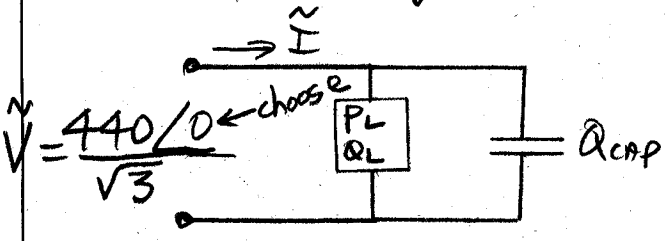
2.4

Convert the 3φ load to one-line diagram. 200 KW is 3φ P, 440 V is line-to-line RMS, pf is same on all phases, 50 KVAr is 3φ Q.

One-line diagram



$$P_L = \frac{200\,KW}{3} = 66.7\,KW$$

$$Q_L = +P_L\sqrt{\left(\frac{1}{PF}\right)^2 - 1} = 66.7\sqrt{\left(\frac{1}{0.707}\right)^2 - 1}$$

$$Q_L = 66.7\,VAr \text{ (lagging pf)}$$

$$Q_{CAP} = \frac{-50\,KVAr}{3} = -16.67\,KVAr$$

So, $P_{TOT} + jQ_{TOT} = 66.7\,KW + j(66.7 - 16.67)\,KVAr$

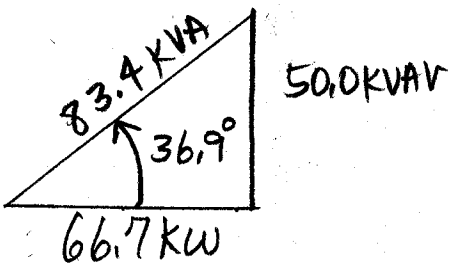
$= 66.7\,KW + j50.0\,KVAr$

$$\underset{TOT}{S} = P_{TOT} + jQ_{TOT} = 83.4\angle 36.9^\circ\ KVA$$

$pf = \cos(36.9^\circ) = 0.800$ lag

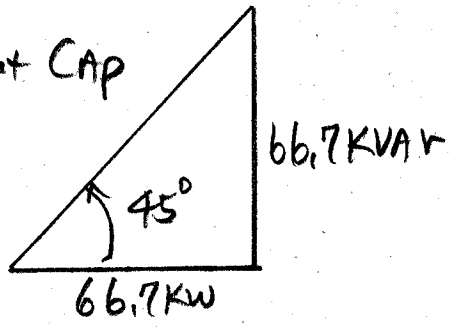
$$S_{TOT} = VI^*,\quad I = \frac{S^*_{TOT}}{V^*} = \frac{83.4\angle -36.9\ KVA}{\frac{440}{\sqrt{3}}\angle 0\ V} = 0.328\angle -36.9\ KA$$

With CAP



$$\underset{\text{with CAP}}{\hat{I}} = 328\angle -36.9\ Amps$$

Without CAP



$$\underset{\text{NO CAP}}{\hat{I}} = \frac{\frac{66.7}{0.1707}\angle -45^\circ\ KVA}{\frac{440}{\sqrt{3}}\angle 0\ V}$$

$$\underset{\text{NO CAP}}{\hat{I}} = 371\angle -45^\circ\ Amps$$

With no change in $\hat{V}$, $|I|$ drops to 0.884 of orig, and delivery losses drop to 0.782 of original