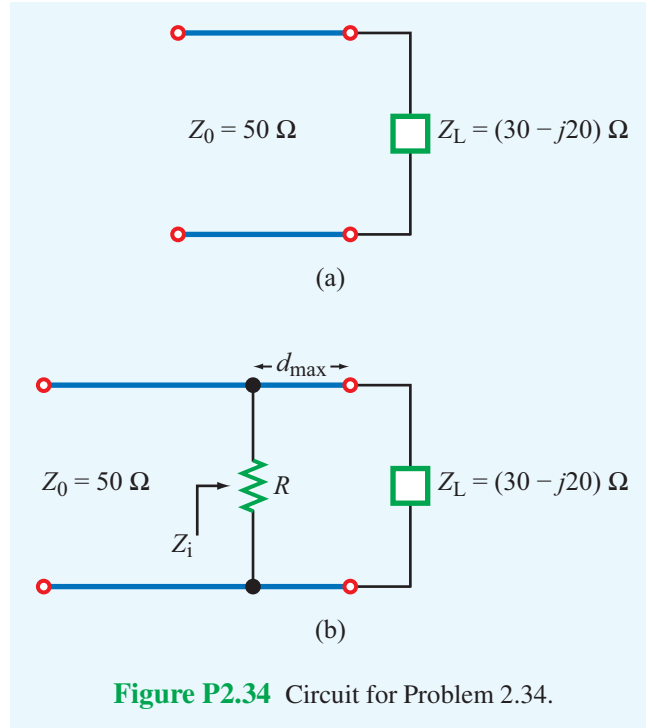


**2.34** A  $50\text{-}\Omega$  lossless line is terminated in a load impedance  $Z_L = (30 - j20)\text{ }\Omega$ .



**Figure P2.34** Circuit for Problem 2.34.

- (a) Calculate  $\Gamma$  and  $S$ .
- (b) It has been proposed that by placing an appropriately selected resistor across the line at a distance  $d_{\max}$  from the load (as shown in Fig. P2.34(b)), where  $d_{\max}$  is the distance from the load of a voltage maximum, then it is possible to render  $Z_i = Z_0$ , thereby eliminating reflection back to the end. Show that the proposed approach is valid and find the value of the shunt resistance.

**Solution:**

(a)

$$\Gamma = \frac{Z_L - Z_0}{Z_L + Z_0} = \frac{30 - j20 - 50}{30 - j20 + 50} = \frac{-20 - j20}{80 - j20} = \frac{-(20 + j20)}{80 - j20} = 0.34e^{-j121^\circ}.$$

$$S = \frac{1 + |\Gamma|}{1 - |\Gamma|} = \frac{1 + 0.34}{1 - 0.34} = 2.$$

(b) We start by finding  $d_{\max}$ , the distance of the voltage maximum nearest to the load. Using (2.70) with  $n = 1$ ,

$$d_{\max} = \frac{\theta_r \lambda}{4\pi} + \frac{\lambda}{2} = \left( \frac{-121^\circ \pi}{180^\circ} \right) \frac{\lambda}{4\pi} + \frac{\lambda}{2} = 0.33\lambda.$$

Applying (2.79) at  $d = d_{\max} = 0.33\lambda$ , for which  $\beta l = (2\pi/\lambda) \times 0.33\lambda = 2.07$  radians, the value of  $Z_{\text{in}}$  before adding the shunt resistance is:

$$\begin{aligned} Z_{\text{in}} &= Z_0 \left( \frac{Z_L + jZ_0 \tan \beta l}{Z_0 + jZ_L \tan \beta l} \right) \\ &= 50 \left( \frac{(30 - j20) + j50 \tan 2.07}{50 + j(30 - j20) \tan 2.07} \right) = (102 + j0) \, \Omega. \end{aligned}$$

Thus, at the location  $A$  (at a distance  $d_{\max}$  from the load), the input impedance is purely real. If we add a shunt resistor  $R$  in parallel such that the combination is equal to  $Z_0$ , then the new  $Z_{\text{in}}$  at any point to the left of that location will be equal to  $Z_0$ .

Hence, we need to select  $R$  such that

$$\frac{1}{R} + \frac{1}{102} = \frac{1}{50}$$

or  $R = 98 \, \Omega$ .

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