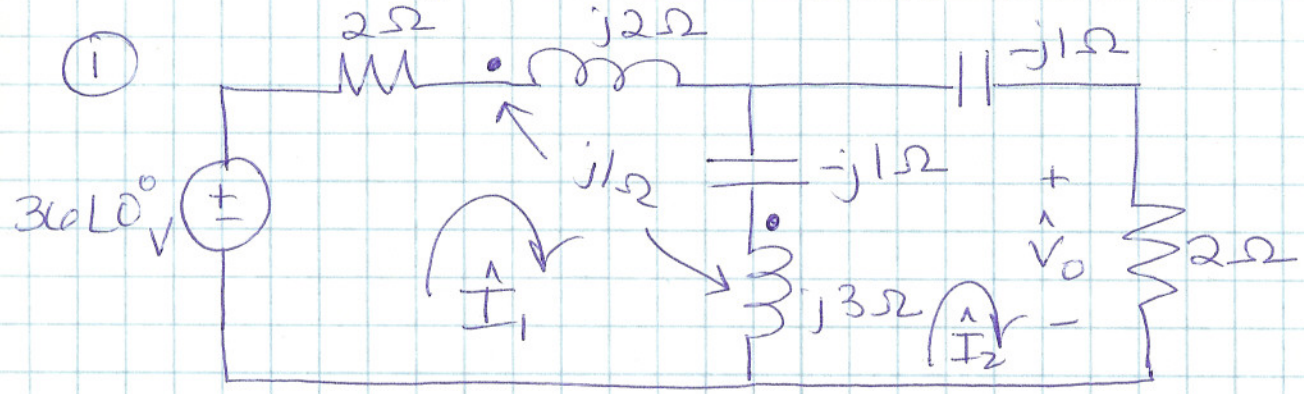
Problem Set #6 - Solutions

① 

m1: $36\angle 0 - 2\hat{I}_1 - (j2\hat{I}_1 + j1(\hat{I}_1 - \hat{I}_2)) \ldots$

$\ldots -(-j1)(\hat{I}_1 - \hat{I}_2) - [j3(\hat{I}_1 - \hat{I}_2) + j1\hat{I}_1] = 0$

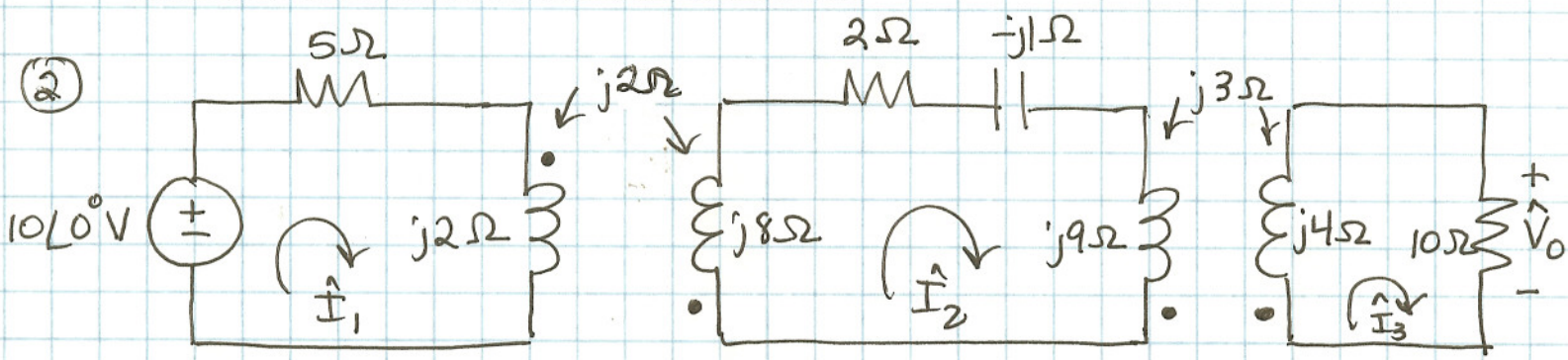
m2: $-[j3(\hat{I}_2 - \hat{I}_1) - j1\hat{I}_1] - (-j1)(\hat{I}_2 - \hat{I}_1) - (2-j1)\hat{I}_2 = 0$

m1: $\hat{I}_1(-2 - j6) + \hat{I}_2(j3) = 36\angle 180$

m2: $\hat{I}_1(j3) + \hat{I}_2(-2 - j1) = 0$

$\hat{I}_1 = 5.14\angle -36.87°\,A \quad \hat{I}_2 = 6.90\angle 26.57°\,A$

$$\hat{V}_o = 2\hat{I}_2 = 13.80\angle 26.57°\,V$$

② 

$m_1 = 0.5\sqrt{2(8)} = 2H$ on $j2\Omega$

$m_2 = 0.5\sqrt{9(4)} = 3H$ on $j3\Omega$

② cont.

