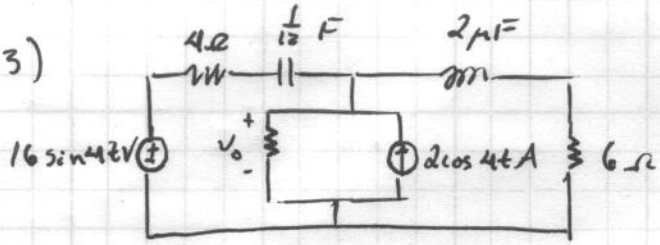
(10.3)



Determine v_o in the circuit.

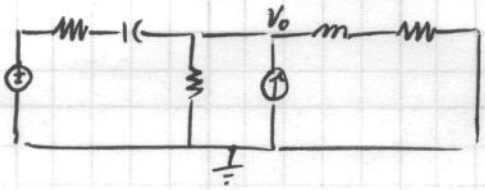
$\omega = 4$

$2\cos 4(t) = 2\angle 0$

$16\sin 4t = 16\angle -90 = -j16$

$2H = j\omega L = j8$

$\frac{1}{12} F = \frac{1}{j\omega c} = -j3$



Nodal Analysis: $\frac{-j16 - V_o}{4 - j3} + 2 = \frac{V_o}{1} + \frac{V_o}{6 + j8}$

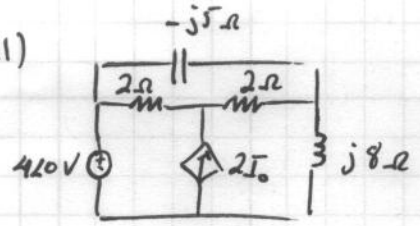
$\frac{-j16}{4-j3} + 2 = \left(1 + \frac{1}{4-j3} + \frac{1}{6+j8}\right) V_o$

$V_o = \frac{3.97 - j2.56}{1.22 + j0.04} = \frac{4.687\angle -33.15^\circ}{1.2207\angle 1.88^\circ}$

$= 3.835\angle -35.02^\circ$

$v_o(t) = \underline{3.835\cos(4t - 35.02^\circ)\ V}$

(10.11)



Determine I_o

Node 1: $\frac{V_1 - 420}{2} - 2I_o + \frac{V_1 - V_2}{2} = 0$

$V_1 - 0.5V_2 - 2I_o = 2$

$I_o = \frac{(4 - V_2)}{-j5} = -j0.2V_2 + j0.8$

$V_1 - 0.5V_2 + j0.4V_2 - j1.6 = 2$

$V_1 + (-0.5 + j0.4)V_2 = 2 + j1.6$

Node 2: $\frac{V_2 - V_1}{2} + \frac{V_2 - 4}{-j5} + \frac{V_2 - 0}{j8} = 0$

$-0.5V_1 + (0.5 + j0.075)V_2 = j0.8$

$$Y = \begin{bmatrix} 1 & -0.5 + j0.4 \\ -0.5 & 0.5 + j0.075 \end{bmatrix}$$

$$I = \begin{bmatrix} 2 + j1.6 \\ 0 + j0.8 \end{bmatrix}$$

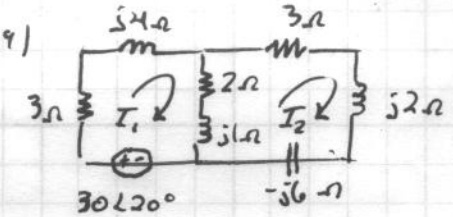
$V = Y^{-1} * I = \begin{matrix} 4.8597 + j0.0543 \\ 4.9955 + j0.9050 \end{matrix}$

$I_o = -j0.2V_2 + j0.8 = -j0.9992 + 0.01086 + j0.8$

$= 0.01086 - j0.1992$

$= 199.5 \angle 86.89° \text{ mA}$

(10.29)



Find I_1 and I_2 using mesh analysis.

mesh 1: $(5+j5)I_1 - (2+j)I_2 - 30\angle 20^\circ = 0$

$30\angle 20 = (5+j5)I_1 - (2+j)I_2$

mesh 2: $(5+j3-j6)I_2 - (2+j)I_1 = 0$

$0 = -(2+j)I_1 + (5-j3)I_2$

$$\begin{bmatrix} 30\angle 20 \\ 0 \end{bmatrix} = \begin{bmatrix} 5+j5 & -(2+j) \\ -(2+j) & (5-j3) \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$

