P 10.20

a) $\bar{S}_1 = (18 + j24)\ kVA$

$\bar{S}_2 = (36 - j48)\ kVA$

$\bar{S}_3 = (18 + j0)\ kVA$

$$\bar{S}_T = \bar{S}_1 + \bar{S}_2 + \bar{S}_3 = (72 - j24)\ kVA$$

$$2400\,\bar{I}^* = \bar{S}_T = (72 - j24) \times 10^3$$

$$\therefore\ \bar{I} = 30 + j10\ \text{A r.m.s.}$$

$$\therefore\ \bar{V}_s = 2400\angle 0° + (30 + j10)(0.2 + j1.6)$$

$$= 2390 + j50$$

$$= 2390.52\angle 1.20°\ \text{V r.m.s.}$$

b) $|\bar{I}_L| = \sqrt{1000}$

$P_\ell = 1000(0.2) = 200\,W$

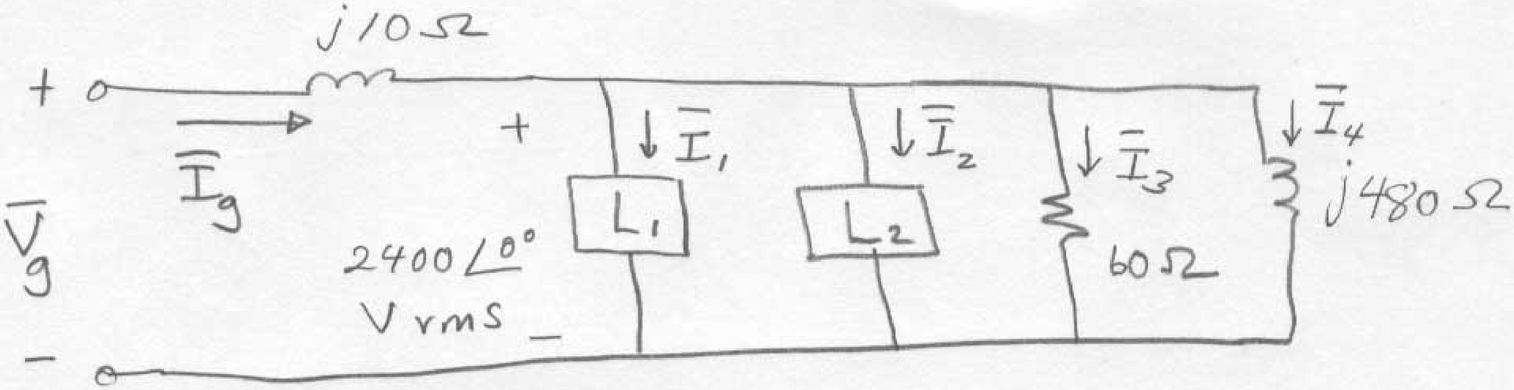
$Q_\ell = 1000(1.6) = 1600\ VAR$

c) $P_s = 72000 + 200 = 72.2\,KW$

$Q_s = -24000 + 1600 = -22.4\,KVAR$

d) $\eta = \frac{72}{72.2} \times 100 = 99.72\%$

P10.21



$$2400\,\bar{I}_1^* = 24{,}000 + j18{,}000$$

$$\bar{I}_1^* = 10 + j7.5, \quad \therefore \bar{I}_1 = 10 - j7.5 \text{ A rms}$$

$$2400\,\bar{I}_2^* = 48{,}000 - j30{,}000$$

$$\bar{I}_2^* = 20 - j12.5, \quad \therefore \bar{I}_2 = 20 + j12.5 \text{ A rms}$$

$$\bar{I}_3 = \frac{2400\angle 0^\circ}{60} = 40 \text{ A rms}$$

$$\bar{I}_4 = \frac{2400\angle 0^\circ}{j480} = -j5 \text{ A rms}$$

$$\bar{I}_g = \bar{I}_1 + \bar{I}_2 + \bar{I}_3 + \bar{I}_4 = 70 \text{ A rms}$$

$$\bar{V}_g = 2400 + 70(j10) = 2400 + j70$$

$$= 2500 \angle 16.26^\circ \text{ V rms.}$$

P10.22

$$\bar{S}_T = 52,800 - j\frac{52,800}{0.8}(0.6) = 52,800 - j39,600 \text{ VA}$$

$$\bar{S}_1 = 40,000(0.96 + j0.28) = 38,400 + j11,200 \text{ VA}$$

$$\bar{S}_2 = \bar{S}_T - \bar{S}_1 = 14,400 - j50,800 = 52,801.52 \angle -74.17^\circ \text{ VA}$$

$$\text{r.f.} = \cos(-74.17^\circ) = -.9621, \quad \text{P.f.} = \cos(-74.17^\circ) = 0.273 \text{ leading}$$

