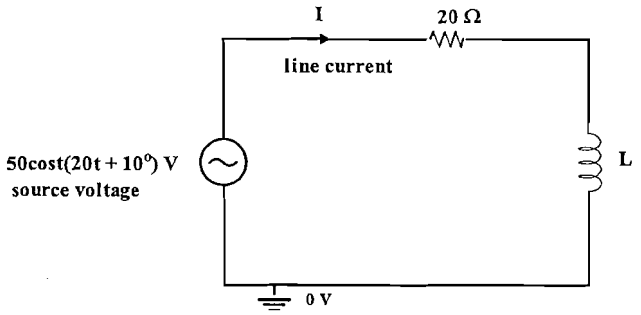
ECE 301
Test 3A
Fall 2007

(1) You are given the circuit of Figure 1 with the indicated source voltage and line current. The line current is know to be; $\mathbf{I} = 1.77\angle -35^\circ$ A. Determine the approximate value of the inductance L.



$$Z = \frac{\vec{V}}{\vec{I}}$$

where $\vec{V} = 50\angle 10^\circ V$, $\vec{I} = 1.77\angle -35^\circ A$

$$Z = \frac{50\angle 10}{1.77\angle -35} = 28.25\angle 45$$

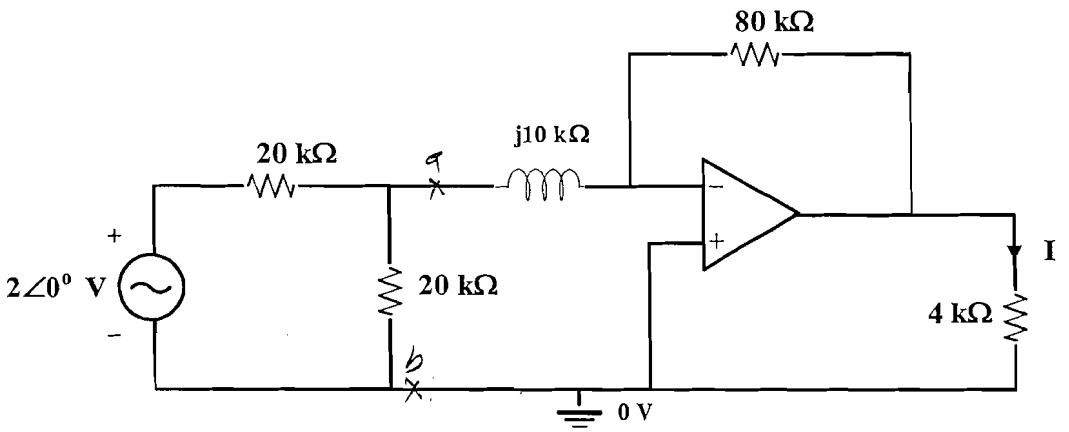
$$Z = R + jwL = 20 + jwL = 19.99 + j19.99$$

$$wL = 19.99$$

$$L = \frac{19.99}{20} \doteq 1\ H$$

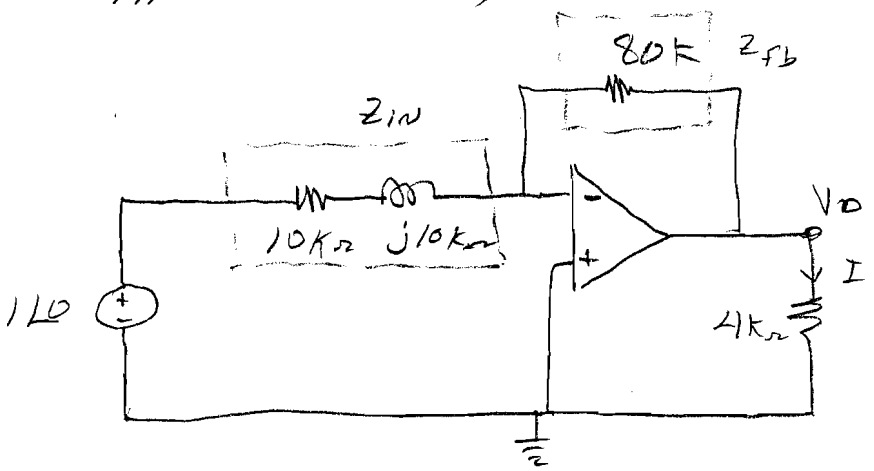
3A

(2) You are given the op-amp circuit of Figure 2. Determine the phasor current **I** shown in the diagram. Express your answer in polar form.



