Soln:

General approach is

$$\underline{V}_s = 250\angle 0^\circ + \underline{I}_s(0.05 + j0.5)$$

where $\underline{I}_s = \underline{I}_1 + \underline{I}_2 + \underline{I}_3$

i) For $\underline{I}_1$

$(\theta_v - \theta_i) = \cos^{-1}(0.8)$

$(\theta_v - \theta_i) = 36.8^\circ$

$$S = \underline{V}\,\underline{I}_1^* = 8000 + j6000$$

$$\therefore \underline{I}_1^* = \frac{8000 + j6000}{250\angle 0^\circ} = 32 + j24 \ A_{rms}$$

$$\therefore \underline{I}_1 = 32 - j24 \ A_{rms}$$

ii) For $\underline{I}_2$:

$$(\theta_v - \theta_i) = \cos^{-1}(0.6) = -53.1^\circ$$

$$\therefore P = (20000)(0.6) = 12{,}000$$

$$Q = (20000)(0.8) = 16{,}000$$

Since Pf is leading — capacitive load → $-Q$

$$\therefore S = 12000 - j16000 \ \text{KVA}$$

$$\therefore \underline{I}_2^* = \frac{12000 - j16000}{250\angle 0^\circ} = 48 - j64 \ A_{rms}$$

$$\therefore \underline{I}_2 = 48 + j64 \ A_{rms}$$

For $\underline{I}_3$ :

$$\underline{I}_3 = \frac{250\angle 0^\circ}{\underline{Z}_3} = \frac{250\angle 0^\circ}{2.5+j5} = 20-j40 \text{ Arms.}$$

$$\therefore \underline{I}_s = 100 + j0 \text{ Arms}$$

$$\therefore \underline{V}_s = 250\angle 0^\circ + (100)(0.05+j0.5)$$

$$= 255 + j50$$

$$= 260 \angle 11^\circ \text{ rms}$$

$$\therefore v_s(t) = \sqrt{2}\, 260 \cos(377t + 11^\circ) \text{ V.}$$

Hwk ~~12.12~~ ~~#12.14~~ 10.20

10.24 (Power factor correction)