2.28 A lossless transmission line of electrical length $l = 0.35\lambda$ is terminated in a load impedance as shown in Fig. P2.28. Find Γ, S, and Z_{in}. Verify your results using CD Modules 2.4 or 2.5. Include a printout of the screen's output display.

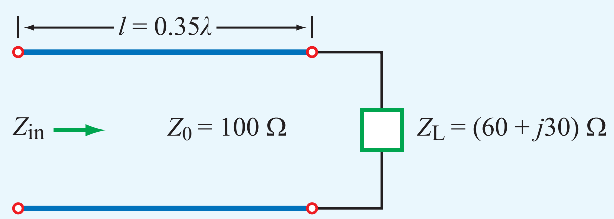


Figure P2.28 Circuit for Problem 2.28.

Solution: From Eq. (2.59),

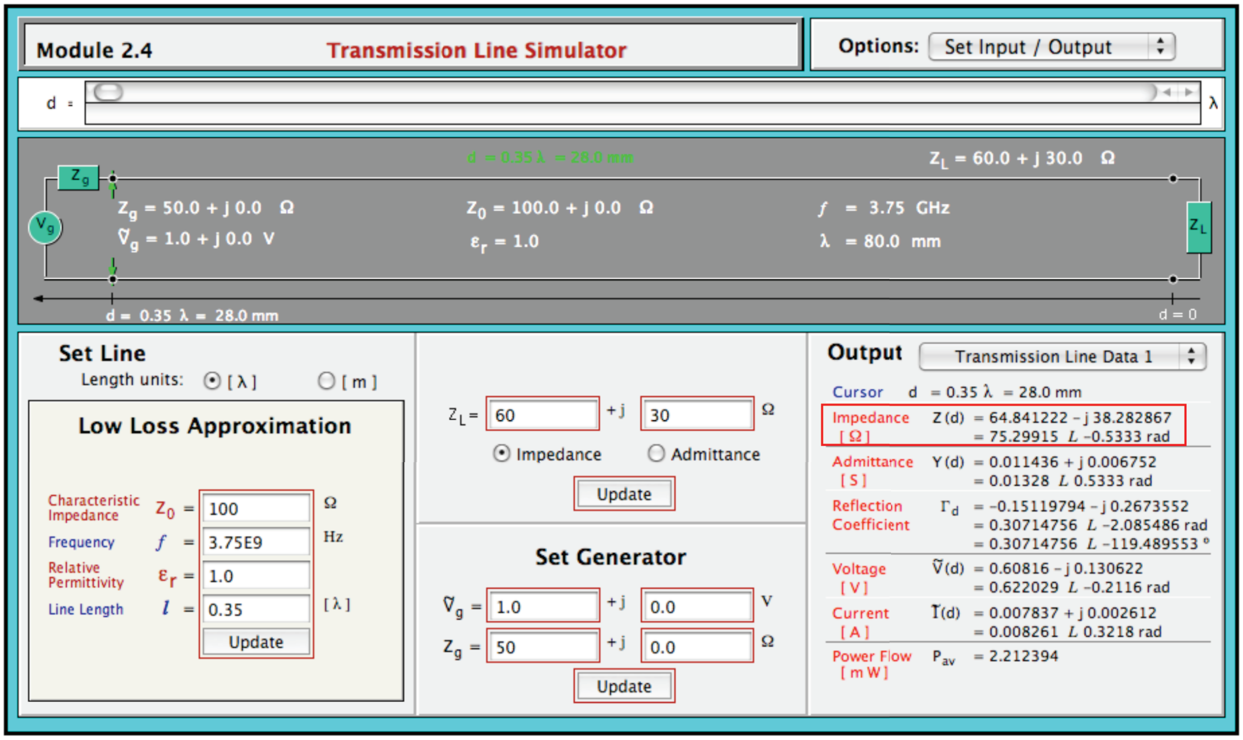
$$\Gamma = \frac{Z_L - Z_0}{Z_L + Z_0} = \frac{(60 + j30) - 100}{(60 + j30) + 100} = 0.307 \exp j132.5^\circ.$$

From Eq. (2.73),

$$S = \frac{1 + |\Gamma|}{1 - |\Gamma|} = \frac{1 + 0.307}{1 - 0.307} = 1.89.$$

From Eq. (2.79)

$$\begin{aligned} Z_{in} &= Z_0 \left(\frac{Z_L + jZ_0 \tan \beta l}{Z_0 + jZ_L \tan \beta l} \right) \\ &= 100 \left[\frac{(60 + j30) + j100 \tan \left(\frac{2\pi \text{ rad}}{\lambda} 0.35\lambda \right)}{100 + j(60 + j30) \tan \left(\frac{2\pi \text{ rad}}{\lambda} 0.35\lambda \right)} \right] = (64.8 - j38.3)\ \Omega. \end{aligned}$$


Module 2.4
Transmission Line Simulator
Options: Set Input / Output
d =
λ
d = 0.35 λ = 28.0 mm
Z_L = 60.0 + j 30.0 Ω
Z_g
V_g
Z_g = 50.0 + j 0.0 Ω
Ṽ_g = 1.0 + j 0.0 V
Z_0 = 100.0 + j 0.0 Ω
ε_r = 1.0
f = 3.75 GHz
λ = 80.0 mm
Z_L
d = 0.35 λ = 28.0 mm
d = 0
Set Line
Length units: [λ] [m]
Low Loss Approximation
Characteristic Impedance Z_0 = 100 Ω
Frequency f = 3.75E9 Hz
Relative Permittivity ε_r = 1.0
Line Length l = 0.35 [λ]
Update
Z_L = 60 + j 30 Ω
Impedance
Admittance
Update
Set Generator
Ṽ_g = 1.0 + j 0.0 V
Z_g = 50 + j 0.0 Ω
Update
Output
Transmission Line Data 1
Cursor d = 0.35 λ = 28.0 mm
Impedance [Ω] Z (d) = 64.841222 – j 38.282867
= 75.29915 ∠ –0.5333 rad
Admittance [S] Y (d) = 0.011436 + j 0.006752
= 0.01328 ∠ 0.5333 rad
Reflection Coefficient Γ_d = –0.15119794 – j 0.2673552
= 0.30714756 ∠ –2.085486 rad
= 0.30714756 ∠ –119.489553 °
Voltage [V] Ṽ(d) = 0.60816 – j 0.130622
= 0.622029 ∠ –0.2116 rad
Current [A] Ĩ(d) = 0.007837 + j 0.002612
= 0.008261 ∠ 0.3218 rad
Power Flow [m W] P_av = 2.212394