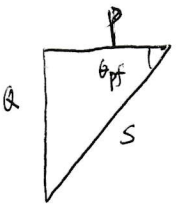
Homework 1 Haoang Wang mw814

Q1. (a) 

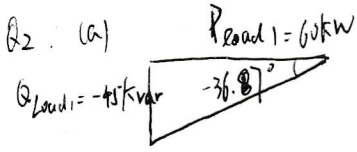
$|S| = 16\ kVA \quad P = |S|\cos\theta_{pf} = 9.6\ kW \quad Q = |S|\sin\theta_{pf} = 12.8\ kvar$

$\theta_{pf} = -\cos^{-1}(0.6) = -53.13^\circ \quad S = 16\angle -53.13^\circ\ kVA$

(b) $S = VI^* \Rightarrow I^* = \frac{S}{V} = \frac{16000\angle -53.13^\circ\ VA}{120\angle 0^\circ V} = \frac{400}{3}\angle -53.13^\circ A$

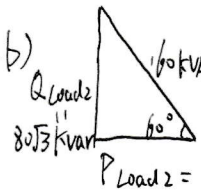
$\Rightarrow I = \frac{400}{3}\angle 53.13^\circ A \Rightarrow Z_{load} = \frac{V_{load}}{I_{load}} = \frac{120\angle 0^\circ V}{400/3\angle 53.13^\circ A} = 0.9\angle -53.13^\circ \Omega$

(c) $I_{line} = I_{load} = \frac{400}{3}\angle 53.13^\circ A \Rightarrow S_{line} = |I_{line}|^2 Z_{line} = 17777.78W + j35555.56\ VAr$

Q2. (a) 

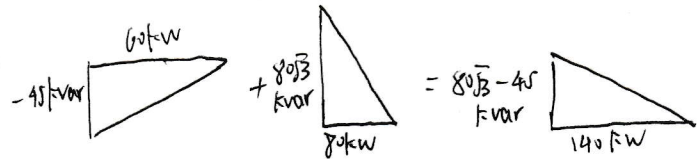
$P_{Load1} = 60\ kW$

$Q_{Load1} = -45\ kvar$

(b) 

$P_{Load2} = 80kw$

$Q_{Load2} = 80\sqrt{3}\ kvar$

(c) 

$\Rightarrow pf = \cos\left(\tan^{-1}\left(\frac{80\sqrt{3}-45}{140}\right)\right) = 0.83142$

$|S_{Load\_eq}| = 168.39\ kVA$

(d) $S_{Load\_eq} = 168.39\angle 33.76^\circ\ kVA, \quad V_{Load} = 13.8\angle 0^\circ\ kV_{rms}$

$S = VI^* \Rightarrow I^*_{load} = \frac{S_{Load\_eq}}{V_{Load}} = 12.17\angle 33.76^\circ A_{rms}$

(e) $pf_{w/comp} = 0.95 \Rightarrow \theta_{w/comp} = \cos^{-1}(0.95) = 18.19^\circ$

$Q_{cap} = Q_{w/comp} - Q_{load} = P_{load\_eq}\cdot\tan(18.19^\circ) - Q_{Load\_eq} = -47.55\ kvar$

$|I_{cap}| = -\frac{Q_{cap}}{|V_{cap}|} = \frac{47.55}{13.8} = 3.45A$

$|Z_{cap}| = \frac{|V_{cap}|}{|I_{cap}|} = \frac{13.8\ kV}{3.45A} = 4000\Omega = \frac{1}{\omega C_{comp}} = \frac{1}{2\pi f C_{comp}} \Rightarrow C_{comp} = \frac{1}{2\pi\times 60\times 4000} = 0.663\ \mu F$

Q3. (a) $P_{Load} = 200kW\ @0.85\ pf \Rightarrow \theta_{pf} = \cos^{-1}(0.85) = 31.788^\circ$

$|P_{Load}| = \sqrt{3}\,V_{Line}\,I_{Line}\cos\theta_{pf} \Rightarrow I_{Line} = 196.879\angle -31.788^\circ$

$V_{phase} = \frac{650}{\sqrt{3}}\angle 0^\circ, \quad Z_{Line} = 3\times j0.4 = j1.2\Omega$

$V_{source/phase} = V_{phase} + I_{phase}\times j1.2 = V_{phase} + I_{Line}\times j1.2 = 560.065\angle 21.011^\circ$

$\Rightarrow V_{source/Line} = \sqrt{3}\,V_{source/phase} = 970.06\angle 21.011^\circ$

(b) $S_{3\text{-}phase} = 3V_{phase}I^*_{Line} = 3\times 560.065\angle 21.011^\circ * 196.879\angle 31.788^\circ$

$= 330795.11\angle 52.799^\circ\ VA = 200003.02 + j263484.711\ VA$

Q4. $|S_1| = 120$ kVA, $pf_1 = 0.9$ lag, $\theta_1 = \cos^{-1}(0.9) = 25.84^\circ$ lag $\Rightarrow S_1 = 108 + j52.3$ kVA

$|P_2| = 180$ kW, $pf_2 = 0.55$ lead, $Q_2 = P_2 \tan\theta_2 = -273.33$ kvar $\Rightarrow S_2 = 180 - j273.33$ kVA

$|P_3| = 30$ kW, $pf_3 = 1 \Rightarrow S_3 = 30$

(a) $S_T = S_1 + S_2 + S_3 = 318 - j221.03$ kVA $= 387.27 \angle -34.8^\circ$

(b) $pf_T = \cos(\angle -34.8^\circ) = 0.821$ leading

(c) $P_{3\phi} = \sqrt{3}\, V_{Line}\, I_{Line} \cos\theta \Rightarrow 318\text{k} = \sqrt{3} \times 3800 \times I_{Line} \times 0.821 \Rightarrow I_{Line} = 58.85$ A