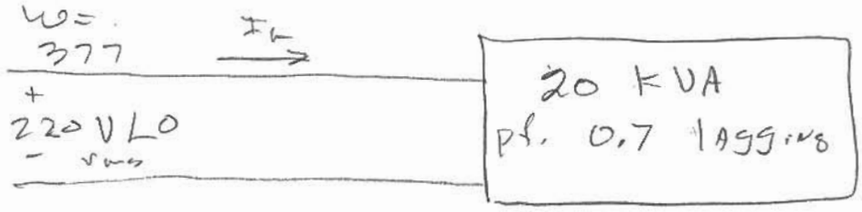
POWER FACTOR CORRECTION

wlg

Suppose we are given the following situation:



(a) Find the I_L with existing system

Since apparent power is

$S = V_{rms} I_{rms}$

and

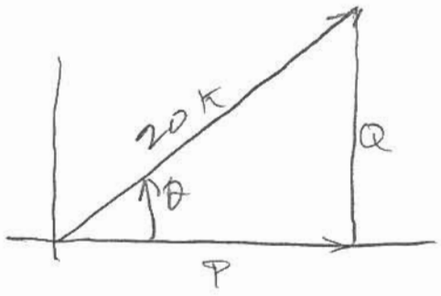
$S = 20{,}000$ VA

$$I_{rms} = \frac{20{,}000}{220} = 90.91 \text{ A}$$

It is desired to place a capacitor in parallel with the load so that the power factor is changed to 0.97. Find the value of the capacitor and the new value of I_L.

w.l.g

We have



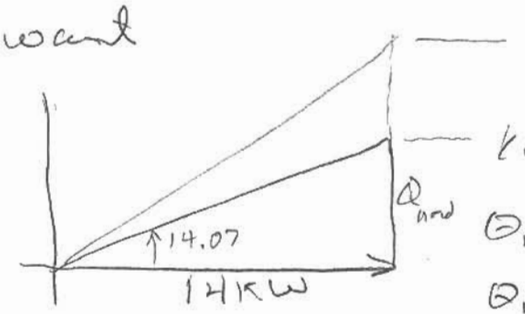
$\cos\theta = 0.7$

$\theta = 45.6^\circ$

$P = 20k \cos\theta = 20k \times .7 = 14\,kW$

$Q_{old} = 20k \sin 45.6 = 14.29\ k\,VAR$

We want



$\cos\theta_{new} = .97$

$\theta_{new} = \cos^{-1}.97$

$\theta_{new} = 14.07^\circ$

$\tan 14.07 = \frac{Q_{new}}{14K}$

$Q_{new} = 14K \tan 14.07 = 3509\ VAR$

$Q_{cap} = Q_{old} - Q_{new} = 14.29 - 3.509$

$Q_{cap} = 10.78\ VAR$

Now,

$$\tilde{S}_{CAP} = \frac{V_{rms}^2}{Z_{cap}^*} = \frac{220^2}{j/\omega C} = -j\,220^2 \omega C$$

b or

$$\hat{S}_{cap} = -j\,Q_{cap} = -j\,10.78\ \text{KVAR} = -j\,220^2\,\omega C$$

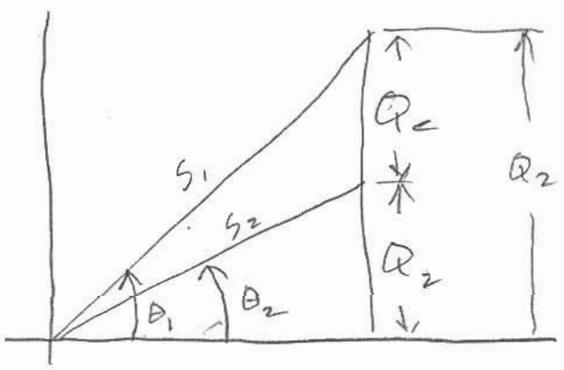
so we have

$$C = \frac{10\,780}{220^2 \times 377} = .6\ \text{mF}$$

$$\boxed{C = 600\ \mu F}$$

A formula

$$C = \frac{P\,[\tan\theta_1 - \tan\theta_2]}{\omega V_{rms}^2}$$



$\theta_1 = 45.6^\circ$, $Q_2 = 14.07$

$$C = \frac{14{,}000\,[\tan 45.6 - \tan 14.07]}{220^2 \times 377}$$

$$C = .0006\ F$$

Now find $I_{L_{new}}$

We see that the new load apparent power is

$\frac{P}{S} = \cos\theta$

$$S_{new} = \frac{P}{\cos 14.07} = \frac{14,000}{\cos 14.07}$$

$$S_{new} = 14.432 \text{ KVA}$$

$$I_{L_{new}} = \frac{14,432}{220} = 65.6 \text{ A}$$

So we have reduced the line current from

$$I_{L_{old}} = 90.91 \text{ A}$$

$$I_{L_{new}} = 65.6 \text{ A}$$