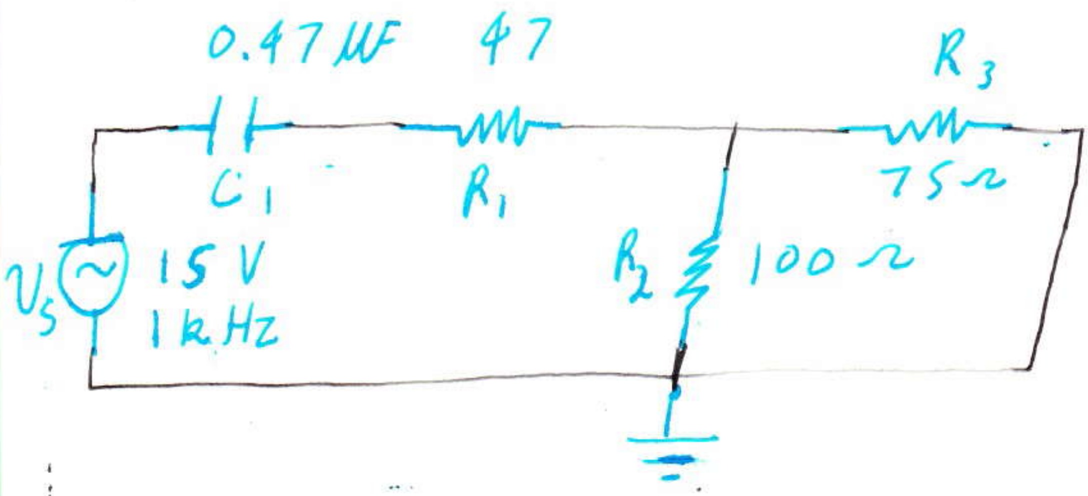
Hw 3 | Cpe ~~#~~ 1150 | Bruce Liu

6 2) Determine P_{true}, $P_{reactive}$, $P_{apparent}$, and power factor for the circuit in Figure 15-102. Draw the power triangle.



equations

$P_{apparent} = i^2 Z$

$P_{reactive} = i^2 X_C$

$P_{true} = i^2 R$

$PF = \cos\theta$

approch

going to find a thevenin equavelent circuit since the objective has no element analsys.

Use i_S and Z, R, X_C.

$$R_{3\parallel 2} = \frac{75 \times 100}{100 + 75} = \frac{7500}{175}$$

$$R_{3\parallel 2} = 42.857$$

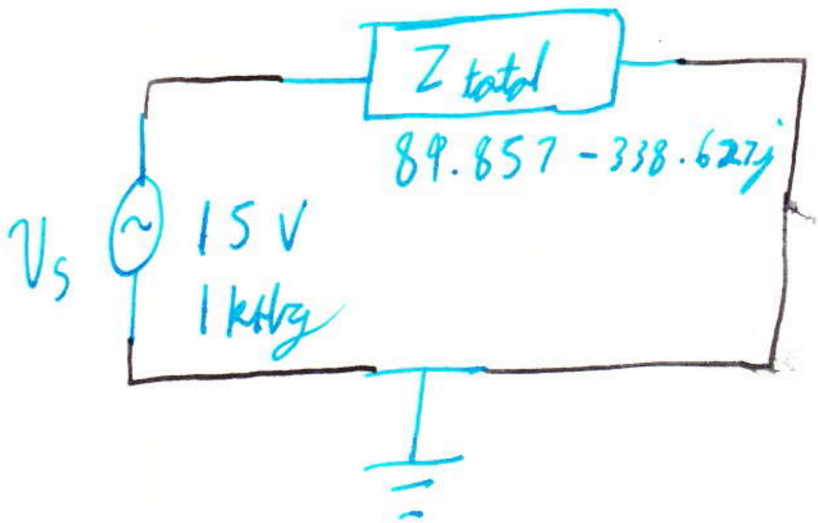
$$R_{3\parallel 2 + 1} = 89.857\ \Omega$$

