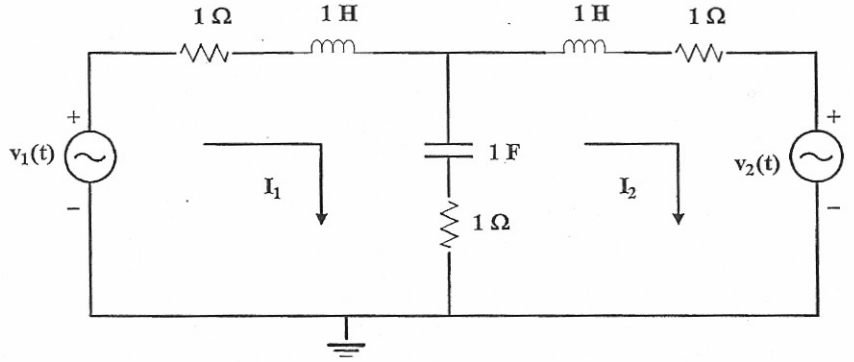
H.W. # 9

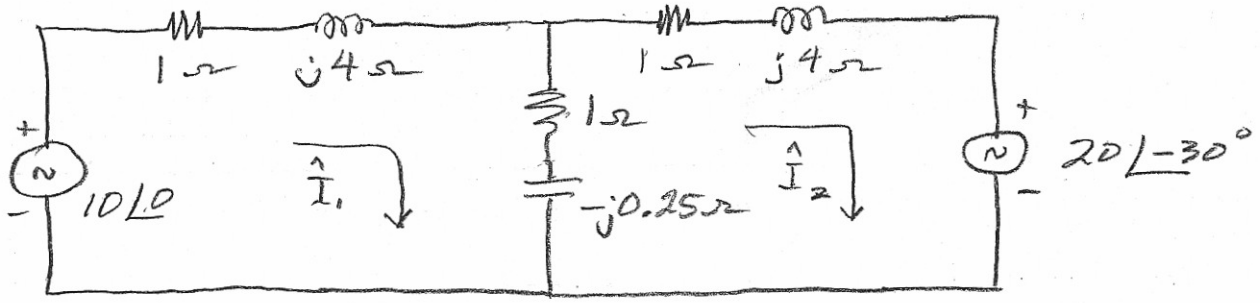
(1) For the circuit in Figure 9.1 $v_1(t)$ 10cos4t , V; $v_2(t) = 20\cos(4t\text{-}30^\circ)$, V. Find the phasor currents $\mathbf{I_1}$ and $\mathbf{I_2}$ and $i_1(t)$ Ans: $I_1 = 2.74\angle -41.07^\circ\ A,\ I_2 = 4.11\angle 92^\circ\ A,\ i_1(t) = 2.74\cos(4t - 41.07)\ A$



Generate the phasor circuit.

$\omega = 4$; $1H$: $j\omega L = j4\ \Omega$

$1F$: $\frac{-j}{\omega C} = \frac{-j}{4\times 1} = -j0.25\ \Omega$



$(1+j4)\hat{I}_1 + (1-j0.25)(\hat{I}_1 - \hat{I}_2) = 10\angle 0$

$(2+j3.75)\hat{I}_1 + (-1+j0.25)\hat{I}_2 = 10\angle 0$

$(1+j4)\hat{I}_2 + (1-j0.25)(\hat{I}_2 - \hat{I}_1) = -20\angle -30^\circ$

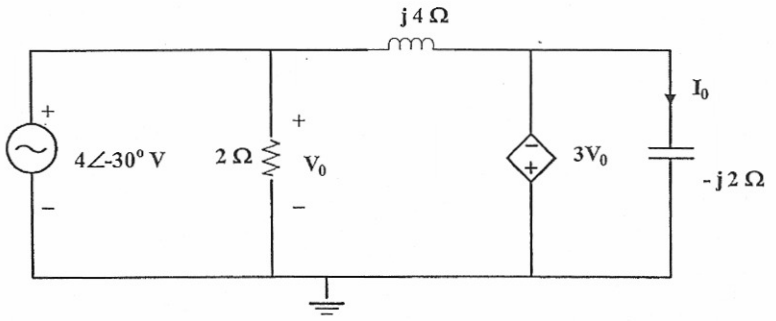
$(-1+j0.25)\hat{I}_1 + (2+j3.75)\hat{I}_2 = -20\angle -30^\circ$

