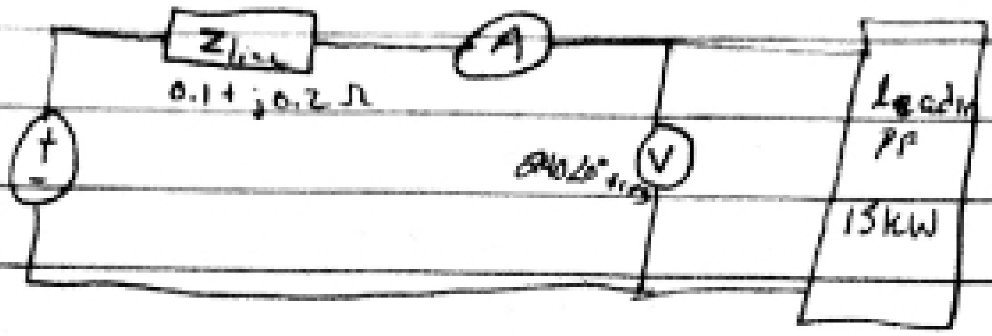
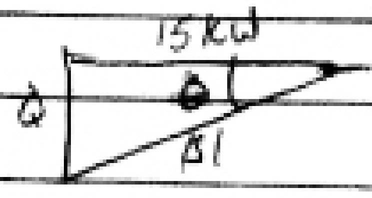
9.71 A transmission line with impedance of $0.1 + j0.2\Omega$ is used to deliver power to a load. The load is capacitive and the load voltage is $240\angle 0°$ Vrms at 60Hz. If the load requires 15kW and the real power loss in the line is 660W, determine the input voltage



$P_{loss} = P_{line} = 660W = I^2 R$ $\qquad I = \sqrt{\frac{660}{0.1}} = 81.24$ Arms

$P = \frac{I_m^2 R}{2}$

$V_z = Z \cdot I_{rms}$



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

$= \frac{|V_{rms}|^2}{Z^*}$

$= |I_{rms}|^2 Z$

$P = V_{rms} I_{rms} (\theta_v - \theta_i)$

$\cos(\theta_v - \theta_i) = \frac{P}{V_{rms} I_{rms}} \qquad \frac{15{,}000}{(240)(81.24)} = 0.769$

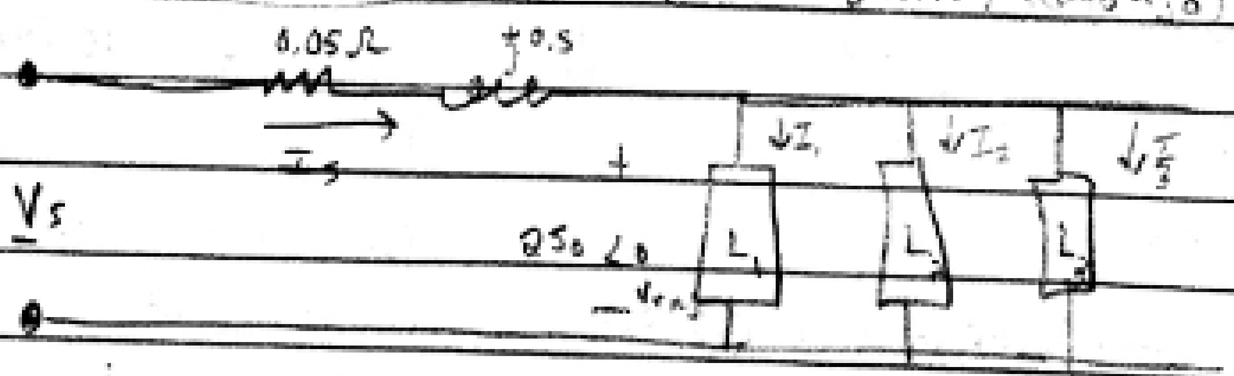
$\theta_v - \theta_i = \cos^{-1} 0.769 = 39.7°$

$I_{rms} = 81.24\angle 39.7°$

$V_z = Z \cdot I_{rms} \qquad V_z = 0.1 + j0.2\Omega\,(81.24\angle 39.7°)$

$= 0.224\angle 63.4°\,(81.24\angle 39.7) = 18.197\angle 103.1°$

$V_s = V_z + 240\angle 0 \qquad (-4.13 + j17.72) + (240 + j0) = 235.87 + j17.72$



Given: L_1 absorbs 8kW @ 0.8 lagging $\qquad$ Find $V_s(t)$ for $W = 377$ rad/sec

L_2 absorbs 20kVA @ 0.6 leading

L_3 has $Z = 2.5 + j5\Omega$

Load 1:

$\frac{P}{|S|} = 0.8 \qquad |S| = 10{,}000$

$\theta_v - \theta_i = \cos^{-1}(0.8) = 36.9°$

$S = V_{rms} I_{rms}^* \qquad I_{rms} = \left(\frac{S}{V_{rms}}\right)^* = \left[\frac{10{,}000\angle 36.9}{250\angle 0°}\right]$

$40\angle 36.9$

$32 - j24$ Arms

L2 :  $\theta_v - \theta_i = \cos^{-1}(0.6) = -53.13$

$\therefore$ 20000 $\angle -53.1°$

$I_{2rms} = \left[\frac{S_2}{250\angle 0°}\right]^* = \frac{(20{,}000\angle -53.1)^*}{250\angle 0} = 80\angle 53.1°$