$$X_C = \frac{-j}{2\pi f C} = \frac{-j}{2\pi (10^3)(4.7 \times 10^{-7})}$$

$$X_C = -338.6275j$$

$$Z_{total} = 89.857 - 338.627j$$

Thevinin equivalent circuit



$$V = iZ$$

$$\frac{V}{Z} = i$$

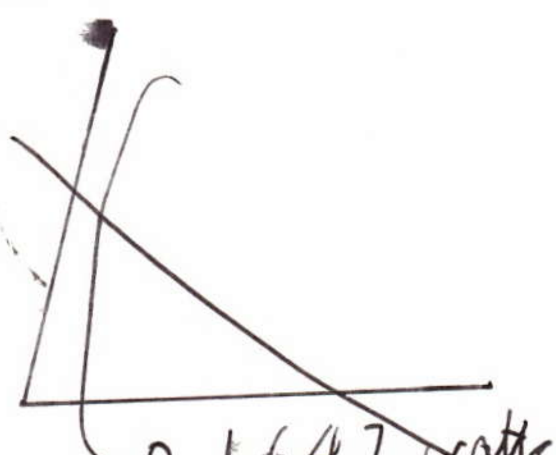
$$\frac{15}{89.857 - 338.627j} = 42.814 \angle 75.138° \text{ mA}$$

$$P_{apparent} = i_s^2 Z$$
$$P_{apparent} = (42.814 \times 10^{-3} \angle 75.138^\circ) \times (89.857 - 338.621j)$$
$$P_{apparent} = 0.64222 \angle 75.1386^\circ$$

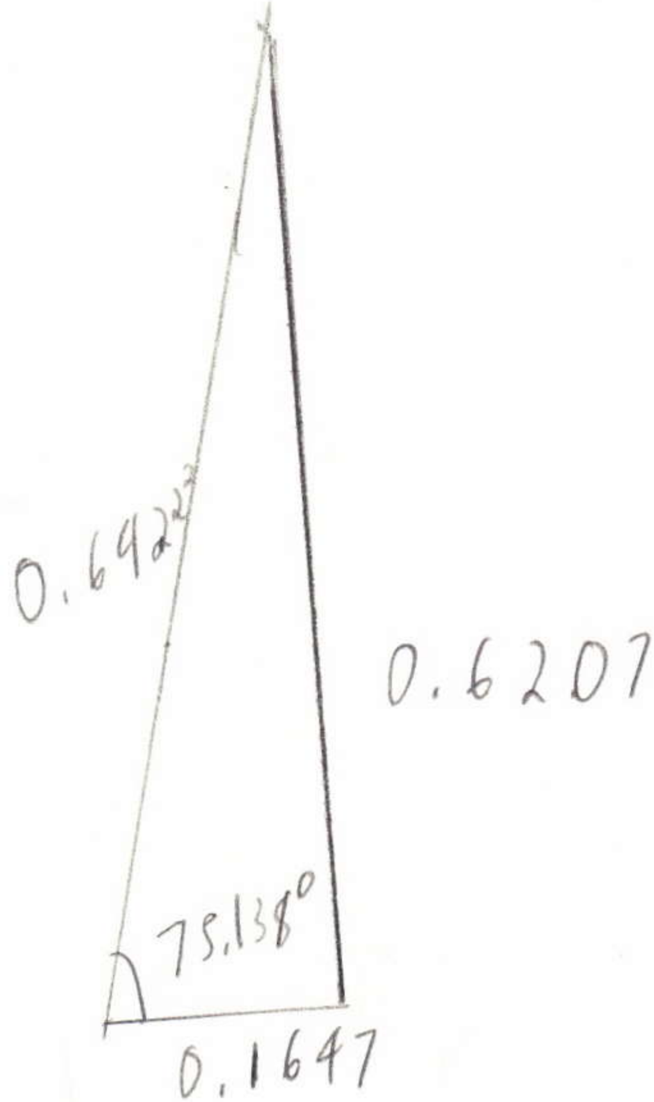
$$P_{real} = i_s^2 R$$
$$P_{real} = (42.814 \times 10^{-3} \angle 75.138^\circ) \times (89.857)$$
$$P_{real} = 0.164717 \angle 150.277^\circ$$

$$P_{reactive} = i_s^2 X_C$$
$$P_{reactive} = (42.814 \times 10^{-3} \angle 75.138^\circ)(-338.621j)$$
~~$P_{reactive} = 0.6207 \angle 60.277^\circ$~~

