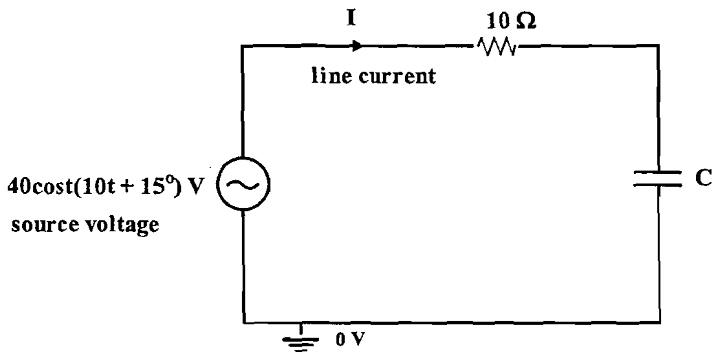
3B

ECE 301
Test 3B
FAll 2007

W & V

(1) You are given the circuit of Figure 1 with the indicated source voltage and line current. The line current is know to be; $\mathbf{I} = 2.83\angle 60^\circ$ A. Determine the approximate value of the capacitor C.



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

where $\vec{V} = 40\angle 15^\circ$ V $\quad \vec{I} = 2.83\angle 60^\circ$ A

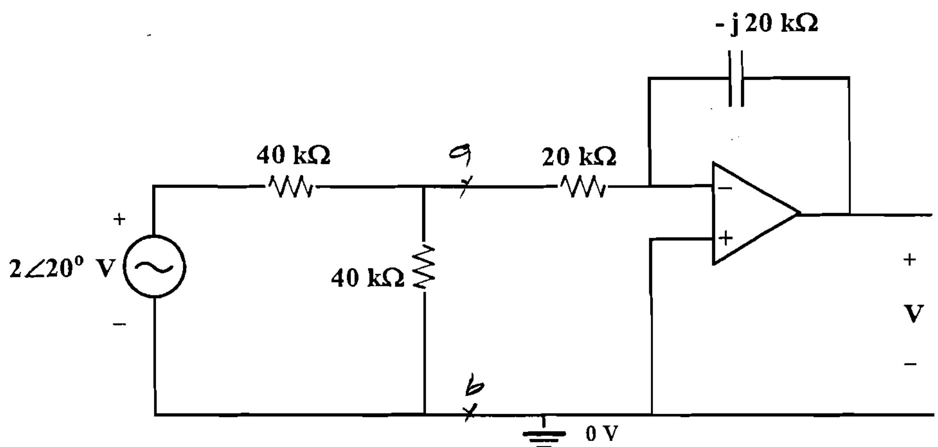
$$\vec{Z} = \frac{40\angle 15^\circ}{2.83\angle 60^\circ} = 9.99 - j\,9.99$$

$$Z = R + \frac{1}{j\omega C} = 10 - \frac{j}{\omega C}$$

$$\frac{-j}{\omega C} = -j\,9.99$$

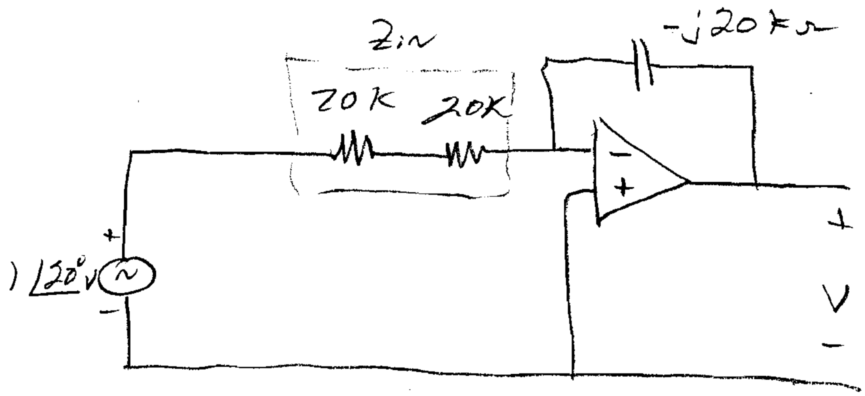
$$C \doteq \frac{1}{10 \times 10} \doteq 0.01 \text{ F}$$

(2) You are given the op-amp circuit of Figure 2. Determine the phasor output voltage **V** as shown in the circuit diagram. Express **V** in polar form.



