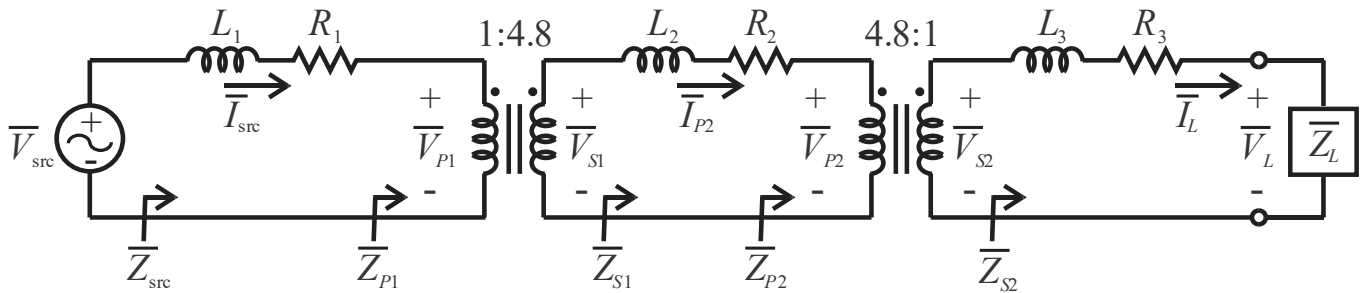


For the circuit shown, it is given:  $\bar{V}_{src} = 125\angle 0^\circ \text{ V}_{rms}$ ,  $f = 400 \text{ Hz}$ ,  $L_1 = 0.5 \text{ mH}$ ,  $L_2 = 1.2 \text{ mH}$ ,  $L_3 = 0.2 \text{ mH}$ ,  $R_1 = 0.4 \Omega$ ,  $R_2 = 1.4 \Omega$ ,  $R_3 = 0.4 \Omega$ , and  $\bar{Z}_L = 6\angle 60^\circ \Omega$ . a) Find the indicated impedances (rectangular format), b) Find the indicated currents and voltages (RMS phasor format w/ angle in degrees). c) Calculate  $V_L / V_{src} * 100\%$ . d) Determine the complex power provided by the source, complex power delivered to the load, and complex power 'lost' in-between. e) What percent of the real power makes it from the source to the load? Assume ideal transformers.



The turns ratios are:  $a_1 = 1/4.8 = 0.208333$  (left) and  $a_2 = 4.8$  (right).

$$\text{a) } \bar{Z}_{S2} = j\omega L_3 + R_3 + \bar{Z}_L = j2\pi(400)0.2 \cdot 10^{-3} + 0.4 + 6\angle 60^\circ \Rightarrow \underline{\bar{Z}_{S2} = 3.4 + j5.6988 \Omega}$$

$$\text{Per (3-17), } \bar{Z}_{P2} = a^2 \bar{Z}_{S2} = 4.8^2(3.4 + j5.6988) \Rightarrow \underline{\bar{Z}_{P2} = 78.336 + j131.3005 \Omega}$$

$$\bar{Z}_{S1} = j\omega L_2 + R_2 + \bar{Z}_{P2} = j2\pi(400)1.2 \cdot 10^{-3} + 1.4 + (78.336 + j131.3005) \\ \Rightarrow \underline{\bar{Z}_{S1} = 79.736 + j134.3164 \Omega}$$

$$\text{Per (3-17), } \bar{Z}_{P1} = a^2 \bar{Z}_{S1} = (1/4.8)^2(79.736 + j134.3164) \Rightarrow \underline{\bar{Z}_{P1} = 3.4608 + j5.8297 \Omega}$$

$$\bar{Z}_{src} = j\omega L_1 + R_1 + \bar{Z}_{P1} = j2\pi(400)0.5 \cdot 10^{-3} + 0.4 + (3.4608 + j5.8297) \\ \Rightarrow \underline{\bar{Z}_{src} = 3.8608 + j7.0863 \Omega}$$

