Chapter 11, Solution 74.

(a) $\theta_1 = \cos^{-1}(0.8) = 36.87°$

$S_1 = \dfrac{P_1}{\cos\theta_1} = \dfrac{24}{0.8} = 30\text{ kVA}$

$Q_1 = S_1 \sin\theta_1 = (30)(0.6) = 18\text{ kVAR}$

$\mathbf{S}_1 = 24 + j18\text{ kVA}$

$\theta_2 = \cos^{-1}(0.95) = 18.19°$

$S_2 = \dfrac{P_2}{\cos\theta_2} = \dfrac{40}{0.95} = 42.105\text{ kVA}$

$Q_2 = S_2 \sin\theta_2 = 13.144\text{ kVAR}$

$\mathbf{S}_2 = 40 + j13.144\text{ kVA}$

$\mathbf{S} = \mathbf{S}_1 + \mathbf{S}_2 = 64 + j31.144\text{ kVA}$

$\theta = \tan^{-1}\left(\dfrac{31.144}{64}\right) = 25.95°$

$\text{pf} = \cos\theta = \mathbf{0.8992}$

(b) $\theta_2 = 25.95°,$ $\theta_1 = 0°$

$Q_c = P[\tan\theta_2 - \tan\theta_1] = 64[\tan(25.95°) - 0] = 31.144\text{ kVAR}$

$C = \dfrac{Q_c}{\omega V_{rms}^2} = \dfrac{31,144}{(2\pi)(60)(120)^2} = \mathbf{5.74\ mF}$