$$P_{reactive} = 0.6207 \angle 60.277^\circ$$



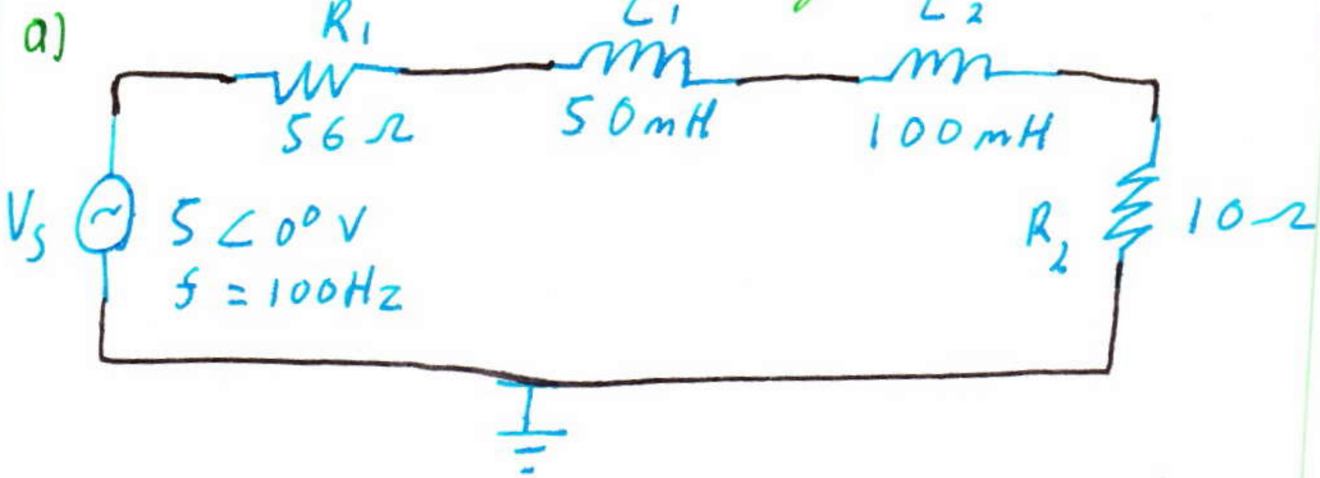
0.1647 watts

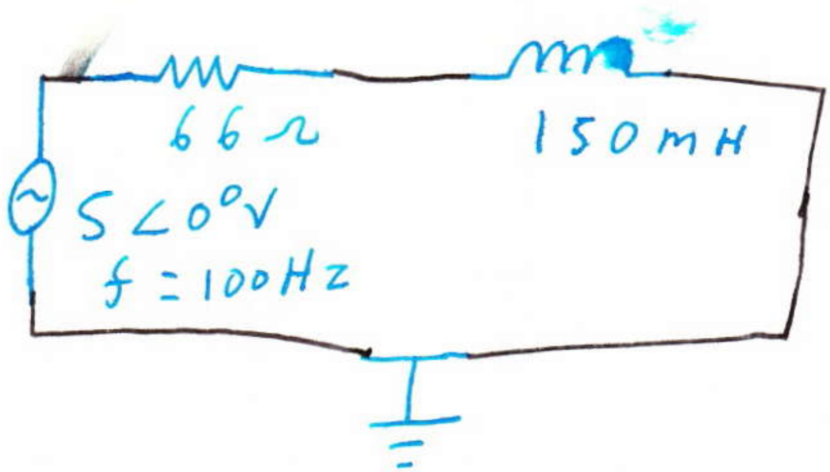


0.64223
0.6207
75.138°
0.1647

4) Determine the impedance magnitude and phase angle in each circuit in Figure 16-59. Draw the impedance diagrams.

a)





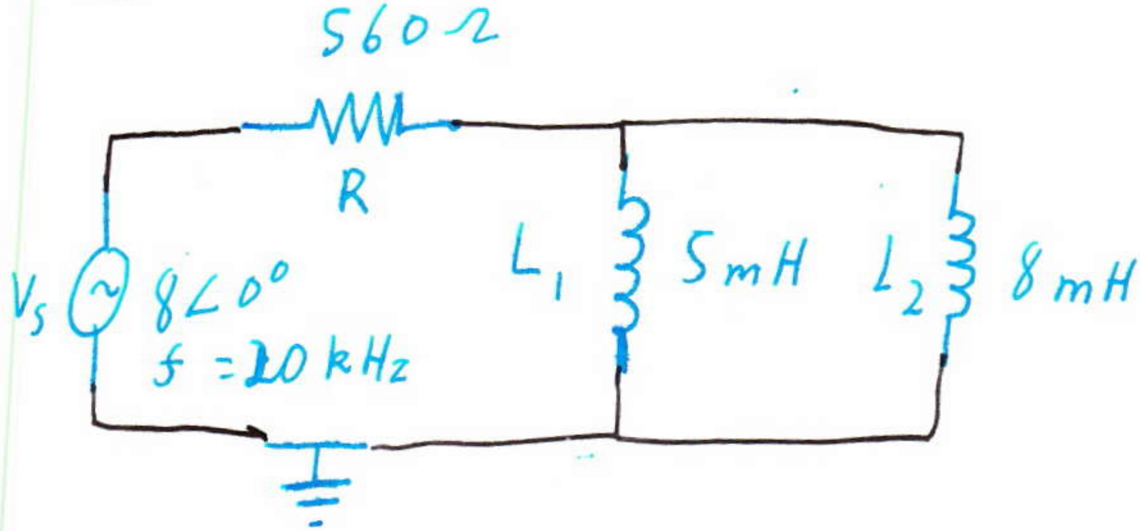
$$2\pi f L = 2\pi(100)(150 \times 10^{-3})$$