$$\text{b) } \bar{I}_{src} = \bar{V}_{src} / \bar{Z}_{src} = 125\angle 0^\circ / (3.8608 + j7.0863) \Rightarrow \underline{\bar{I}_{src} = 15.4898\angle -61.4177^\circ (\text{A}_{rms})}$$

$$\bar{V}_{P1} = \bar{V}_{src} (\bar{Z}_{P1} / \bar{Z}_{src}) = 125\angle 0^\circ (3.461 + j5.83) / (3.861 + j7.086) \\ \Rightarrow \underline{\bar{V}_{P1} = 105.0142\angle -2.1129^\circ (\text{V}_{rms})}$$

$$\text{Per (3-5), } \bar{V}_{S1} = \bar{V}_{P1} / a_1 = (105.0142\angle -2.1129^\circ) / 0.208333 \\ \Rightarrow \underline{\bar{V}_{S1} = 504.0683\angle -2.1129^\circ (\text{V}_{rms})}$$

$$\text{Per (3-6), } \bar{I}_{P2} = a_1 \bar{I}_{\text{src}} = 0.208333(15.4898 \angle -61.4177^\circ) \\ \Rightarrow \underline{\bar{I}_{P2} = 3.227 \angle -61.4177^\circ \text{ (V}_{\text{rms}}\text{)}}$$

$$\bar{V}_{P2} = \bar{I}_{P2} \bar{Z}_{P2} = (3.227 \angle -61.4177^\circ)(78.336 + j131.3005) \\ \Rightarrow \underline{\bar{V}_{P2} = 493.3942 \angle -2.2387^\circ \text{ (V}_{\text{rms}}\text{)}}$$

$$\text{Per (3-5), } \bar{V}_{S2} = \bar{V}_{P2} / a_2 = (493.3942 \angle -2.2387^\circ) / 4.8 \\ \Rightarrow \underline{\bar{V}_{S2} = 102.7905 \angle -2.2387^\circ \text{ (V}_{\text{rms}}\text{)}}$$

$$\text{Per (3-6), } \bar{I}_L = a_2 \bar{I}_L = 4.8(3.227 \angle -61.4177^\circ) \Rightarrow \underline{\bar{I}_L = 15.4898 \angle -61.4177^\circ \text{ (V}_{\text{rms}}\text{)}}$$

$$\bar{V}_L = \bar{I}_L \bar{Z}_L = (15.4898 \angle -61.4177^\circ)(6 \angle 60^\circ) \Rightarrow \underline{\bar{V}_L = 92.939 \angle -1.4177^\circ \text{ (V}_{\text{rms}}\text{)}}$$

$$\text{c) } V_L / V_{\text{src}} * 100\% = 92.939/125 \Rightarrow \underline{V_L / V_{\text{src}} * 100\% = 74.351\%}$$

$$\text{d) } \bar{S}_{\text{src}} = \bar{V}_{\text{src}} \bar{I}_{\text{src}}^* = 125 \angle 0^\circ (15.4898 \angle 61.4177^\circ) \Rightarrow \underline{\bar{S}_{\text{src}} = 926.333 + j1700.263 \text{ (VA)}}$$

$$\bar{S}_L = \bar{V}_L \bar{I}_L^* = 92.939 \angle -1.418^\circ (15.4898 \angle 61.418^\circ) \Rightarrow \underline{\bar{S}_L = 719.805 + j1246.739 \text{ (VA)}}$$

$$\bar{S}_{\text{lost}} = \bar{S}_{\text{src}} - \bar{S}_L = (926.333 + j1700.263) - (719.805 + j1246.739) \\ \Rightarrow \underline{\bar{S}_{\text{lost}} = 206.527 + j453.523 \text{ (VA)}}$$

$$\text{e) } P_L / P_{\text{src}} * 100\% = 719.805 / 926.333 \Rightarrow \underline{P_L / P_{\text{src}} * 100\% = 77.705\%}$$