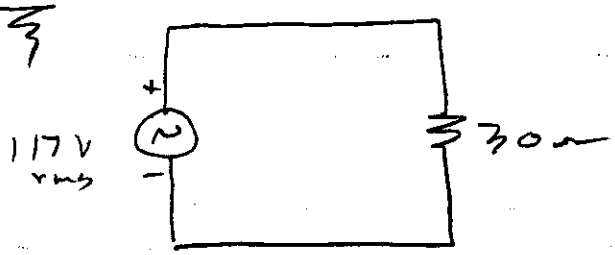
wlg N.W. #7

7.1



Find P_{30}:

$$P_{30} = \frac{V_{rms}^2}{30} = \frac{(117)^2}{30} = 456.3\ W$$

7.6

1.2 kW
.8 Pf
120 V rms 6 Hz

Load

(a) Find I_{rms}

$$P = 12\ kW = V_{rms} I_{rms} \cos(\theta_v - \theta_I)$$

$$\theta_v = 0 \quad \theta_I = \cos^{-1} .8$$

$$I_{rms} = \frac{1.2 \times 10^3}{120 \times 0.8} = \underline{12.5\ A}$$

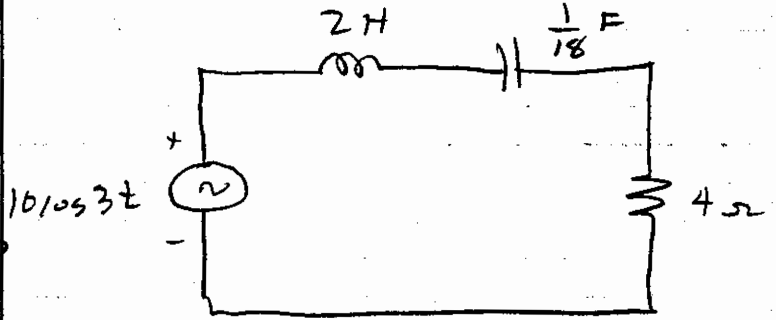
(b) $\theta = \cos^{-1}(.8) = \underline{36.87^\circ}$

(c) $Z = \dfrac{120}{12.5 \angle \pm 36.87} = \underline{9.6 \angle \pm 36.87}$

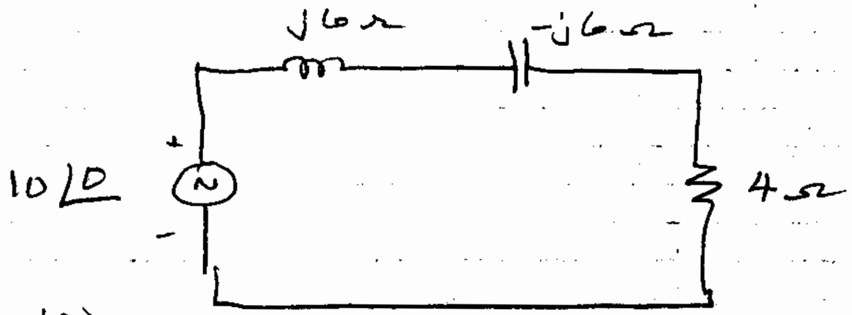
(d) $P = 1200 = I_{rms}^2 R$

$R = 7.7\ \Omega$

7.12 Find the real power and reactive power supplied by the source in the following circuit.
Repeat if the frequency is increased by a factor of 3.



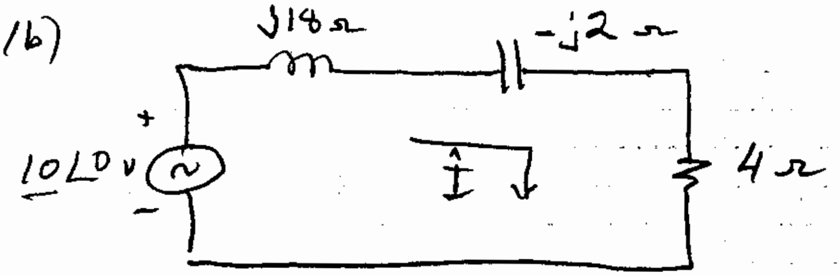
$X_L = \omega L = 3 \times 2 = 6, \quad X_C = \frac{-1}{\omega C} = -6$



1a) $\theta_V = \theta_I = 0$

$P = \frac{10}{\sqrt{2}} \times \frac{10/\sqrt{2}}{4} = 12.5\,W \qquad Q = 0$

1b)