$$X_L = 94.247$$

$$Z = 66 + 94.247j$$

$$\boxed{Z = 115.058 \angle 54.996^\circ}$$

b)



$$\frac{5\times10^{-3}\,8\times10^{-3}}{5\times10^{-3}+8\times10^{-3}} = L_{total}$$

$$L_{total} = 3.0769\times10^{-3}\,H$$

$$X_L = 2\pi f L$$

$$X_L = 2\pi(20\times10^{3})\cancel{(20\times10^{-3})}$$

$$(3.0769\cancel{\times10^{-3}})$$

$$X_L = 3.865\times10^{2}$$

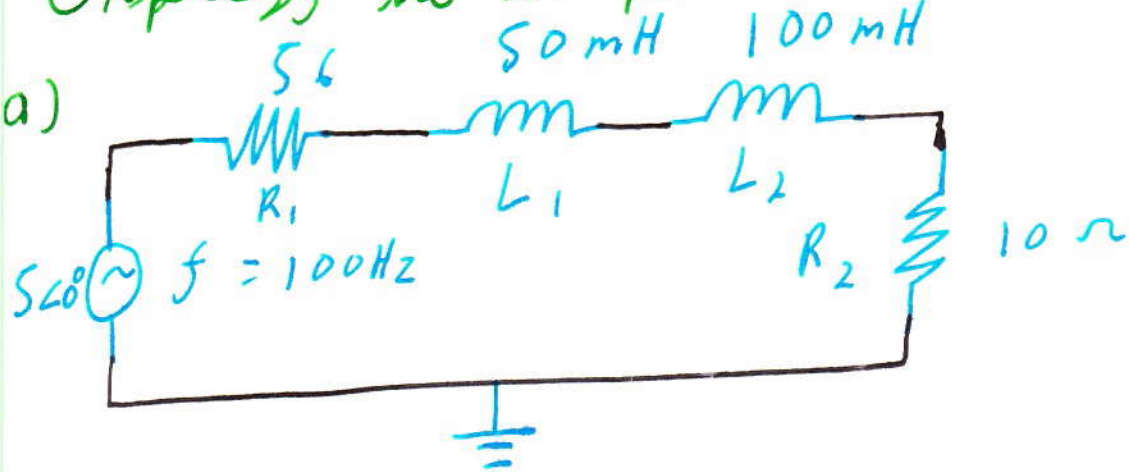
$$X_L = 386.5\,\Omega$$

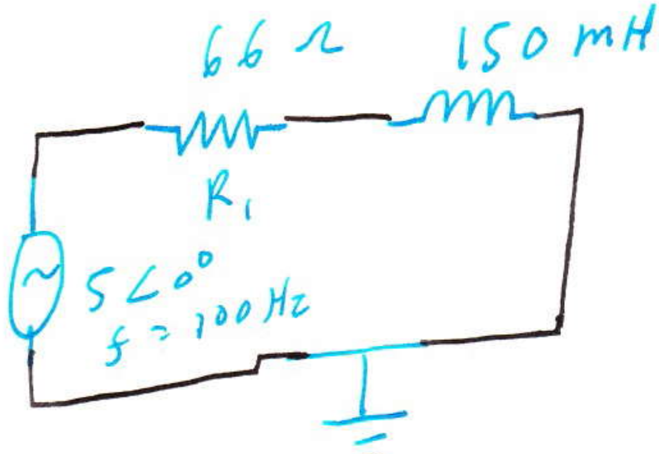
$$Z = 560 + 386.5j$$

$$\boxed{Z = 680.427 \angle 34.612^\circ}$$

11) Calculate the total current in each circuit of Figure 16 - 59 and express ~~it~~ in polar form.