$$m1: \quad 10\angle 0 - 5\hat{I}_1 - [j2(\hat{I}_1) + j2\hat{I}_2] = 0$$

$$m2: \quad -[j8\hat{I}_2 + j2\hat{I}_1] - (2-j1)\hat{I}_2 - [j9\hat{I}_2 - j3\hat{I}_3] = 0$$

$$m3: \quad -[j4\hat{I}_3 - j3\hat{I}_2] - 10\hat{I}_3 = 0$$

$$m1: \quad \hat{I}_1(-5-j2) + \hat{I}_2(-j2) = 10\angle 180$$

$$m2: \quad \hat{I}_1(-j2) + \hat{I}_2(-2-j16) + \hat{I}_3(j3) = 0$$

$$m3: \quad \hat{I}_2(j3) + \hat{I}_3(-10-j4) = 0$$

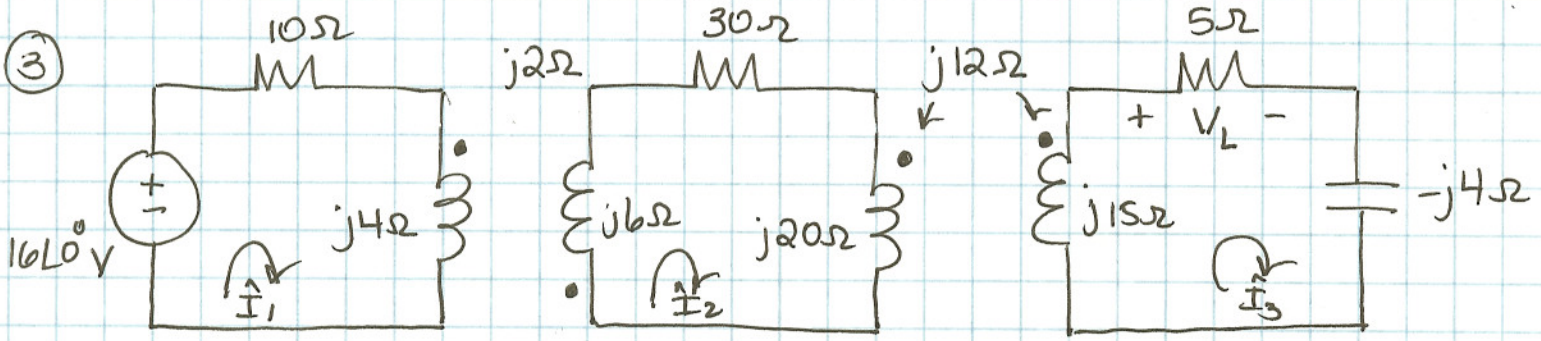
$$\hat{I}_1 = 1.87\angle -19.16^\circ \text{ A}$$

$$\hat{I}_2 = 0.24\angle 170.87^\circ \text{ A}$$

$$\hat{I}_3 = 0.065\angle -120.93^\circ \text{ A}$$

$$\hat{V}_o = 10\hat{I}_3 = 0.65\angle -120.93^\circ \text{ V}$$

③



$$m1: \quad 16\angle 0 - 10\hat{I}_1 - [j4\hat{I}_1 + j2\hat{I}_2] = 0$$

$$m2: \quad -[j6\hat{I}_2 + j2\hat{I}_1] - 30\hat{I}_2 - [j20\hat{I}_2 - j12\hat{I}_3] = 0$$