$\Delta = 37 + j6$

$= 37.48\angle 9.21^\circ$

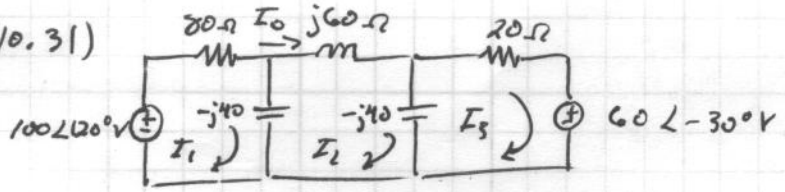
$\Delta_1 = (30\angle 20)(5.831\angle -30.96) = 175\angle -10.96^\circ$

$\Delta_2 = (30\angle 20)(2.356\angle 26.56^\circ) = 67.08\angle 46.56^\circ$

$I_1 = \frac{\Delta_1}{\Delta} = 4.67\angle -20.17^\circ A$

$I_2 = \frac{\Delta_2}{\Delta} = 1.79\angle 37.35^\circ A$

(10.31)



Loop 1: $-100\angle 120° + (80 - j40)I_1 + j40I_2 = 0$

$10\angle 120° = 4(2-j)I_1 + j4I_2$

Loop 2: $j40I_1 + (j60 - j80)I_2 + j40I_3 = 0$

$0 = 2I_1 - I_2 + 2I_3$

Loop 3: $60\angle -30° + (20 - j40)I_3 + j40I_2 = 0$

$-6\angle -30° = j4I_2 + 2(1-j2)I_3$

$2I_3 = I_2 - 2I_1$

Substituting:

$-6\angle -30° = -2(1-j2)I_1 + (1+j2)I_2$

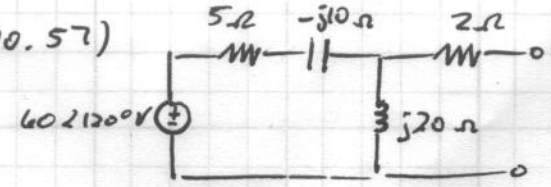
$$\begin{bmatrix} 10\angle 120 \\ -6\angle -30 \end{bmatrix} = \begin{bmatrix} 4(2-j) & j4 \\ -2(1-j) & 1+j2 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$

$$\Delta = \begin{bmatrix} 8-j4 & -j4 \\ -2+j4 & 1+j2 \end{bmatrix} = 32 + j20 = 37.74\angle 32°$$

$$\Delta_2 = \begin{bmatrix} 8-j4 & 10\angle 120° \\ -2+j4 & -6\angle -30° \end{bmatrix} = -4.928 + j82.11$$

$$I_o = I_2 = \frac{\Delta_2}{\Delta} = \underline{\underline{2.179\angle 61.44° \text{ A}}}$$

(10.57)



- Find the Thevenin and Norton equivalent circuits

$$Z_n = Z_{th} = 2 + j20 \,||\, (5 - j10) = 2 + \frac{(j20)(5-j10)}{5+j10}$$

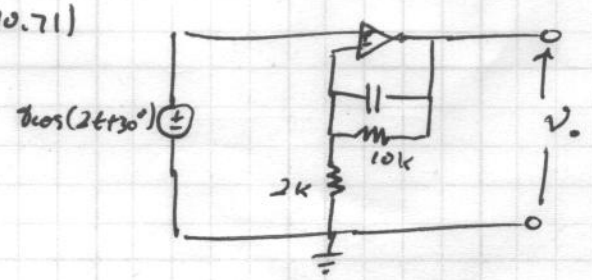
$$= 18 - j12 = \underline{\underline{21.63\angle -33.7^\circ\ \Omega}}$$

$$V_{th} = \frac{j20}{5-j10+j20}(60\angle 120^\circ) = \frac{j4}{1+j2}(60\angle 120^\circ)$$

$$= \underline{\underline{107.3\angle 146.56^\circ V}}$$

$$I_N = \frac{V_{th}}{Z_{th}} = \underline{\underline{4.961\angle -179.7^\circ A}}$$

(10.71)



Find v_o in the opamp circuit.

$8\cos(2t+30°) \longrightarrow 8\angle 30°$

$0.5\,\mu F \longrightarrow \frac{1}{j\omega c} = \frac{1}{(j2)(0.5)(10^{-6})} = -j\,1M\Omega$

Inverting Terminal: $\frac{V_o - 8\angle 30}{-j1000k} + \frac{V_o - 8\angle 30°}{10k}$

$= \frac{8\angle 30}{2k}$

$V_o(1 - j100) = 8\angle 30 + 800\angle -60° + 4000\angle -60°$

$V_o = \frac{6.928 + j4 + 2400 - j4157}{1 - j100} = \frac{4800\angle -59.9°}{100\angle -89.43°}$

$= 48\angle 29.53°$

$v_o(t) = \underline{\underline{48\cos(2t + 29.53°)\,V}}$