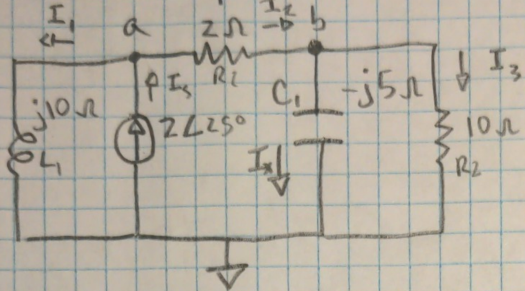
Chris Hunt HW5 ENGR 202

5.1) Use unit output to find the phase current through C_1



$I_x' = 1\angle 0 = 1A \quad V_b' = I_x' \cdot Z_{C_1} \rightarrow V_b' = 1\angle 0 \cdot 5\angle -90 \rightarrow V_b' = 5\angle -90\,V$

$I_3' = \frac{V_b'}{Z_{R_2}} = \frac{5\angle -90\,V}{10\angle 0\,\Omega} = \frac{1}{2}\angle -90\,A = -j.5\,A$

$I_2' = I_x' + I_3' \rightarrow I_2' = 1 - j.5\,A$

$V_a' = I_2' \cdot Z_{R_1} + V_b \rightarrow V_a' = (1 - j.5\,A) + -j5 = V_a' = 1 - j5.5\,V$

$I_1' = \frac{V_a'}{Z_{L_1}} = \frac{1 - j5.5\,V}{j10} = -.55 - j.1\,A$

$I_s' = I_1' + I_2' = -.55 - j.1\,A + 1 - j.5\,A = .45 - j.6\,A$

$\frac{I_x'}{I_s'} = \frac{I_x}{I_s} \qquad I_x = I_s\left(\frac{I_x'}{I_s'}\right)$

$I_x = 2\angle 25\left(\frac{1}{.45 - j.6A}\right) \rightarrow I_x = 2\angle 25(.8 + j1.067)$

$I_x = .5485 + j2.6096\,A = \boxed{2.67\angle 78.13°\,A}$

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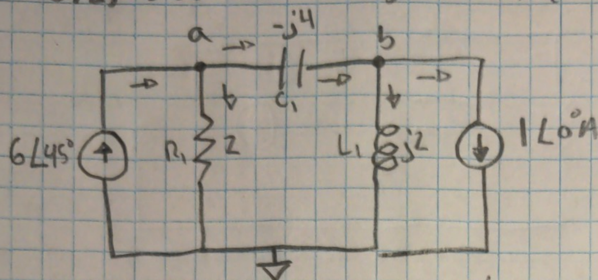
5.2) Use node-voltage to find I_x throug L_1



@a) $\left(6\angle 45 = \frac{V_a}{2} + \frac{V_a - V_b}{-j4}\right) 1\Omega \rightarrow 6\angle 45 V = .5V_a + j.25V_a + j.25V$

@b) $\left(\frac{V_a - V_b}{-j4} = \frac{V_b}{j2} + 1A\right) 1\Omega \rightarrow j.25V_a - j.25V_b = -j.5V_b + 1V$

$1V = j.25V_a + j.25V_b$

$$\begin{bmatrix} .5+j.25 & j.25 \\ j.25 & j.25 \end{bmatrix} \begin{bmatrix} V_a \\ V_b \end{bmatrix} = \begin{bmatrix} 4.2426+j4.2426 \\ 1 \end{bmatrix}$$

$V_a = 6.4852 + j8.4852$ $V_b = -6.4852 - j12.4852$

$$I_x = \frac{V_b}{Z_{L_1}} = \frac{-6.4852 - j12.4852}{j2}$$

$$I_x = -6.2426 + j3.2426 = \boxed{7.035\angle 152.55° A}$$

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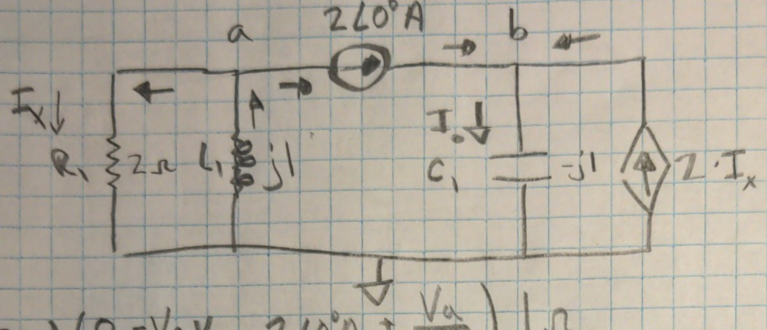
5.3) Find I_o using nodal analysis



@a) $\left(\frac{0 - V_a V}{j1\Omega} = 2\angle 0° A + \frac{V_a}{2\Omega} \right) 1\Omega$

$jV_a = 2v + .5V_a \rightarrow (-.5 + j)V_a = 2v$

@b) $\left(\frac{V_b}{-j\Omega} = 2\angle 0°_A + 2\left(\frac{V_a}{2\Omega}\right) \right) 1\Omega$

$jV_b = 2v + V_a \longrightarrow -V_a + jV_b = 2v$

$$\overset{A}{\begin{bmatrix} -.5+j & 0 \\ -1 & j \end{bmatrix}} \overset{x}{\begin{bmatrix} V_a \\ V_b \end{bmatrix}} = \overset{b}{\begin{bmatrix} 2 \\ 2 \end{bmatrix}}$$

$\downarrow A^{-1}b = X$

$$\begin{bmatrix} V_a \\ V_b \end{bmatrix} = \begin{bmatrix} -.8 - j1.6 \\ -1.6 - j1.2 \end{bmatrix}$$

$$I_o = \frac{V_b}{Z_{C1}} = \frac{-1.6 - j1.2}{-j} = 1.2 - j1.6 = \boxed{2\angle -53.15° A}$$

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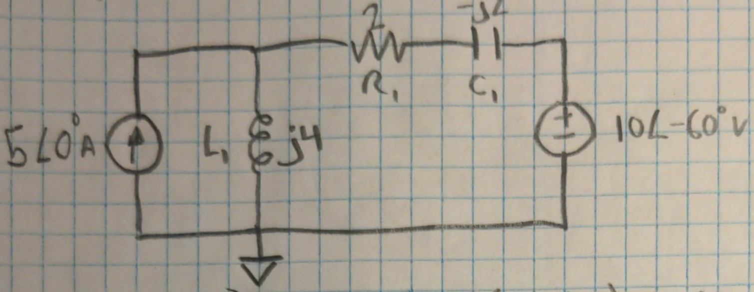
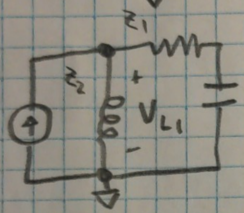
5.4) Use superposition to find the voltage across L_1



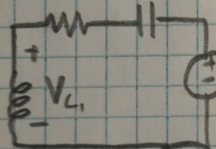
1)



$$Z_{eq} = \frac{(2-j2)\cdot j4}{2+j2} = 4\,\Omega = 4\angle0°$$

$$V_{L1_1} = 5\angle0°A \cdot 4\angle0° = 20\angle0°V = 20V$$

2)



$$Z_{eq} = 2+j2\,\Omega$$

$$I = \frac{10\angle-60V}{2+j2\,\Omega} = 2.83-j2.17\,A$$

$$V_{L1_2} = 2.83-j2.17A \cdot j4 = 8.66+j11.34V$$

$$V_{L1\,tot} = V_{L1_1} + V_{L1_2} = 28.66+j11.34V = \boxed{30.82\angle21.59V}$$