Thevenin to the left of a-b

$V_{TH} = 1\angle 0^\circ$; $R_{TH} = 10k\Omega$



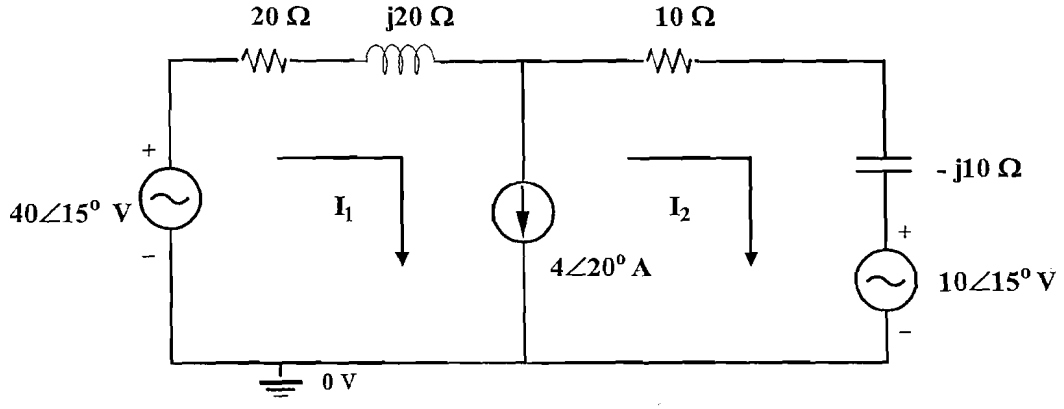
$$\hat{V}_o = -1\angle 0^\circ \times \frac{80k}{10k + j\,10k} = -\frac{8}{1+j}$$

$$\hat{I} = \frac{\hat{V}_o}{4k} = -\frac{2}{1+j}\ mA$$

$$\hat{I} = 1.414\angle 135^\circ\ mA$$

3A

(3) You are given the AC circuit shown in Figure 3. Use mesh analysis to find the mesh currents $\mathbf{I}_1$ and $\mathbf{I}_2$ as indicated in the circuit diagram. Express $\mathbf{I}_1$ and $\mathbf{I}_2$ in polar form.



Around the supermesh:

$$-40\angle 15 + (20+j20)\hat{I}_1 + (10-j10)I_2 + 10\angle 15 = 0$$

$$(20+j20)I_1 + (10-j10)I_2 = 40\angle 15 - 10\angle 15$$

$$= 40\angle 15 + 10\angle -165$$

OR

$$30\angle 15$$

Constraint

$$I_1 - I_2 = 4\angle 20$$

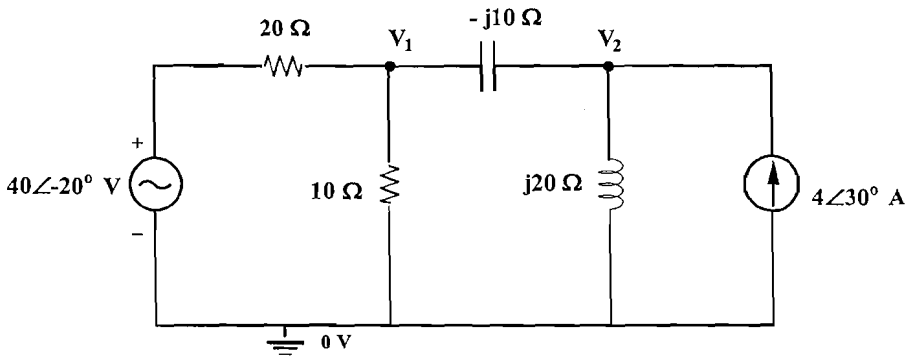
$$\begin{bmatrix} (20+j20) & (10-j10) \\ 1 & -1 \end{bmatrix} \begin{bmatrix} \hat{I}_1 \\ \hat{I}_2 \end{bmatrix} = \begin{bmatrix} 30\angle 15 \\ 40\angle 15 + 10\angle -165 \\ 4\angle 20 \end{bmatrix}$$

$$\hat{I}_1 = 2.59\angle -29.8^\circ \text{ A} \qquad \hat{I}_2 = 3.06\angle -119.7^\circ \text{ A}$$

(4) You are given the AC circuit shown in Figure 4.

(a) Use nodal analysis to find the node voltages $\mathbf{V}_1$ and $\mathbf{V}_2$ as indicated in the circuit diagram. Express $\mathbf{V}_1$ and $\mathbf{V}_2$ in polar form.

(b) Prepare a phasor diagram showing $\mathbf{V}_1$ and $\mathbf{V}_2$. Which voltage is leading? Explain.