$$m3: \quad -[j15\hat{I}_3 - j12\hat{I}_2] - (5-j4)\hat{I}_3 = 0$$

③ cont

m1: $\hat{I}_1(-10-j4) + \hat{I}_2(-j2) = 16\angle 180$

m2: $\hat{I}_1(-j2) + \hat{I}_2(-30-j26) + \hat{I}_3(j12) = 0$

m3: $\hat{I}_2(j12) + \hat{I}_3(-5-j11) = 0$

$\hat{I}_1 = 1.47\angle -21.41^\circ$ A

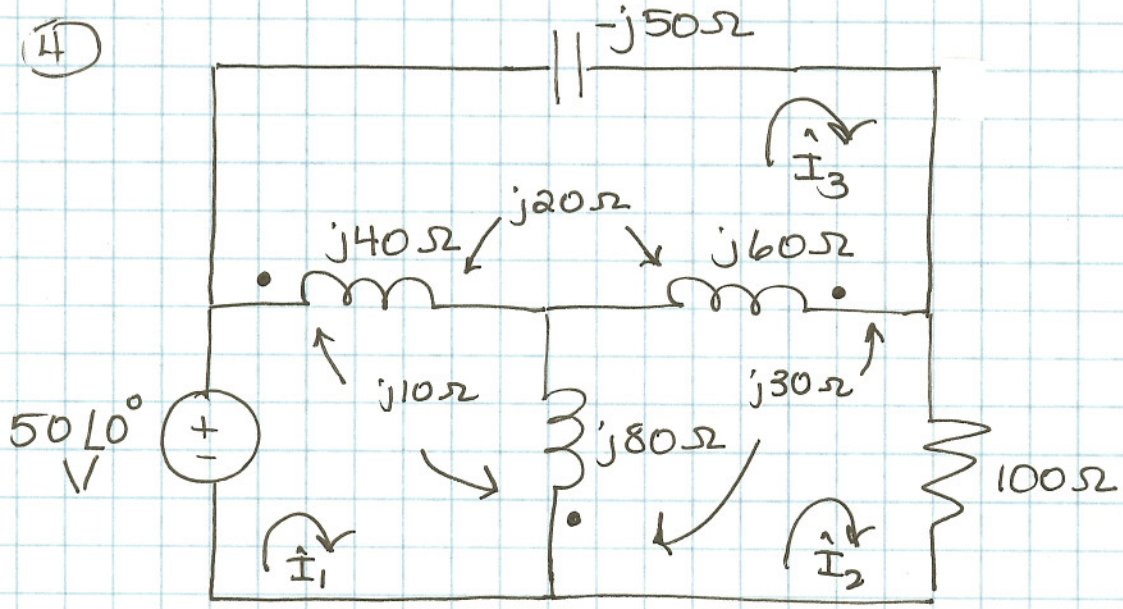
$\hat{I}_2 = 0.077\angle -134.85^\circ$ A

$\hat{I}_3 = 0.077\angle -110.41^\circ$ A

$\hat{V}_L = 5\hat{I}_3$

$\boxed{\hat{V}_L = 0.385\angle -110.41^\circ \text{ V}}$

④



m1: $50\angle 0 - [j40(\hat{I}_1 - \hat{I}_3) + j10(\hat{I}_2 - \hat{I}_1) + j20(\hat{I}_3 - \hat{I}_2)] - \ldots$

$\ldots - [j80(\hat{I}_1 - \hat{I}_2) + j10(\hat{I}_3 - \hat{I}_1) + j30(\hat{I}_2 - \hat{I}_3)] = 0$

m2: $-[j80(\hat{I}_2 - \hat{I}_1) + j10(\hat{I}_1 - \hat{I}_3) + j30(\hat{I}_3 - \hat{I}_2)] - \ldots$

$\ldots - [j60(\hat{I}_2 - \hat{I}_3) + j30(\hat{I}_1 - \hat{I}_2) + j20(\hat{I}_3 - \hat{I}_1)] - 100\hat{I}_2 = 0$

④ cont

m3: $-(-j50)\hat{I}_3 - [j60(\hat{I}_3 - \hat{I}_2) + j30(\hat{I}_2 - \hat{I}_1) + j20(\hat{I}_1 - \hat{I}_3)] \ldots$

$\ldots - [j40(\hat{I}_3 - \hat{I}_1) + j20(\hat{I}_2 - \hat{I}_3) + j10(\hat{I}_1 - \hat{I}_2)] = 0$

simplify:

(m1) $\hat{I}_1(-j100) + \hat{I}_2(j60) + \hat{I}_3(j40) = 50\angle 180$

(m2) $\hat{I}_1(j60) + \hat{I}_2(-100 - j80) + \hat{I}_3(j20) = 0$

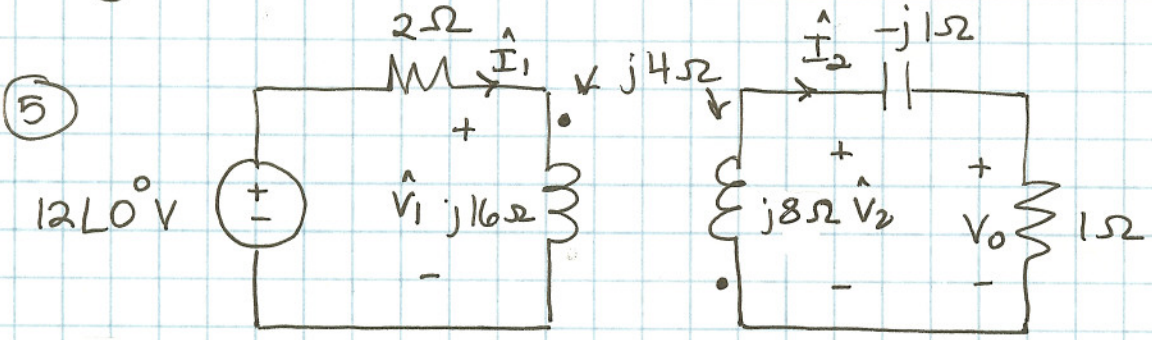
(m3) $\hat{I}_1(j40) + \hat{I}_2(j20) + \hat{I}_3(-j10) = 0$