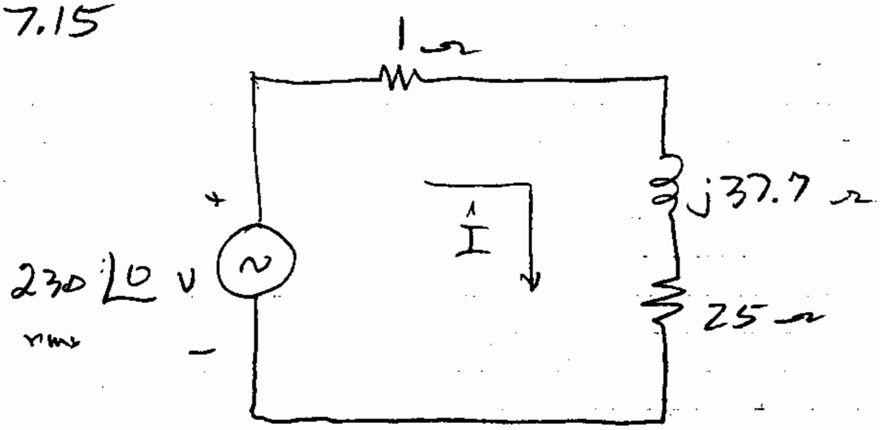


$\hat{I} = \frac{10}{4 + j16} = 0.147 - j0.588 = 0.606\angle{-75.96}$

$P = \frac{10 \times 0.606}{2} \cos(75.96) = 0.735\,W \qquad Q = \frac{10 \times .606}{2} \sin 75.96 = 2.94\ VAR$

$\frac{1}{2} V_m I_m \left[\cos(\theta_V - \theta_I) + j\sin(\theta_V - \theta_I)\right]$

7.15



$$\hat{I} = \frac{230}{26 + j37.7} = 5.02 \angle -55.41^\circ \text{ A rms}$$

(a)

$$|S| = (230)(5.02) = 1.155 \text{ KVA}$$

(b)

$$\hat{S}_L = V_L \hat{I}_L^* = (I_L I_L^*)\hat{Z} = |\hat{I}|^2 (25 + j37.7)$$

$$= 1140 \angle 56.5$$

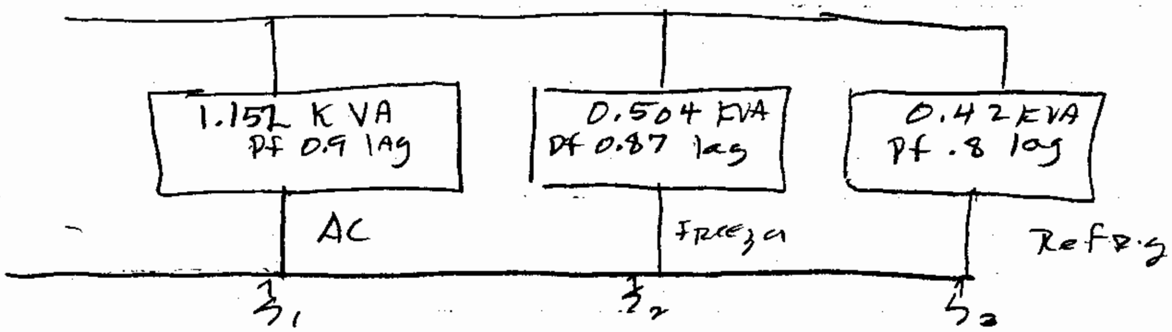
$$|S_L| = 1.14 \text{ KVA}$$

(c)