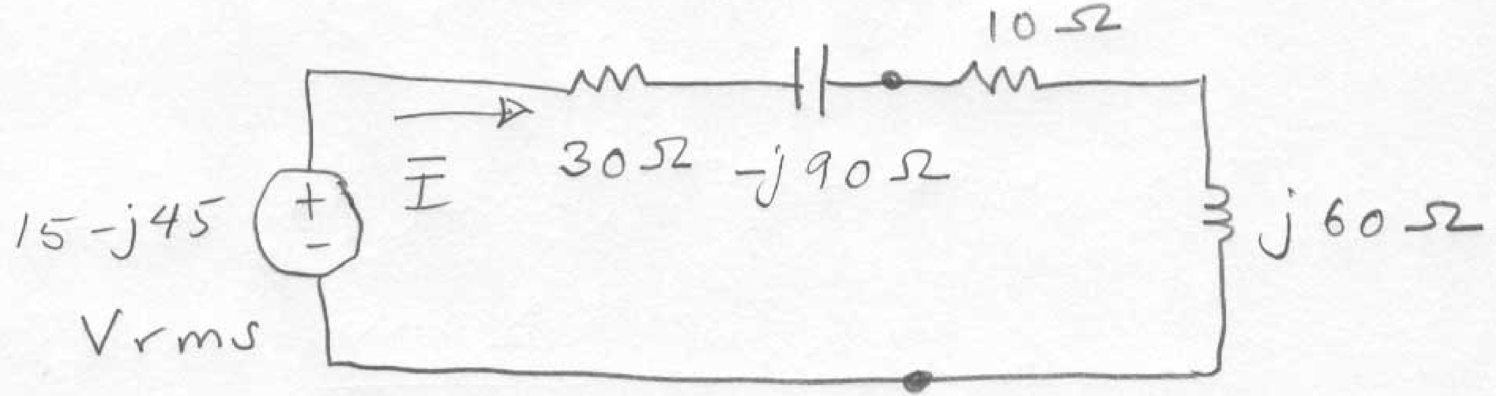
P10.31 a) Find Thevenin equiv. circuit first:

$$\frac{1}{j\omega C} = \frac{10^6}{j10^4} = -j100\ \Omega$$

$$\bar{Z}_{TH} = \frac{300(-j100)}{300 - j100} = 30 - j90\ \Omega$$

$$\bar{V}_{TH} = \frac{150(-j100)}{300 - j100} = 15 - j45\ \text{V rms}$$

$$j\omega L = j10^4(6 \times 10^{-3}) = j60\ \Omega$$



$$\bar{I} = \frac{15 - j45}{40 - j30} = \frac{1.5}{25}(13 - j9)\ \text{A rms}$$

$$I = |\bar{I}| = \frac{1.5}{25}\sqrt{250} \text{ A rms}$$

$$P = \frac{2.25}{625}(250)(10) = 9\text{W}$$

b) Set $L_o = 8\text{ mH}$, Set R_o as close as possible to:

$$R_o = \sqrt{30^2 + 10^2} = \sqrt{1000} = 31.62\ \Omega$$

$$\therefore R_o = 20\ \Omega$$

c) $$\bar{I} = \frac{15 - j45}{50 - j10} = \frac{3 - j9}{10 - j2} \text{ A rms}$$

$\therefore \quad I = |\bar{I}| = \dfrac{\sqrt{90}}{104}$

$$P = |\bar{I}|^2 (20) = \frac{90}{104}(20) = 17.31 \text{ W}$$

Yes, $17.31 \text{ W} > 9\text{W}$

d) $\bar{I} = \dfrac{15 - j45}{60} = \dfrac{1 - j3}{4}$ A rms

$$P = \left(\frac{\sqrt{10}}{4}\right)^2 30 = 18.75 \text{ W}$$

e) $R_o = 30\,\Omega, \quad L_o = 9\text{ mH}$

f) Yes, $18.75 \text{ W} > 17.31 \text{ W}$

P10.32 a) $L_o = 8\text{ mH}, \quad R_o = \sqrt{30^2 + 10^2} = 31.62\,\Omega$

$$\bar{I} = \frac{15(1-j3)}{61.62-j10} = \frac{15\sqrt{10}}{62.43} \angle -62.35^\circ \text{ A rms}$$

$$P = \left(\frac{15\sqrt{10}}{62.43}\right)^2 (31.62) = 18.26 \text{ W}$$

b) Yes, $18.26\text{ W} > 17.31\text{ W}$

c) Yes, $18.26\text{ W} < 18.75\text{ W}$