Thevenin to the left of a-b

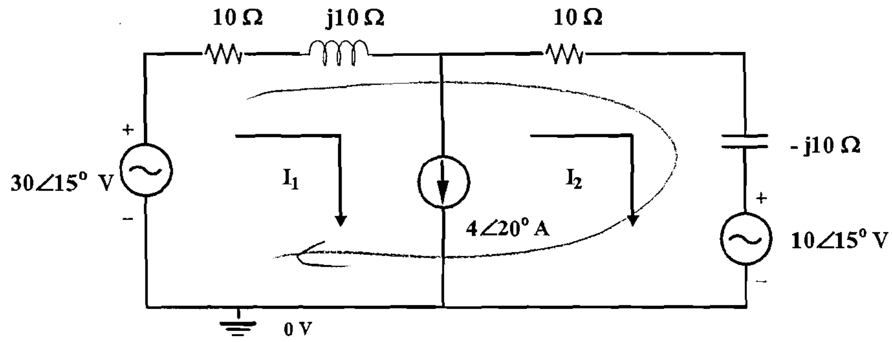
$V_{TH} = 1\angle 20° \, V$; $R_{TH} = 20k\Omega$



$$\vec{V} = -1\angle 20° \times \frac{Z_{fb}}{Z_{in}} = \frac{1\angle -160 \, (20\angle -90)\,k}{40\,k}$$

$$\vec{V} = 0.5 \angle 110° \, V$$

(3) You are given the AC circuit shown in Figure 3. Use mesh analysis to find the mesh currents I_1 and I_2 as indicated in the circuit diagram. Express I_1 and I_2 in polar form.



Supermesh

$$-30\angle 15 + (10+j10)I_1 + (10-j10)I_2 + 10\angle 15 = 0$$

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

Constraint

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

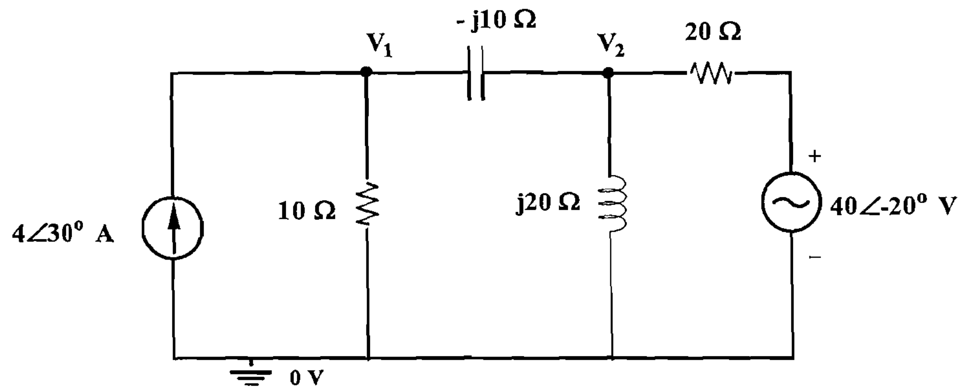
$$\begin{bmatrix} (10+j10) & (10-j10) \\ 1 & -1 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 20\angle 15 \\ 4\angle 20 \end{bmatrix}$$

