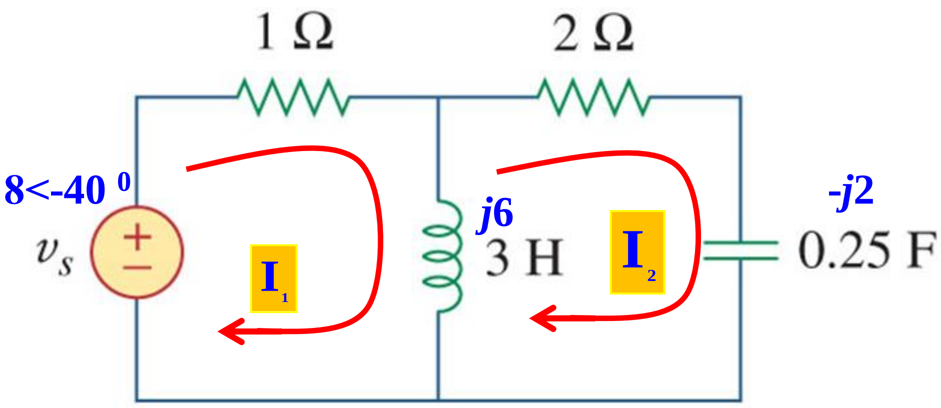
Problem 11.5 P491

Assuming that $v_s = 8\cos(2t - 40°)$ V in the circuit of Fig. 11.37, find the average power delivered to each of the passive elements.



Solution:

$$I_1: \ (1+j6)I_1 - j6I_2 = 8\angle -40°$$

$$I_2: \ -j6I_1 + (2-j2+j6)I_2 = 0$$

$$\Rightarrow \ I_1 = 1.68\angle -25°$$

$$I_2 = 2.26\angle 1°$$

So: $$P_{1\Omega} = \frac{|I_1|^2}{2}\times 1 = \frac{1.68^2}{2} = 1.41 \text{ W}$$

$$P_{2\Omega} = \frac{|I_2|^2}{2}\times 2 = \frac{2.26^2}{2}\times 2 = 5.11 \text{ W}$$

