PROBLEM SET #26

Chapter 11, Solution 63.

Let $\mathbf{S} = \mathbf{S}_1 + \mathbf{S}_2 + \mathbf{S}_3$.

$$\mathbf{S}_1 = 12 - j\frac{12}{0.866}\sin(\cos^{-1}(0.866)) = 12 - j6.929$$

$$\mathbf{S}_2 = 16 + j\frac{16}{0.85}\sin(\cos^{-1}(0.85)) = 16 + j9.916$$

$$\mathbf{S}_3 = \frac{(20)(0.6)}{\sin(\cos^{-1}(0.6)} + j20 = 15 + j20$$

$$\mathbf{S} = 43 + j22.987 = \frac{1}{2}\mathbf{V}\,\mathbf{I}_o^*$$

assumes pk values for Ph-sors

$$\mathbf{I}_o^* = \frac{2\mathbf{S}}{\mathbf{V}} = \frac{2(43 + j22.99)\text{x}10^3}{220} = 390.9 + j209 = 443.3\angle 28.13°$$

$$\mathbf{I}_o = \underline{\mathbf{443.3\angle -28.13°\,A}}$$

IF assume $\tilde{V}_{IN} = 220 V_{rms} \angle 0°$ then

$$\hat{S} = (43 + j22.987)\text{k} = \tilde{V}_{IN}\,\tilde{I}_{IN}^*$$

so

$$\tilde{I}_{IN}^* = \frac{43\text{k} + j22.987\text{k}}{220\,V\angle 0°} = 221.6 A_{rms} \angle 28.13°$$

$$\tilde{I}_{IN} = 221.6 A_{rms} \angle -28.13°$$

Chapter 11, Solution 74.

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

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

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

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

$$\theta_2 = \cos^{-1}(0.95) = 18.19°$$

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

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

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

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

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

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

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

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

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

Or

$Q_{Loads} = Q_1 + Q_2 = 31.144 \text{ kVAR}$

$\theta_{pf,des} = \cos^{-1}(pf_{des}) = \cos^{-1}(1) = 0°$

$Q_{des} = P_{Loads} \tan\theta_{pf,des} = 40\text{kW} \tan(0°) = 0$

$Q_{des} = Q_{Loads} + Q_C \longrightarrow Q_C = -Q_{Loads} = -31.144 \text{ kVAR}$

$Q_C = -\omega C |\hat{V}_{in}|^2 = -(2\pi 60) C (120\text{Vrms})^2 = -31.144 \text{ kVAR}$

$C = 5.74 \text{ mF}$