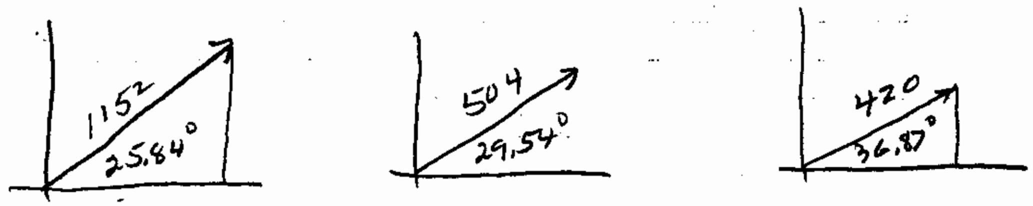
$$pf = \cos(55.41) \text{ lagging}$$

$$pf = 0.5677 \text{ lagging}$$

7.20



$$\hat{S} = \hat{S}_1 + \hat{S}_2 + \hat{S}_3$$

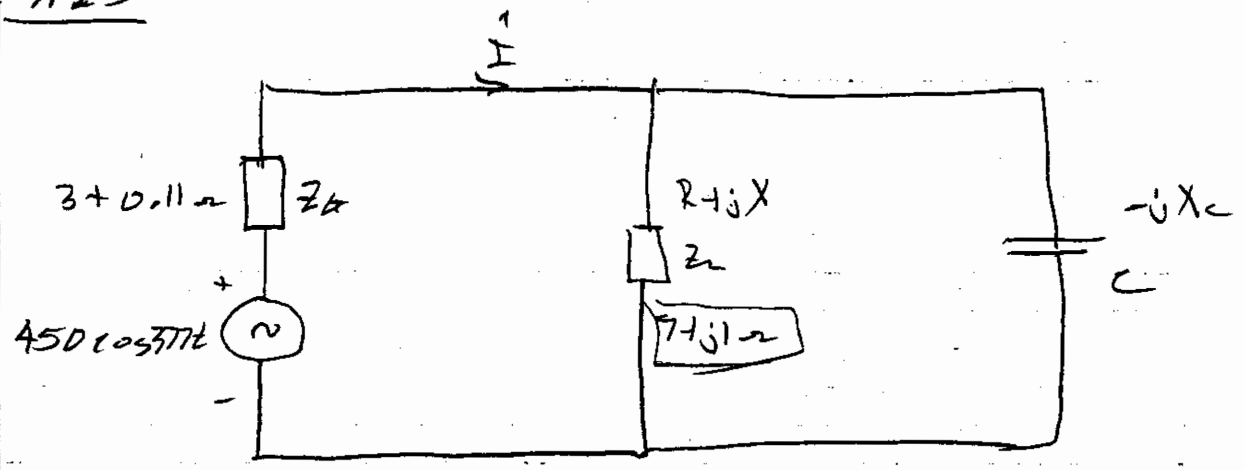


$S_1 = 1152\angle 25.84$ VA $\quad S_2 = 504\angle 29.54^\circ$ VA $\quad \hat{S}_3 = 420\angle 36.87$

$$\hat{S} = 1152\angle 25.84^\circ + 504\angle 29.54 + 420\angle 36.87$$

$$\hat{S} = 1811.3 + j1002.6 \text{ VA}$$

7.25



ADD C so that P.F. = 1

To make the Pf = 1, we want the load impedance to be real (No j term)

$$\frac{(R+jX)(-jX_c)}{R+j(X-X_c)} = R_{eq} + jX_{eq} \implies X_{eq} = 0$$

$$\frac{(-XX_c - jRX_c)(R - j(X-X_c))}{R^2 + (X-X_c)^2}$$

$$\frac{RXX_c - RX_c(X-X_c) - (jR^2X_c + XX_c(X-X_c))}{R^2 + (X-X_c)^2} = 0$$

so $R^2 X_c + X X_c (X - X_c) = 0$

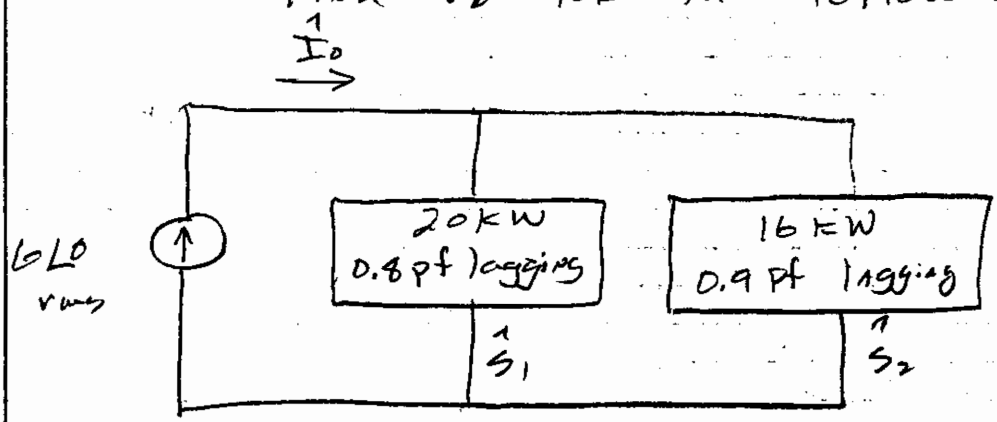
$$X_c = \frac{R^2 + X^2}{X} = \frac{7^2 + 1^2}{1^2} = \frac{49+1}{1}$$