$48 + j64$

load 3

$Z = 2.5 + j5$ $\quad V = ZI \quad I_{3rms} = \frac{250\angle 0}{5.6\angle 63.4} = 44.6\angle -63.4 = 20 - j40$ Arms

$I_s = I_1 + I_2 + I_3$

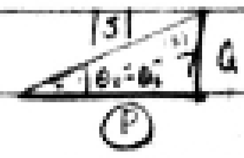
$= 32 - j24 + 48 + j64 + 20 - j40 = 100\angle 0°$ Arms

$V_s = V_R + 250\angle 0 \qquad V_s = (0.05 + j0.5)\,100\angle 0 + 250\angle 0°$

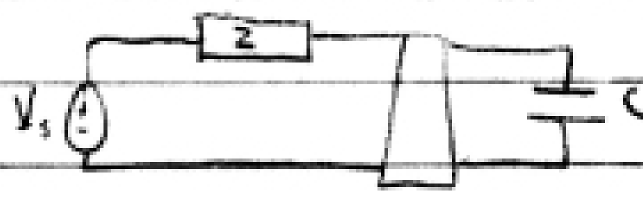
$V_s = 5 + j50 + 250\,j0 = 255 - j50$ Vrms $= 259.86\angle 11.09$ Vrms

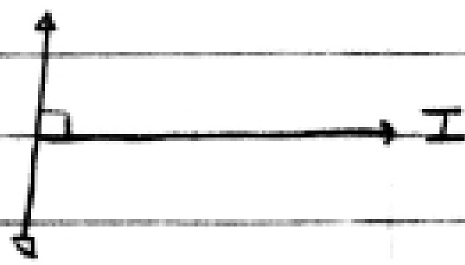
$\boxed{V_s(t) = 259.86\,(\cos(377t + 11.09°))}$

Power Factor Correction

$PF = \frac{P}{|S|} = \cos(\theta_v - \theta_i)$  $S = P + jQ$

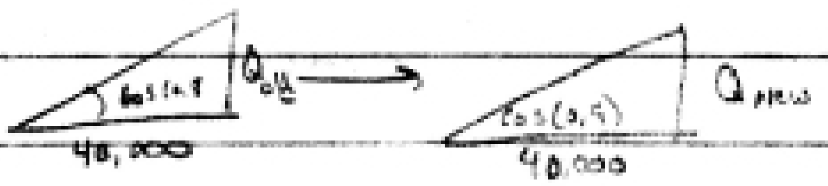
ELI the ICE Man





9.90

A particular load has a Pf of 0.8 lagging the Power Delivered to the load is 40 kW from a 270 Vrms, 60 Hz line, What Value of Capacitance in Parallel with the load will rise the Power Factor to 0.9 Lagging



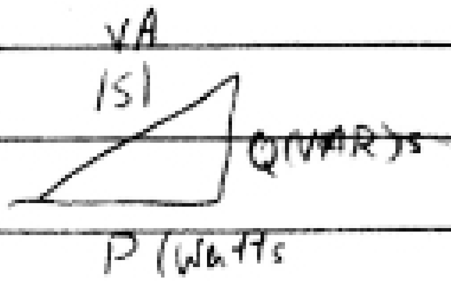
$Q_C = Q_{old} - Q_{new}$

$Q_C = \frac{|V_{rms}|^2}{1/\omega C} = \omega C\,|V_{rms}|^2$

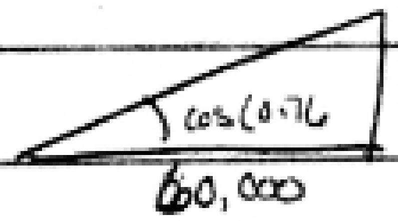
$Q_{old} = 40000\,(\tan(\cos^{-1} 0.8)) = 30{,}000 \qquad Q_C = 30{,}000 - 19{,}372.9$

$Q_{new} = 40{,}000\,(\tan(\cos^{-1}(0.9)) = 19{,}372.9 \qquad Q_C = 10627$

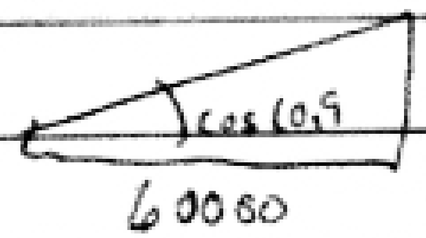
$\therefore C = \frac{10627}{377(270)^2} = 386.6\ \mu F$



9.92 a 60Hz line Voltage for a 60KW, 0.76 lagging Pf industrial load find the capacitance that when Placed in Parallel with load will Rise the Pf to, 0.9 lagging, $240\angle 0°$ Vrms



$Q_{old} = 60{,}000 \tan(\cos(0.76)) = 51310$ VARS



$Q_{new} = 60{,}000 \tan(\cos(0.9)) = 29059$ VARs

$Q_c = Q_o - Q_N = 51310 - 29059 = 22259$ Var

$C = \frac{22259}{377(240)^2} = 1025\ \mu F$

HW 9.93