$\hat{I}_1 = 0.24\angle 37.06^\circ$ A

$\hat{I}_2 = 0.31\angle 105.25^\circ$ A

$\hat{I}_3 = 1.30\angle 62.98^\circ$ A

⑤



$\hat{V}_2 = (1 - j1)\hat{I}_2$ (load)

$\hat{V}_2 = -j8\hat{I}_2 - j4\hat{I}_1$

so: $(1 - j1)\hat{I}_2 = -j8\hat{I}_2 - j4\hat{I}_1$

$\hat{I}_2(1 - j1 + j8) = \hat{I}_1(-j4)$

$\hat{I}_2 = \hat{I}_1(.566\angle -171.87^\circ)$

(5) cont

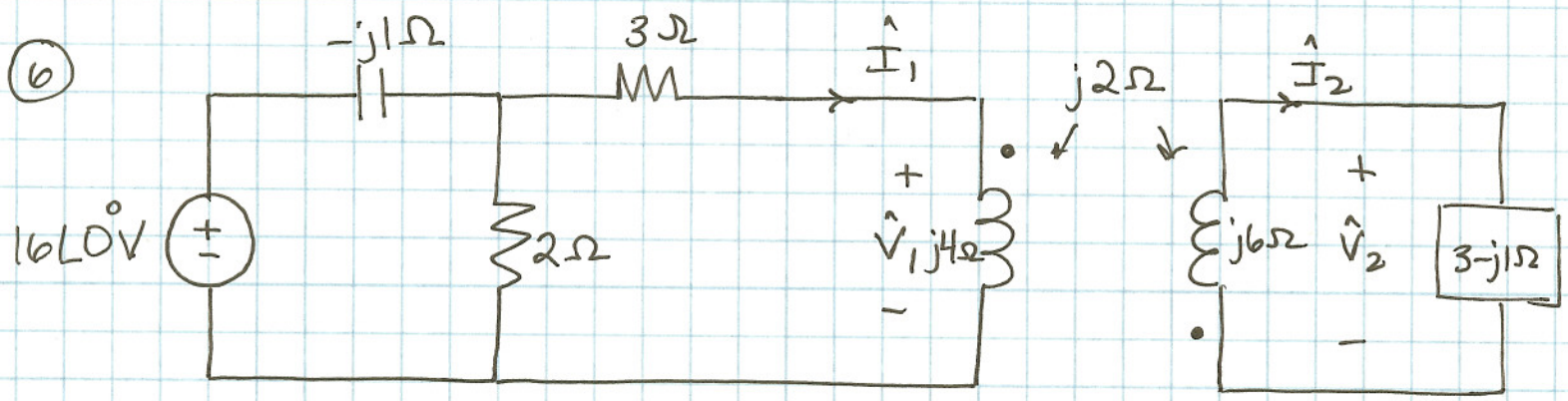
$$\hat{V}_1 = j16\hat{I}_1 + j4\hat{I}_2 \quad (\text{sub for } \hat{I}_2)$$

$$\hat{V}_1 = j16\hat{I}_1 + j4(\hat{I}_1(.566\angle -171.87^\circ))$$

$$\hat{V}_1 = \hat{I}_1(13.76\angle 88.67^\circ)$$

$$Z_1 = \frac{\hat{V}_1}{\hat{I}_1} = 13.76\angle 88.67^\circ$$

(6)



$$\hat{V}_2 = \hat{I}_2(3-j1) \qquad \hat{V}_2 = -j6\hat{I}_2 - j2\hat{I}_1$$

$$\hat{I}_2 = (0.34\angle -149.04)\hat{I}_1 \qquad \frac{\hat{I}_2}{\hat{I}_1} = (.34\angle -149.04)$$

$$\hat{V}_1 = j4\hat{I}_1 + j2\hat{I}_2$$

$$\hat{V}_1 = \hat{I}_1(j4 + j2(.34\angle -149.04))$$

$$\hat{V}_1 = \hat{I}_1(3.43\angle 84.09)$$

$$\frac{\hat{V}_2}{\hat{V}_1} = \frac{\hat{V}_2}{\hat{I}_2} \cdot \frac{\hat{I}_2}{\hat{I}_1} \cdot \frac{\hat{I}_1}{\hat{V}_1} = [(3-j1)][(.34\angle -149.04)]\left[\frac{1}{(3.43\angle 84.09)}\right]$$

$$\frac{\hat{V}_2}{\hat{V}_1} = (.31\angle 108.43)$$