a)





$$2\pi f L = X_L$$

$$X_L = 2\pi(100)(150\times10^{-3})$$

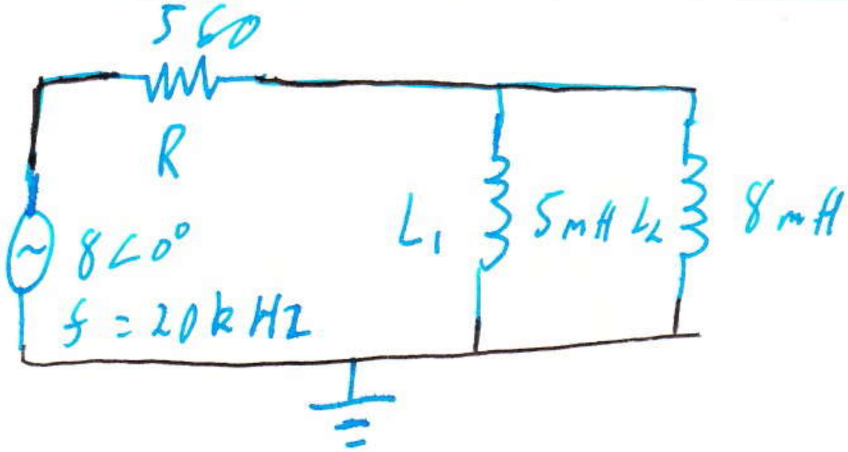
$$X_L = 94.247$$

$$Z = 66 + 94.247j$$

$$\frac{V}{Z} = i \qquad i = \frac{5}{66+94.247j}$$

$$\boxed{i = 43.456\angle -54.996^\circ \text{ mA}}$$

all elements have same current series



$$X_{L_1} = 2\pi f L = 2\pi(20\times10^{3})(5\times10^{-3})$$

$$X_{L_1} = 628.318\ \Omega$$

$$X_{L_2} = 2\pi(20\times10^{3})(8\times10^{-3})$$

$$X_{L_2} = 1005.309\ \Omega$$

$$\frac{X_{L_1}\,X_{L_2}}{X_{L_1}+X_{L_2}} = X_{L_{Total}}$$

$$X_L = \frac{628.318 \times 1005.309}{628.318 + 1005.309}$$

$$X_L = 861.001j\Omega$$

$$Z = 560 + 861.001j\Omega$$

$$\frac{V}{Z} = i$$

$$\frac{8\angle 0^\circ}{560 + 860.001j} = i$$

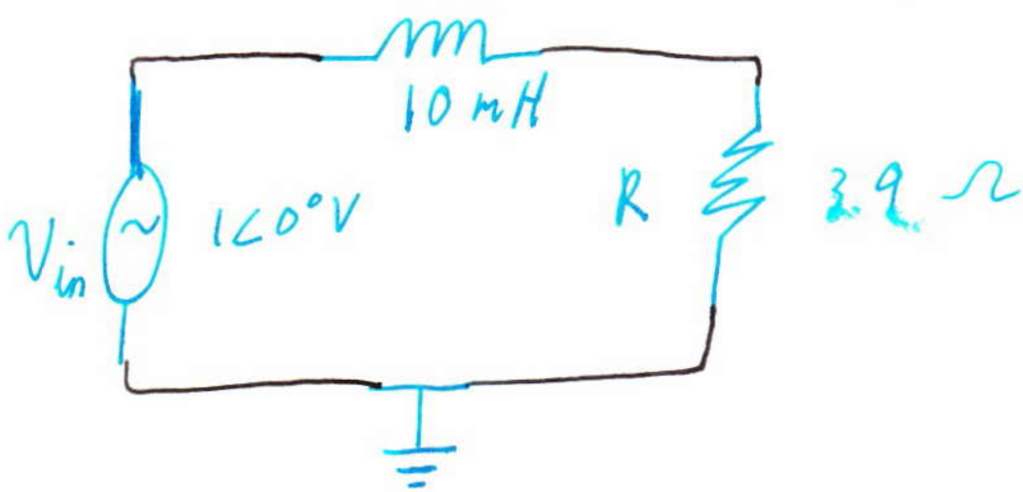
$$\cancel{i = 9.291\,m}$$

$$\cancel{i = 991.429}$$

$$\boxed{i = 532.812 \angle 32.005^\circ}$$

17) For the lag circuit in Figure 16-65, determine the phase lag of the output voltage with respect to the input for the following frequencies.