$\hat{I}_1 = 2.07 - j1.8 = 2.72\angle -41.4$

$\hat{I}_2 = -0.144 + j4.11 = 4.11\angle 92^\circ\ A$

$i_1(t) = 2.72\cos(4t - 41.4^\circ)\ A$

(2) Determine V_0 and I_0 in the following circuit. Ans: $I_0 = 8.49\angle 15^\circ\ A$; $V_0 = 5.66\angle -75^\circ\ V$



Obviously, with the circuit above,

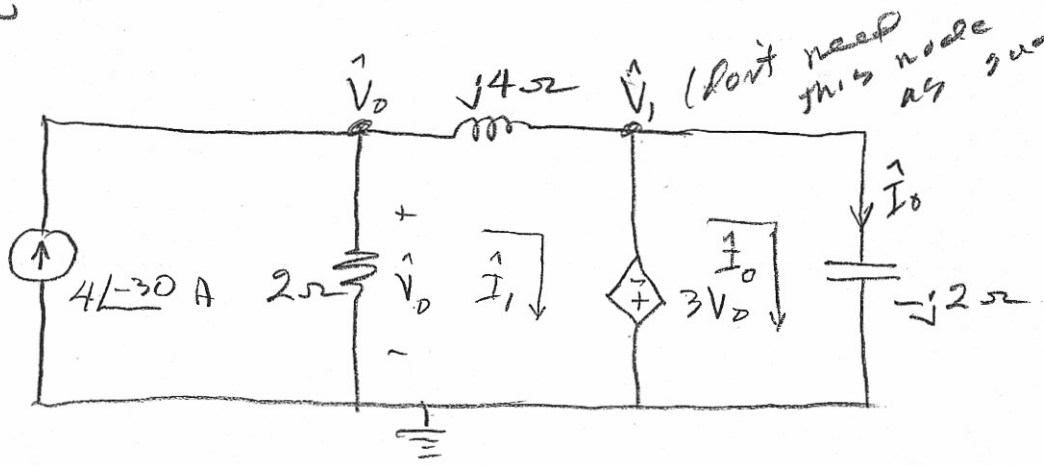
$$\hat{V}_0 = 4\angle -30^\circ$$

The voltage across the capacitor is

$$-3\hat{V}_0 = -12\angle -30$$

$$\therefore \hat{I}_0 = \frac{-12\angle -30}{-j2} = 6\angle -120^\circ\ A.$$

The problem is, the voltage source should have been a current source As below



(2) continued (2)

At $\vec{V}_1$

$$(\times 4) \quad \frac{\vec{V}_0}{2} + \frac{4\vec{V}_0}{j4} = 4\angle -30$$

$$2\vec{V}_0 - j4\vec{V}_0 = 16\angle -30$$

$$(2 - j4)\vec{V}_0 = 16\angle -30$$

$$\vec{V}_1 = 3.58\angle 33.43^\circ$$

$$\vec{I} = \frac{-3V_0}{-j2} = \frac{3 \times 3.58\angle 33.43}{j2} = \frac{10.74\angle 33.43}{j2}$$

$$\vec{I} = 5.37\angle -56.5 = \vec{I}_0$$

Now work the problem by mesh, using $\vec{I}_1$ & $\vec{I}_2$ As shown in the circuit.

Go around the second mesh:

$$3V_0 - j2I_0 = 0 \qquad (1)$$

but $\vec{V}_0 = 8\angle -30 - 2I_1 \qquad (2)$

Put (2) into (1)

$$24\angle -30 - 6\vec{I}_1 - j2I_0 = 0$$

(2) cont.

$$-j2\vec{I}_o - 6\vec{I}_1 = -24\angle -30$$

or

$$\boxed{j2\vec{I}_o + 6\vec{I}_1 = 24\angle -30} \quad (A)$$

Now go around the two mesh:

$$2I_1 - 8\angle -30 + j4\vec{I}_1 - j2I_o = 0$$

$$\boxed{-j2I_o + (2+j4)\vec{I}_1 = 8\angle -30} \quad (B)$$

Solve (A) & (B)

$$\vec{I}_o = (2.96 - j4.48)\ A = 5.37\angle -56.5$$

$$\vec{I}_1 = (1.97 - j2.99)\ A \quad \text{check}$$

$$V_o = 8\angle -30 - 2I_1 = 8\angle -30 - 2(1.97 - j2.99)$$

$$V_o = 3.58\angle 33.52\ V \quad \text{check}$$