At node V_1

$$\frac{V_1 - 40\angle -20}{20} + \frac{V_1}{10} + \frac{V_1 - V_2}{-j10} = 0$$

$$0.05V_1 + 0.1V_1 + j0.1V_1 - j0.1V_2 = 2\angle -20$$

$$(0.15 + j0.1)V_1 + (0 - j0.1)V_2 = 2\angle -20$$

At node V_2

$$\frac{V_2 - V_1}{-j10} + \frac{V_2}{j20} = 4\angle 30$$

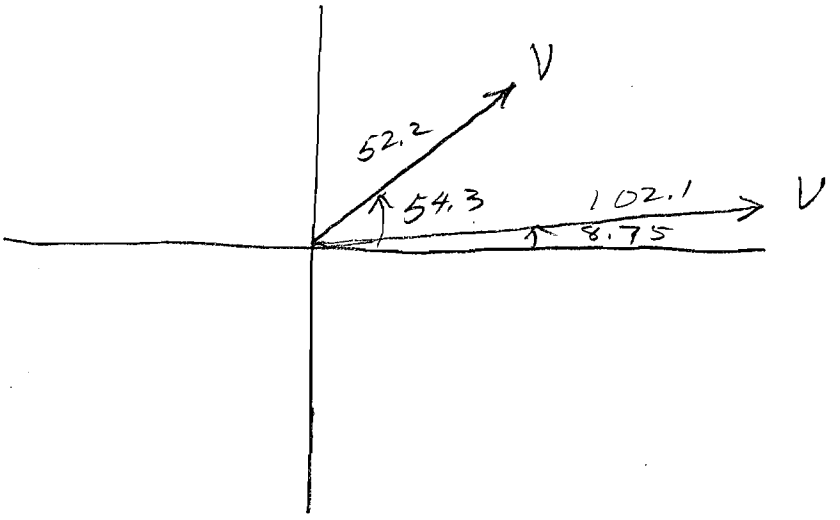
$$j0.1V_2 - j0.1V_1 - j0.05V_2 = 4\angle 30$$

$$(0 - j0.1)V_1 + (0 + j0.05)V_2 = 4\angle 30$$

$$\begin{bmatrix} (0.15+j0.1) & (0-j0.1) \\ (0-j0.1) & (0+j0.05) \end{bmatrix} \begin{bmatrix} \hat{V}_1 \\ \hat{V}_2 \end{bmatrix} = \begin{bmatrix} 2\angle -20 \\ 4\angle 30 \end{bmatrix}$$

$\hat{V}_1 = 52.2\angle 54.3°$ V $\hat{V}_2 = 102.1\angle 8.75°$ V

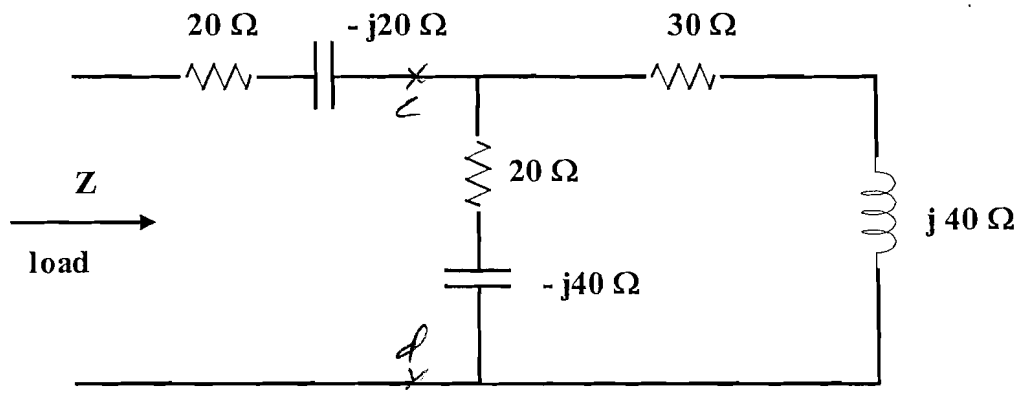
(4) (b)



V_1 leads V_2 by $54.3 - 8.75 = 45.6°$
The reason is that angle of V_1 is greater than the angle of V_2

3A

(5) The load for a certain AC circuit is shown in Figure 5.
(a) Find the impedance of this load, **Z**, as indicated in the diagram. Express your answer in polar form.
(b) Determine whether this is a leading or lagging load. Explain your answer.



1a)

$$Z_{cd} = \frac{(30+j40)(20-j40)}{30+j40+20-j40} = \frac{(30+j40)(20-j40)}{50}$$

$$Z = 20-j20 + Z_{cd}$$

$$Z = 64-j28\ \Omega$$

$$Z = 69.86\angle -23.6^\circ\ \Omega$$

1b) lagging load, angle of Z is negative.