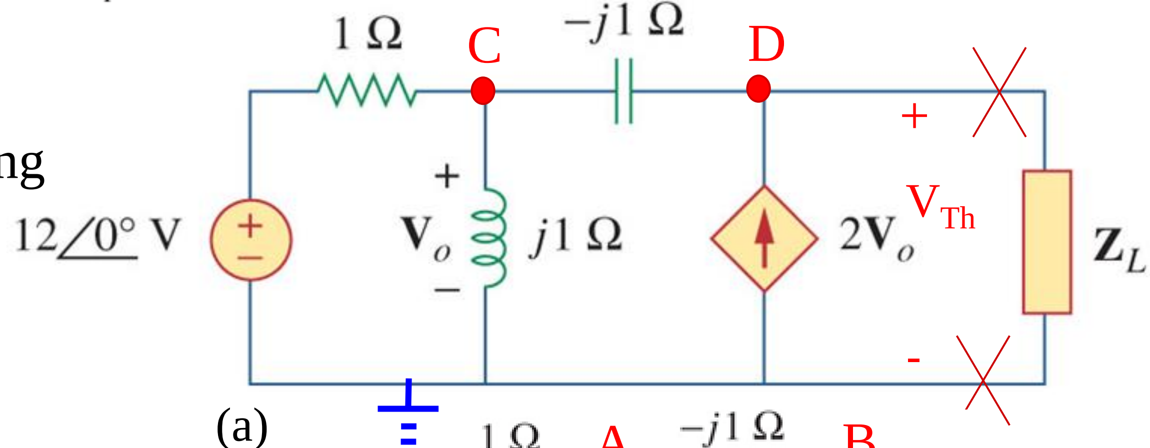
$$P_{3H} = P_{0.25F} = 0 \text{ W}$$

Problem 11.15 P492

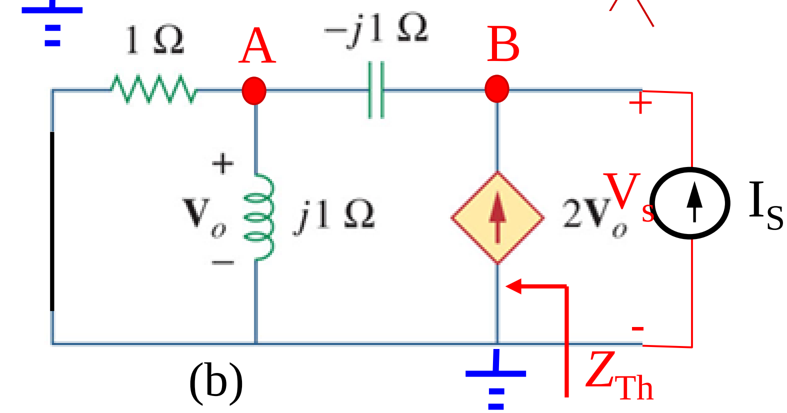
In the circuit of Fig. 11.46, find the value of Z_L that will absorb the maximum power and the value of the maximum power.

Solution:

As shown in Fig.(b), for find Z_{Th}, Adding a current source I_S, Applying KCL at node A and node B:



(a)



(b)

$$\left(\frac{1}{1}+\frac{1}{-j1}+\frac{1}{j1}\right)\mathbf{V}_0-\frac{1}{-j1}\mathbf{V}_S=0$$

$$-\frac{1}{-j1}\mathbf{V}_0+\frac{1}{-j1}\mathbf{V}_s=2\mathbf{V}_0+\mathbf{I}_s$$

So we get $Z_{Th}=\dfrac{\mathbf{V}_S}{\mathbf{I}_S}=0.5+j0.5$

So $Z_L=0.5-j0.5$

For the V_{Th}. As shown in Fig.(a) Applying KCL at node C and node D:

$$\left(\frac{1}{1}+\frac{1}{-j1}+\frac{1}{j1}\right)\mathbf{V}_0-\frac{1}{-j1}\mathbf{V}_{Th}-\frac{1}{1}\times 12=0$$

$$-\frac{1}{-j1}\mathbf{V}_0+\frac{1}{-j1}\mathbf{V}_{Th}=2\mathbf{V}_0$$

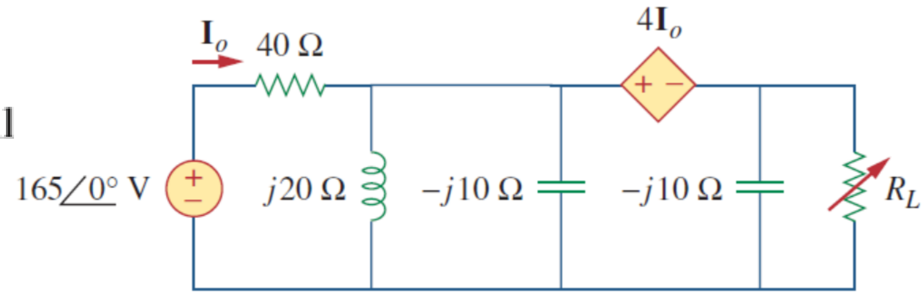
So we get $\mathbf{V}_{Th}=6(-3+j)$

$$\left|\mathbf{V}_{Th}\right|=6\sqrt{10}$$

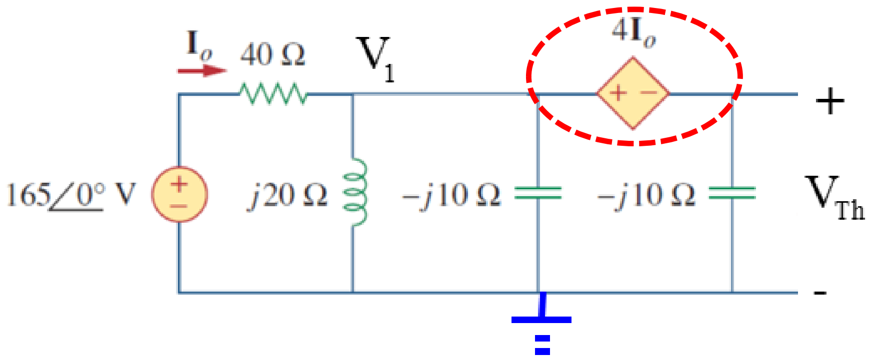
So we find $P_{max}=\dfrac{\left|\mathbf{V}_{Th}\right|^2}{8R_{Th}}=\dfrac{\left(6\sqrt{10}\right)^2}{8\times 0.5}=90\text{W}$

