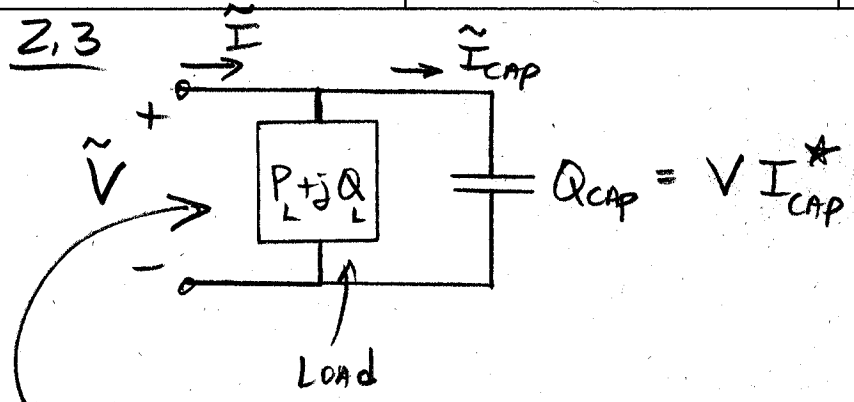
2.3



Conservation of P, Q says $P = P_L + \cancel{P_{CAP}}^{0}$

$$Q = Q_L + Q_{CAP}$$

A negative number

Without Cap

$P_L = 5\,MW$

$pf = 0.7$ lagging

$Q_L = +5\sqrt{\left(\frac{1}{0.7}\right)^2 - 1}$

$Q_L = 5.10\,MVAr$

$S_L = P_L + jQ_L = 5.0 + j5.10$

$S_L = 7.14\angle 45.6°\,MVA$

With Cap

$P = 5\,MW$

$pf = 0.9$ lagging

$Q = 5\sqrt{\left(\frac{1}{0.9}\right)^2 - 1} = 2.42\,MVAr$

$S = P + jQ = 5.55\angle 25.8°$

$Q = Q_L + Q_{CAP} = 2.42$

$Q_{CAP} = 2.42 - 5.10 = -2.68\,MVAr$

If we knew the voltage, we could use

$Q_{CAP} = -V^2 \omega C$ to get C (typically μF)

What is the impact on $\tilde{I}$ total

Without Cap

$$\tilde{I}_{NO\,CAP} = \frac{S_L^*}{V^*} = \frac{7.14\angle -45.6}{V^*}$$

With Cap

$$\tilde{I}_{with\,CAP} = \frac{S^*}{V^*} = \frac{5.55\angle -25.8}{V^*}$$

If $\tilde{V}$ is relatively unchanged, then

$$\frac{I(\text{with cap})}{I(\text{without cap})} = \frac{5.55}{7.14} = 0.777.$$

Delivery losses go down to ratio $(0.777)^2 = 0.60$ of NO CAP case