a) 1 Hz d) 10 kHz



$$X_L = 2\pi f L$$

$$X_L = 2\pi f L$$

$$-\tan^{-1}\left(\frac{X_L}{R}\right) = \theta$$

$$X_L = 2\pi(1)(10\times10^{-3})$$

$$X_L = 2\pi(10^{-2})$$

$$-\tan^{-1}\left(\frac{2\pi(10^{-2})}{39}\right) = \theta$$

$$\boxed{-0.092^\circ = \theta \quad a)}$$

$$X_L = 2\pi f L$$

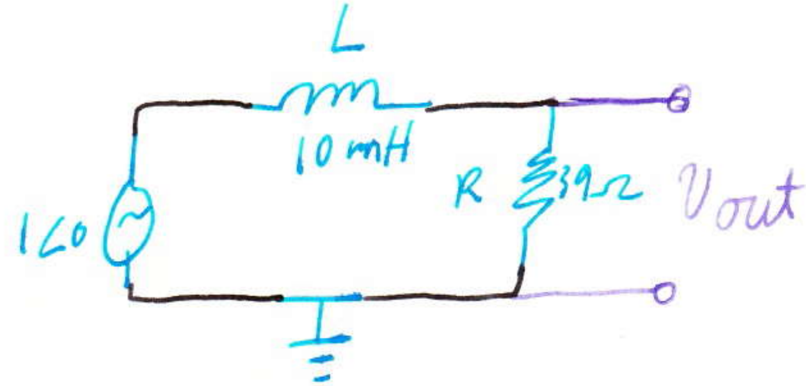
$$X_L = 2\pi\, \cancel{10^3} \times 10 \times \cancel{10^{-3}}$$

$$X_L = 2\pi 10$$

$$-\tan^{-1}\left(\frac{2\pi 10}{39}\right) = \theta$$

$$\boxed{\theta = -58.171}$$

19) express V_{out} in Figure 16-66 in polar form for each frequency in problem 17.



b) 100 Hz

c) 10^3 Hz

b)

$$X_L = 2\pi(\cancel{100})(10\times10^{-3})$$

$$\cancel{10^{-2}}$$

$$X_L = 2\pi$$

$$Z = 39 + 2\pi j$$

$$V_{out} = \frac{39}{39+2\pi j} 1\angle 0^\circ = \frac{R}{Z} V_s$$

$$V_{out} = 0.987 \angle -91.521^\circ$$

c)

$X_L = 2\pi f L$

$X_L = 2\pi \times 10^3 \times 10 \times 10^{-3}$

$X_L = 20\pi$

$Z = 39 + 20\pi j$

$V_{out} = \frac{39}{39 + 20\pi j} 1 = \frac{R}{Z} V_s$

$V_{out} = 0.527 \angle -58.171°$

28) $I_T = i_{R_1} + i_{L_1} + i_{(R_2+R_3)}$

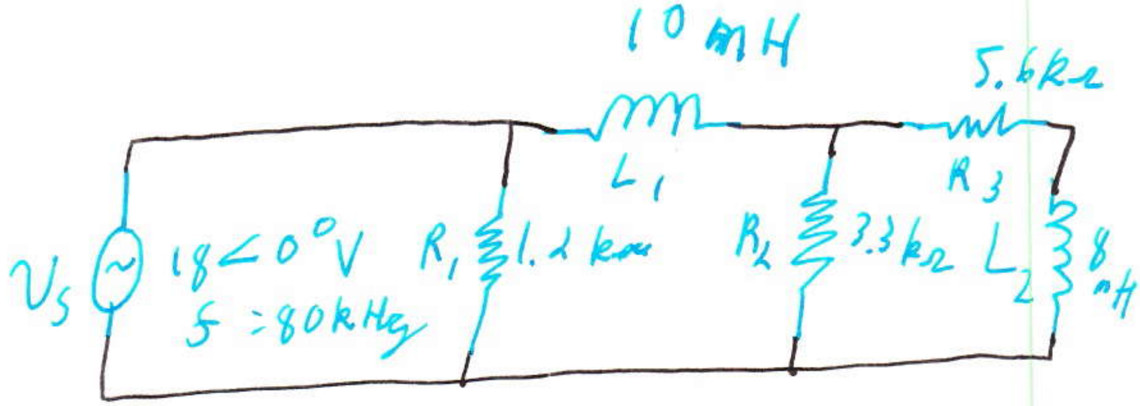
$$I_T = (5 + 8.3 + 3) \times 10^{-3}$$

$$\boxed{I_T = 16.3 \times 10^{-3}\ A}$$

cannot be correct
because of inductor.