Problem 11.20 P492

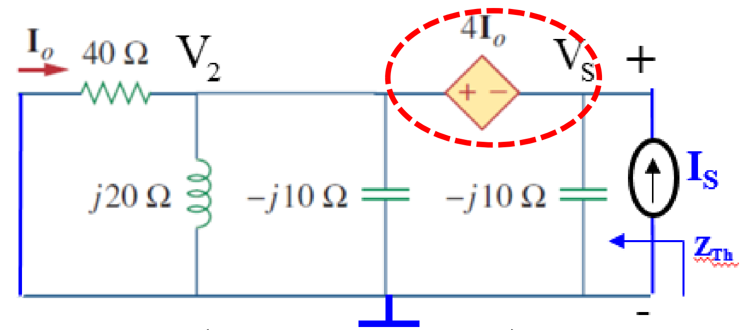
The load resistance R_L in Fig. 11.51 is adjusted until it absorbs the maximum average power. Calculate the value of R_L and the maximum average power.



Solution: For V_{Th}:



For Z_{Th}:



$$V_1 + V_{Th}: \left(\frac{1}{40} + \frac{1}{j20} + \frac{1}{-j10}\right)V_1 + \frac{1}{-j10}V_{Th} - \frac{1}{40} \times 165\angle 0^\circ = 0$$

$$V_1 - V_{Th} = 4I_0$$

$$I_0 = \frac{165\angle 0^\circ - V_1}{40}$$

$$\Rightarrow V_{Th} = 26\angle -92^\circ$$

$$V_2 + V_S: \left(\frac{1}{40} + \frac{1}{j20} + \frac{1}{-j10}\right)V_2 + \frac{1}{-j10}V_S = I_S$$

$$V_2 - V_S = 4I_0$$

$$I_0 = \frac{-V_2}{40}$$

$$\Rightarrow Z_{Th} = \frac{V_S}{I_S} = 1.05 - j6.71$$

So: $R_L = |Z_{Th}| = 6.79\Omega$

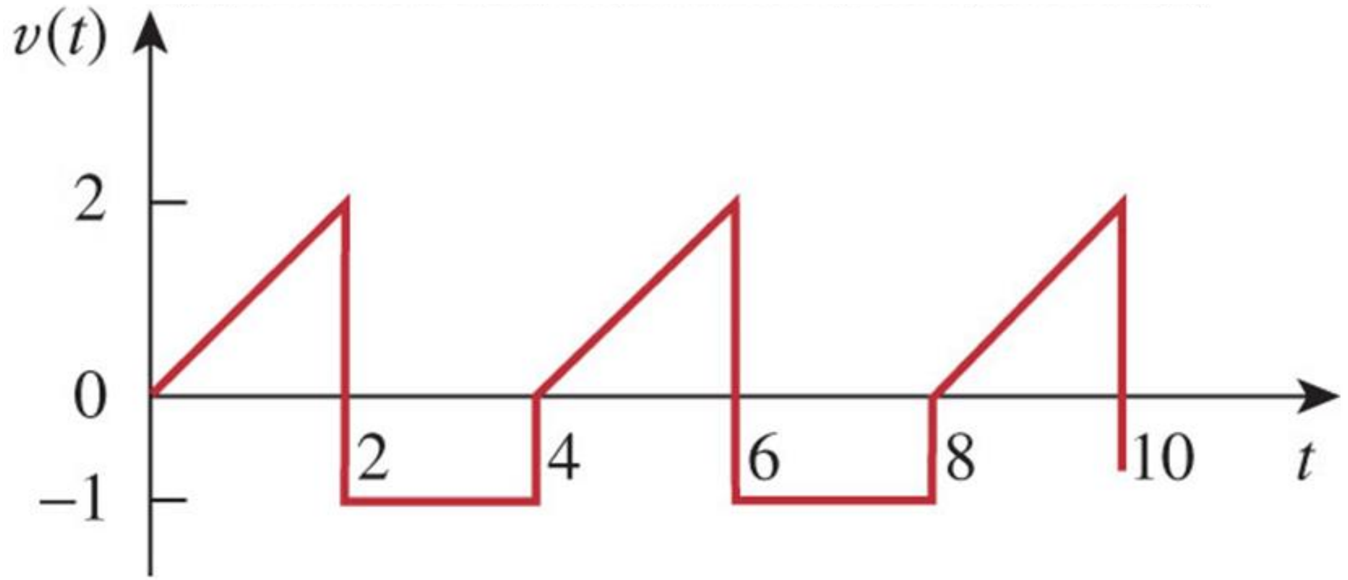
$$I = \frac{V_{Th}}{Z_{Th} + R} = \frac{26\angle -92^\circ}{1.05 - j6.71 + 6.79}$$