$$X_c = 50 = \frac{1}{\omega C}$$

$$C = \frac{1}{50 \times 377} = 53.05\,\mu F$$

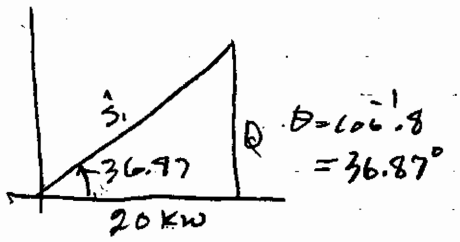
EX #1

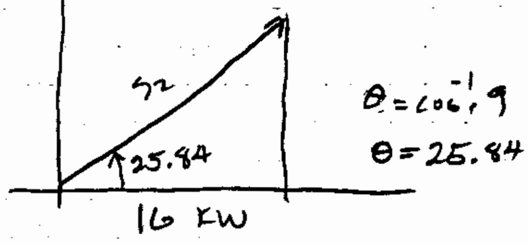
Find $\hat{V}_o$ for the following circuit



$$\hat{S} = \hat{V}_{rms} \hat{I}^*_{rms} = 6 \cdot \hat{I}_o^*$$

$$\hat{S} = \hat{S}_1 + \hat{S}_2$$





$$S_1 = (20 + j20 \times \tan 36.87) \text{ kVA} \qquad \hat{S}_2 = (16 + j16 \times \tan 25.84) \text{ kVA}$$

$$\hat{S}_1 = (20 + j15) \text{ kVA} \qquad \hat{S}_2 = (16 + j7.75) \text{ kVA}$$

$$\hat{S} = (20 + j15 + 16 + j7.75) \text{ kVA}$$

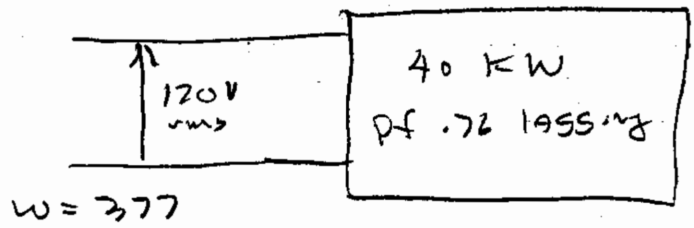
$$\hat{S} = (36 + j22.75) \text{ kVA} = 42.59 \angle 32.3 \text{ kVA}$$

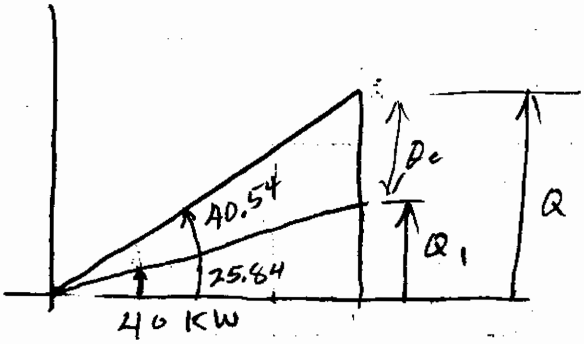
$$\hat{V}_o = \frac{42.59 \angle 32.3}{6} \times 10^3 = 7.098 \angle 32.3 \text{ kV}$$

$$\text{p.f.} = \cos(32.3) \text{ lagging}$$

$$\text{p.f.} = 0.8453 \text{ lagging}$$

Ex # 2





$\theta_1 = \cos^{-1}(.76) = 40.54^\circ$

$\theta_2 = \cos^{-1}(.9) = 25.84$

(a)

$Q_c = Q - Q_1 = P(\tan 40.54 - \tan 25.84)$

$Q_c = 14.84$ KVARS

$\therefore \; \underline{C} = \dfrac{14.84 \times 10^3}{120^2 \times 377} = \underline{2.73 \text{ mF}}$

(b) To bring to unity power factor:

$Q_c = 40\text{KW}\,[\tan 40.54 - \tan(0)]$

$Q_c = 34.2$ K VARs

$C = \dfrac{34.2 \times 10^3}{120^2 \times 377}$

$\underline{C = 6.3 \text{ mF}}$