32) For the circuit in Figure 16-73, determine the following:

a) I_{total}



b) θ

c) V_{R_1}

d) V_{R_2}

e) V_{R_3}

f) V_{L_1}

g) V_{L_2}

$$X_{L_1} = 2\pi f L$$

$$X_{L_1} = 2\pi(10\cancel{\times 10^{-3}})(80\cancel{\times 10^{3}})$$

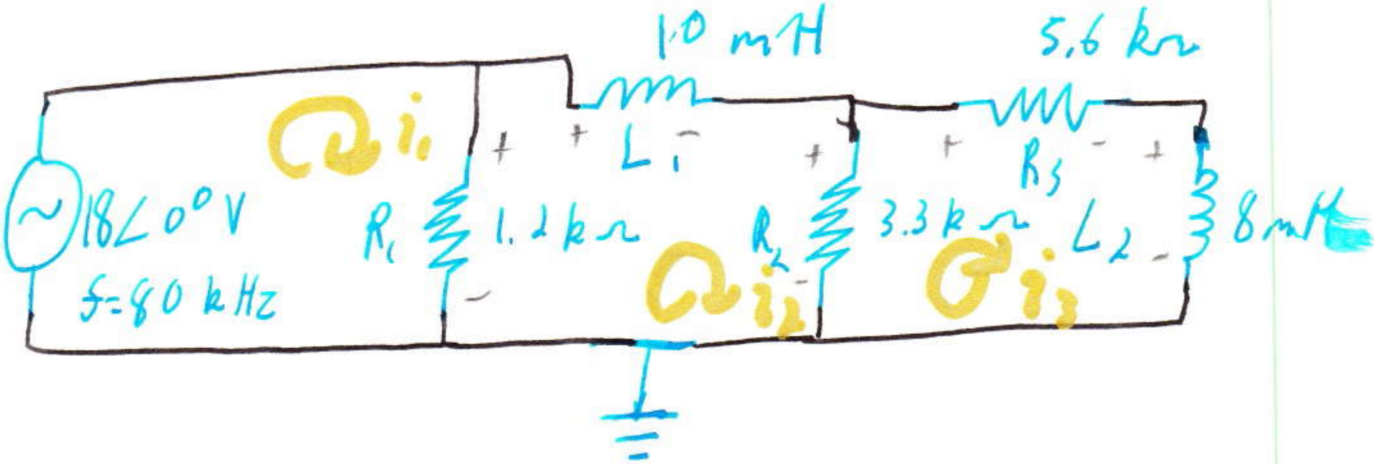
$$X_{L_1} = 2\pi(800)$$

$$X_{L_1} = 5026.548j$$

$$X_{L_2} = 2\pi(80\cancel{\times 10^{3}})(8\cancel{\times 10^{-3}})$$

$$X_{L_2} = 2\pi 640$$

$$X_{L_2} = 4021.238j$$



$\cancel{0 = i_1 R_1}$

$0 = (i_1 - i_2) R_1 - 18$

$0 = (i_2 - i_1) R_1 + (i_2 - i_1) L_1 +$
$(i_2 - i_3) R_2$

$0 = (i_3 - i_2) R_2 + (i_3) R_3 +$
$i_3 (L_2)$

$$\begin{array}{ccc} i_1 & i_2 & i_3 \end{array}$$

$$\begin{bmatrix} R_1 & -R_1 & 0 \\ -R_1 & R_1+L_1+R_2 & -R_2 \\ 0 & -R_2 & R_2+R_3+L_2 \end{bmatrix} \begin{bmatrix} 18 \\ 0 \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} 1200 & -1200 & 0 \\ & & (3.3\,k\Omega) \\ -1200 & (1200+5026.548j+3300) & \\ 0 & 3300 & (3300+5600+4021.238j) \end{bmatrix} \begin{bmatrix} 18 \\ 0 \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} 1200 & -1200 & 0 \\ -1200 & (4500+5026.548j) & (3300) \\ 0 & 3300 & 8900+4021.238j \end{bmatrix} \begin{bmatrix} 18 \\ 0 \\ 0 \end{bmatrix}$$

$$\dot{i}_1 = 0.01891706 - 0.00204913j$$

$$\dot{i}_2 = 0.00391706 - 0.00204913j$$

$$\dot{i}_3 = -0.00092105 + 0.00117596j$$

$$\dot{i}_1 = 0.19028 \times 10^{-3} \angle -61.823^\circ$$

$$\dot{i}_2 = 4.4207 \times 10^{-3} \angle -27.615^\circ$$

$$\dot{i}_3 = 1.4937 \times 10^{-3} \cancel{\angle 128.07^\circ}$$

$$\angle 128.07^\circ$$

a).