$$P_{max} = \frac{1}{2}|I|^2 R_L$$

$$= \frac{1}{2} \times \frac{26^2}{(1.06 + 6.79)^2 + 6.71^2} \times 6.79 = 21.55\text{W}$$

Problem 11.30 P494

Compute the rms value of the waveform depicted in Fig. 11.61.

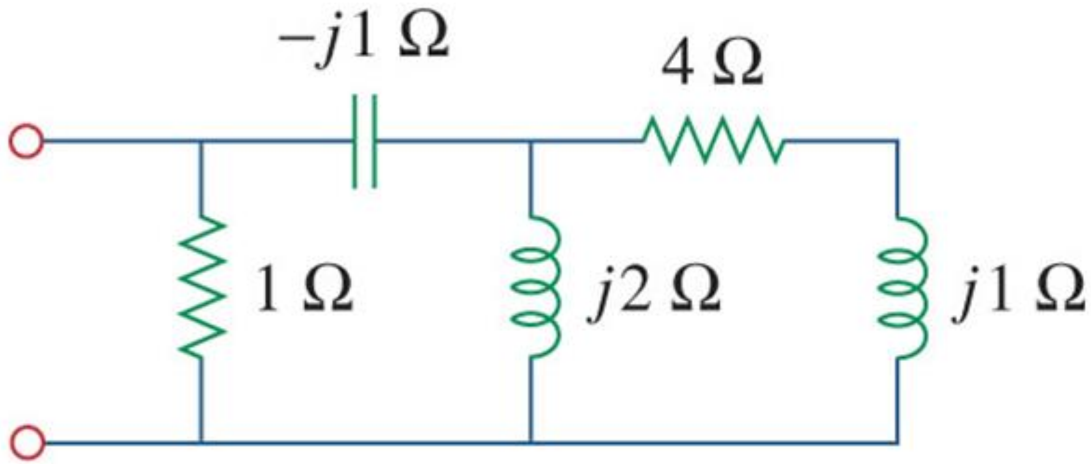


Solution:

$$V_{\text{rms}} = \sqrt{\frac{1}{4}\int_0^4 v^2 dt} = \frac{1}{2}\sqrt{\int_0^2 t^2 dt + \int_2^4 (-1)^2 dt} = 1.08 \text{ V}$$

Problem 11.41 P495

Obtain the power factor for each of the circuits in Fig. 11.68. Specify each power factor as leading or lagging.



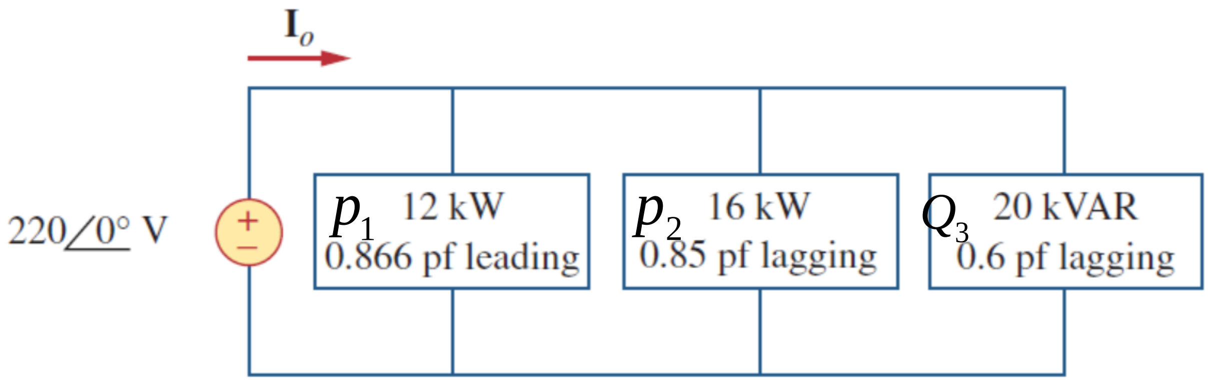
Solution:

$$Z = \left[(4 + j1) \| j2 - j1 \right] \| 1 = 0.48\angle 21.5^\circ$$

$$\text{pf} = \cos 21.5^\circ = 0.93 \text{ lagging}$$

Problem 11.63 P497

Find $\mathbf{I}_o$ in the circuit of Fig. 11.82.



Solution:

$$P_1 = 12\text{kW}. \quad \theta_1 = -\cos^{-} 0.866 = \text{-}30°. \quad Q_1 = P_1 \times \tan(\text{-}30°) = -6.924\text{kVAR}$$

$$P_2 = 16\text{kW}. \quad \theta_2 = \cos^{-} 0.85 = 32°. \quad Q_2 = P_2 \times \tan(32°) = 10\text{kVAR}$$

$$Q_3 = 20\text{kVAR}. \quad \theta_3 = \cos^{-} 0.6 = 53°. \quad P_3 = Q_3 \times \text{ctan}\,\theta_3 = 15.08\text{kW}$$

$$\text{So}: P = P_1 + P_2 + P_3 = 43.08\text{kW}$$

$$Q = Q_1 + Q_2 + Q_3 = 23.08\text{kVAR}$$

$$\theta = \tan^{-}\left(\frac{Q}{P}\right) = 28°$$

$$\text{As}: P = V_{\text{rms}} I_{\text{rms}} \cos\theta \quad \Rightarrow \quad I_{\text{rms}} = \frac{43.08 \times 10^3}{220 \times \cos 28°} = 221.7\text{A}$$

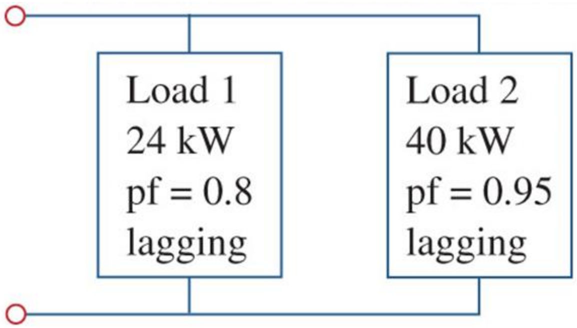
$$\text{So}: \text{I} = 221.7\angle\text{-}28°\text{A}$$

Problem 11.74 P499

A 120-V rms 60-Hz source supplies two loads connected in parallel, as shown in Fig. 11.89.

(a) Find the power factor of the parallel combination.

(b) Calculate the value of the capacitance connected in parallel that will raise the power factor to unity.



Solution:

$$P_1 = 24\text{kW}. \quad \theta_1 = \cos^{-} 0.8 = 37°. \quad Q_1 = P_1 \times \tan(37°) = 18\text{kVAR}$$

$$P_2 = 40\text{kW}. \quad \theta_2 = \cos^{-} 0.95 = 18°. \quad Q_2 = P_2 \times \tan(18°) = 13\text{kVAR}$$

$$\text{So}: P = P_1 + P_2 = 64 \text{ kW}$$

$$Q = Q_1 + Q_2 = 31 \text{ kVAR}$$

$$\text{pf} = \cos\left[\tan^{-}\left(\frac{Q}{P}\right)\right] = 0.9 \text{ lagging}$$

$$\text{As}: Q = wC \times V_{\text{rms}}^2 \quad \Rightarrow \quad C = \frac{31 \times 10^3}{2\pi \times 60 \times 120^2} = 5.71\text{mF}$$