$I_1 = 3.65\angle -14.9^\circ$ A $\qquad I_2 = 2.32\angle -95.7^\circ$ 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

$$\frac{V_1}{10} + \frac{V_1 - V_2}{-j10} = 4\angle 30$$

$$0.1V_1 + j0.1V_1 - j0.1V_2 = 4\angle 30$$

$$(0.1 + j0.1)V_1 + (0 - j0.1)V_2 = 4\angle 30$$

At node V_2

$$\frac{V_2 - V_1}{-j10} + \frac{V_2}{j20} + \frac{V_2 - 40\angle -20}{20} = 0$$

$$j0.1V_2 - j0.1V_1 - j0.05V_2 + 0.05V_2 = 2\angle -20$$

$$(0 - j0.1V_1) + (0.05 + j0.05)V_2 = 2\angle -20$$

$$\begin{bmatrix} (0.1+j0.1) & (0-j0.1) \\ (0-j0.1) & (0.05+j0.05) \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} 4\angle 30 \\ 2\angle -20 \end{bmatrix}$$

$V_1 = 34.11\angle 27.9°\ V$ $\qquad$ $V_2 = 33.19\angle 38.1°\ V$

(4)

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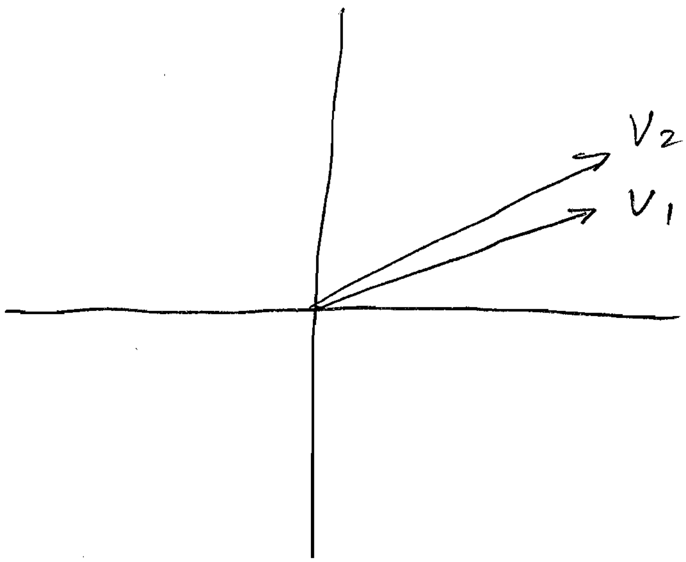
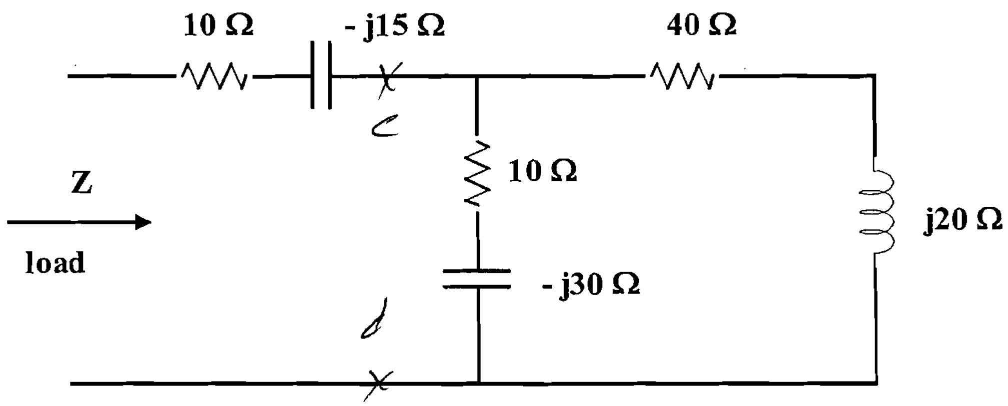


V_2 leads V_1 by $38.1 - 27.9 = 10.2°$

(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 **Z** in polar form.

(b) Determine whether this is a leading or lagging load. Explain your answer.



$$Z_{cd} = \frac{(40+j20)(10-j30)}{40+j20+10-j30} = \frac{(40+j20)(10-j30)}{(50-j10)}$$

$$Z = 10 - j15 + Z_{cd}$$

$$Z = 44.9 \angle -42.6^\circ \ \Omega$$