$$\dot{i}_{total} = \dot{i}_1 + \dot{i}_2 + \dot{i}_3$$

$$\dot{i}_{total} = (0.19028 \times 10^{-3} \angle -61.823^\circ) + (4.4207 \times 10^{-3} \angle -27.615^\circ) + (1.4937 \times 10^{-3} \angle 128.07^\circ)$$

$$\cancel{\dot{i}_{total} = 1.9908}$$

$$\boxed{\dot{i}_{total} = 0.19908 \times 10^{-3} \angle 53.006^\circ}$$

~~b) ∠~~

$$\boxed{b)\ 53.006^\circ}$$

c) $V_{R_1} = R_1(i_1 - i_2)$

$$V_{R_1} = 1200\,(0.19028\times10^{-3}\angle{-61.823^\circ} - 4.4207\times10^{-3}\angle{-27.615^\circ})$$

$$\boxed{V_{R_1} = 23.391\angle 74.929^\circ}$$

d) $v_{R_2} = R_2(i_2 - i_3)$

$$v_{R_2} = 3300\,(4.4207\times10^{-3}\angle{-27.615^\circ} - 1.4937\times10^{-3}\angle 128.07^\circ)$$

$\cancel{v_{R_2} = 1.918}$

$$\boxed{v_{R_2} = 19.183\angle{-33.685^\circ}}$$

e)

$$V_{R_3} = R_3 \, i_3$$

$$V_{R_3} = 5600 \times 1.4937 \times 10^{-3} \angle 128.07^\circ$$

$$\boxed{V_{R_3} = 8.3608 \angle 128.07^\circ}$$

f) $$V_{L_1} = X_{L_1} \, i_2$$

$$V_{L_1} = 5026.548j \times (4.4207 \times 10^{-3} \angle -27.615^\circ)$$

$$\boxed{V_{L_1} = 22.217 \angle 62.385^\circ}$$

g)

$$V_{L_2} = X_{L_2}\, i_3$$

$$V_{L_2} = 4021.236j \times (1.4937\times10^{-3}\angle 128.07^\circ)$$

$$\boxed{V_{L_2} = 6.0037\angle -141.93^\circ}$$

41) Determine P_{true}, $P_{reactive}$, $P_{apparent}$ and PF for the circuit in Figure 16-73. Sketch the power triangle.

$p = iV$

$\cancel{V = 180\angle 0^\circ}$

$V = 18\angle 0^\circ$

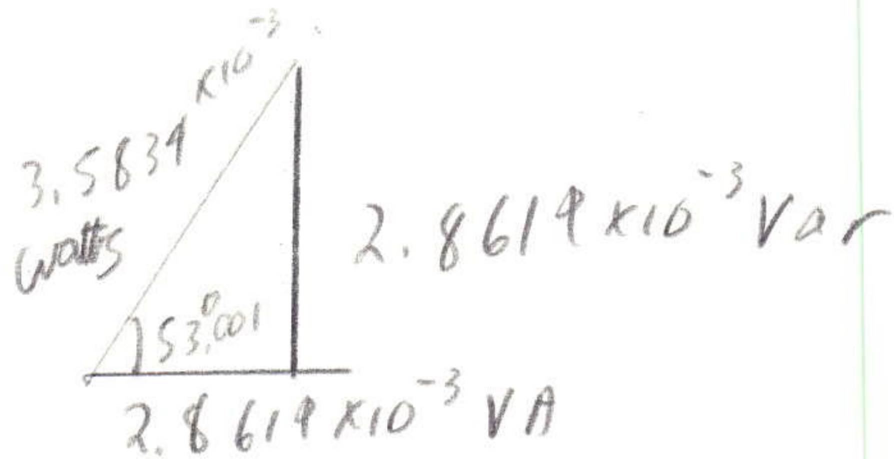
$i_{total} = 0.1.9908 \times 10^{-3} \angle 53.001^\circ$

$P_{true} = 2.1565 \times 10^{-3}$

$P_{reactive} = 2.8619 \times 10^{-3}$

$P_{apparent} = 3.5834 \times 10^{-3}$

$pf = 53.001^\circ$


3.5839 x10^-3 watts
2.8619 x10^-3 Var
53.001°
2.8619 x10^-3 VA