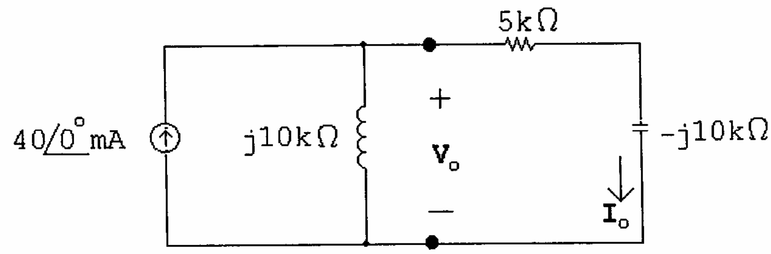
Homework 10

P 10.9 $\mathbf{I}_g = 40\underline{/0^\circ}\,\text{mA}$

$$j\omega L = j10{,}000\,\Omega; \qquad \frac{1}{j\omega C} = -j10{,}000\,\Omega$$



$$\mathbf{I}_o = \frac{j10{,}000}{5000}(40\underline{/0^\circ}) = 80\underline{/90^\circ}\,\text{mA}$$

$$P = \frac{1}{2}|\mathbf{I}_o|^2(5000) = \frac{1}{2}(0.08)^2(5000) = 16\,\text{W}$$

$$Q = \frac{1}{2}|\mathbf{I}_o|^2(-10{,}000) = -32\,\text{VAR}$$

$$S = P + jQ = 16 - j32\,\text{VA}$$

$$|S| = 35.78\,\text{VA}$$

P 10.13 $Z_\text{f} = -j10{,}000\|20{,}000 = 4000 - j8000\,\Omega$

$$Z_\text{i} = 2000 - j2000\,\Omega$$

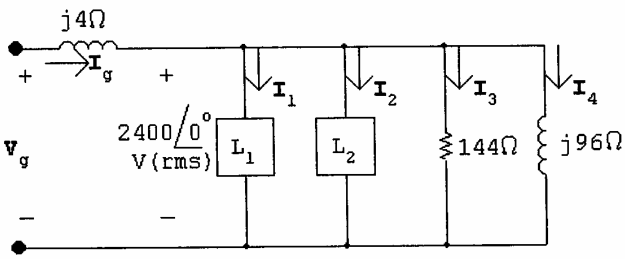
$$\therefore\ \frac{Z_\text{f}}{Z_\text{i}} = \frac{4000 - j8000}{2000 - j2000} = 3 - j1$$

$$\mathbf{V}_o = -\frac{Z_\text{f}}{Z_\text{i}}\mathbf{V}_g; \qquad \mathbf{V}_g = 1\underline{/0^\circ}\,\text{V}$$

$$\mathbf{V}_o = (3 - j1)(1) = 3 - j1 = 3.16\underline{/-18.43^\circ}\,\text{V}$$

$$P = \frac{1}{2}\frac{V_m^2}{R} = \frac{1}{2}\frac{(10)}{1000} = 5\times 10^{-3} = 5\,\text{mW}$$

P 10.21



$$2400\mathbf{I}_1^* = 60{,}000 + j40{,}000$$

$$\mathbf{I}_1^* = 25 + j16.67; \qquad \therefore\ \mathbf{I}_1 = 25 - j16.67\,\text{A(rms)}$$

$$2400\mathbf{I}_2^* = 20{,}000 - j10{,}000$$

$$\mathbf{I}_2^* = 8.33 - j4,167; \qquad \therefore\ \mathbf{I}_2 = 8.33 + j4.167\,\text{A(rms)}$$

$$\mathbf{I}_3 = \frac{2400\underline{/0^\circ}}{144} = 16.67 + j0\,\text{A}; \qquad \mathbf{I}_4 = \frac{2400\underline{/0^\circ}}{j96} = 0 - j25\,\text{A}$$

$$\mathbf{I}_g = \mathbf{I}_1 + \mathbf{I}_2 + \mathbf{I}_3 + \mathbf{I}_4 = 50 - j37.5\,\text{A}$$

$$\mathbf{V}_g = 2400 + (j4)(50 - j37.5) = 2550 + j200 = 2557.83\underline{/4.48^\circ}\,\text{V(rms)}$$

P 10.25 **[a]** $\mathbf{I} = \dfrac{465\underline{/0^\circ}}{124 + j93} = 2.4 - j1.8 = 3\underline{/-36.87^\circ}\,\text{A(rms)}$

$$P = (3)^2(4) = 36\,\text{W}$$

[b] $Y_\text{L} = \dfrac{1}{120 + j90} = 5.33 - j4\ \text{mS}$

$$\therefore\ X_\text{C} = \frac{1}{-4 \times 10^{-3}} = -250\,\Omega$$

[c] $Z_\text{L} = \dfrac{1}{5.33 \times 10^{-3}} = 187.5\,\Omega$

[d] $\mathbf{I} = \dfrac{465\underline{/0^\circ}}{191.5 + j3} = 2.43\underline{/-0.9^\circ}\,\text{A}$

$$P = (2.43)^2(4) = 23.58\,\text{W}$$

[e] $\% = \dfrac{23.58}{36}(100) = 65.5\%$

Thus the power loss after the capacitor is added is 65.6% of the power loss before the capacitor is added.

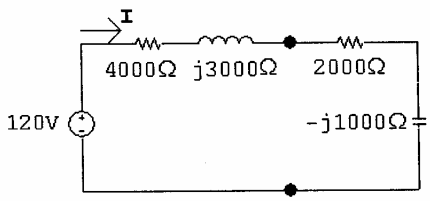
P 10.38 **[a]** First find the Thévenin equivalent:

$$j\omega L = j3000\,\Omega$$

$$Z_{\text{Th}} = 6000\|12{,}000 + j3000 = 4000 + j3000\,\Omega$$

$$\mathbf{V}_{\text{Th}} = \frac{12{,}000}{6000 + 12{,}000}(180) = 120\underline{/0^\circ}\text{ V}$$

$$\frac{-j}{\omega C} = -j1000\,\Omega$$



$$\mathbf{I} = \frac{120}{6000 + j2000} = 18 - j6\text{ mA}$$

$$P = \frac{1}{2}|\mathbf{I}|^2(2000) = 360\text{ mW}$$

[b] Set $C_o = 0.1\,\mu\text{F}$ so $-j/\omega C = -j2000\,\Omega$ $\quad j3000 - j2000 = j1000\,\Omega$

Set R_o as close as possible to

$$R_o = \sqrt{4000^2 + 1000^2} = 4123.1\,\Omega$$

$$\therefore \quad R_o = 4000\,\Omega$$

[c] $\mathbf{I} = \dfrac{120}{8000 + j1000} = 14.77 - j1.85\text{ mA}$

$$P = \frac{1}{2}|\mathbf{I}|^2(4000) = 443.1\text{ mW}$$

Yes; $\quad 443.1\text{ mW} > 360\text{ mW}$

[d] $\mathbf{I} = \dfrac{120}{8000} = 15\text{ mA}$

$$P = \frac{1}{2}(0.015)^2(4000) = 450\text{ mW}$$

[e] $R_o = 4000\,\Omega$; $\quad C_o = 66.67\text{ nF}$

[f] Yes; $\quad 450\text{ mW} > 443.1\text{ mW}$