ECE 300
Spring Semester, 2006
HW Set #16

Due: April 20, 2006
wlg

Name Desk Copy
Print (last, first)

Use engineering paper. Work only on one side of the paper. Use this sheet as your cover sheet, placed on top of your work and stapled in the top left-hand corner. Number the problems at the top of the page, in the center of the sheet. **Do neat work. Underline your answers. Show how you got your equations. Be sure to show how you got your answers.** Each problem counts 10 points.

13.7 $V_o = 540.5\angle 144.2^\circ \ mV$

13.18

$Z_{TH} = (2.215 + j29.12)\ \Omega$

$V_{TH} = 61.37\angle -46.2^\circ V$

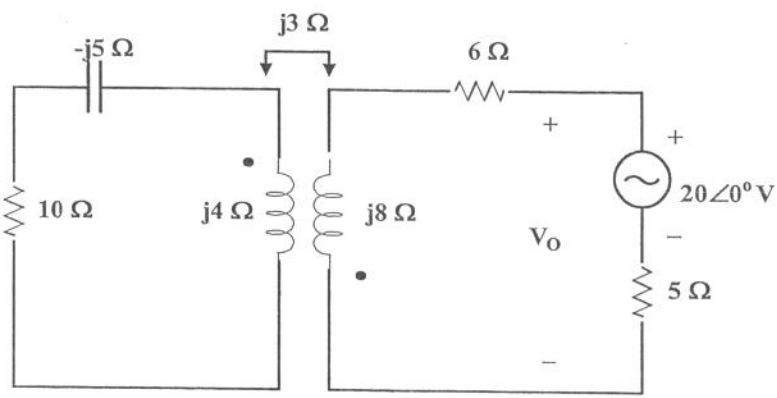
13.26

$I_o = 3.755\angle -36.34^\circ \ A$

$I_o = 3.755\angle 143.66^\circ \ A$

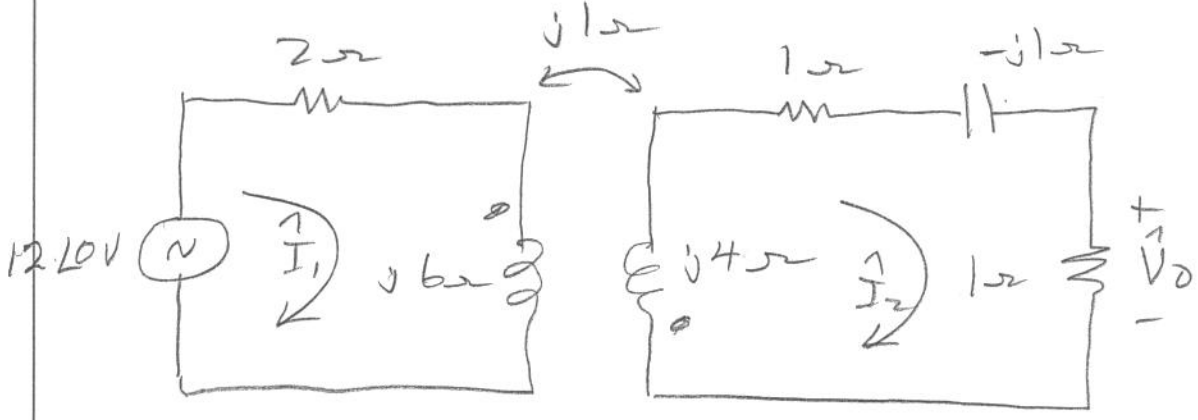
13.35 $I_1 = 1.48\angle -21.4^\circ \ A;\ I_2 = 0.0775\angle -134.85^\circ \ A;\ I_3 = 0.77\angle -110.41^\circ \ A$

13.xx Extra credit (10 points). Find V_O



13.7

GIVEN: FIND $\hat{V}_o$



Assume currents as shown:

Mesh 1

$$(2+j6)\hat{I}_1 + j1\hat{I}_2 = 12\angle 0$$

Mesh 2

$$j1\hat{I}_1 + (2+j3)\hat{I}_2$$

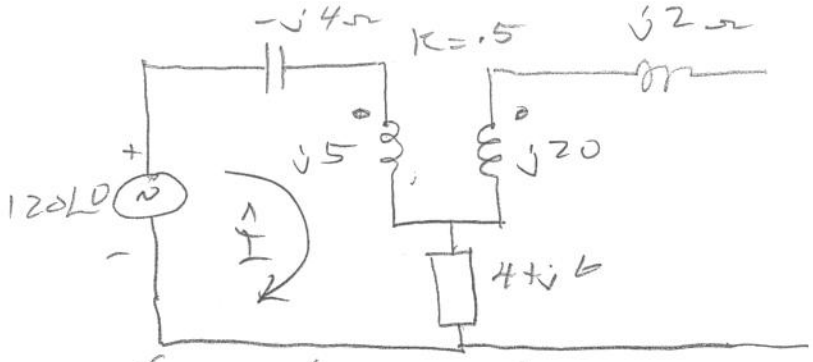
$$\begin{bmatrix} 2+j6 & j1 \\ j1 & 2+j3 \end{bmatrix}\begin{bmatrix} \hat{I}_1 \\ \hat{I}_2 \end{bmatrix} = \begin{bmatrix} 12\angle 0 \\ 0 \end{bmatrix}$$

$I_1 = 0.685 - j1.83$ A

$I_2 = -0.438 + j0.316 = 0.541\angle 144.16$ A

$\therefore V_o = 0.541\angle 144.16$ V

13.18



Transform to a T:

$$L_a = L_1 - M \qquad L_b = L_2 - M \qquad L_c = M$$

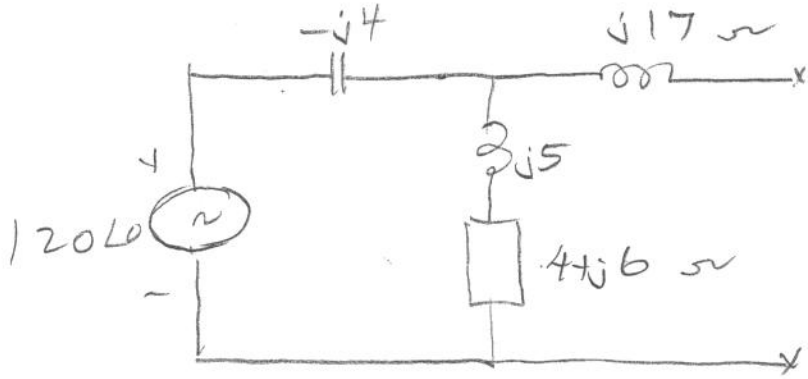
using $K = \dfrac{M}{\sqrt{L_1 L_2}}$

$$.5 = \frac{j\omega M}{\sqrt{\omega L_1 \, \omega L_2}}$$

$$\omega M = 5$$

$$j\omega L_a = j\omega L_1 - j\omega M = j\omega 5 - j\omega 5 = 0$$

$$j\omega L_b = j20 - j5 = j15$$



$$V_{TH} = \frac{120 \times (4 + j11)}{(4 + j7)} = 174.21 \angle 9.76 \text{ V}$$

13.18 cont.

Work by straight circuit theory

$$(-j4 + j5 + 4 + j6)\hat{I} = 120\angle 0$$

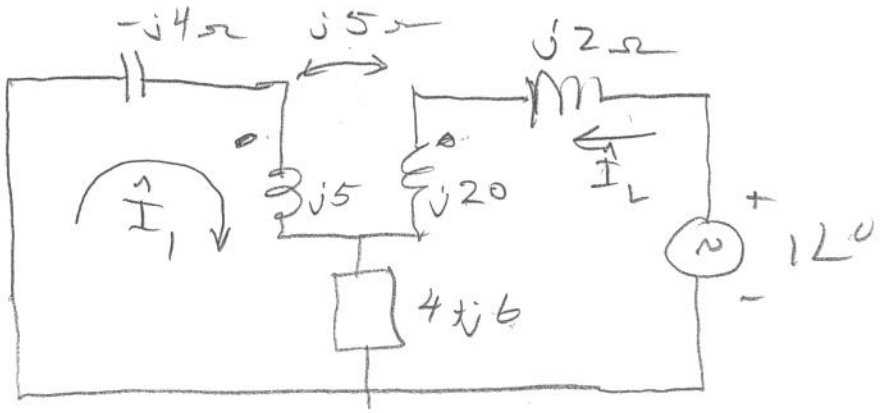
$$\hat{I} = \frac{120\angle 0}{4 + j7}$$

$$V_{TH} = (j5 + 4 + j6)\hat{I}$$

$$V_{TH} = \frac{(4 + j11)}{(4 + j7)} \times 120\angle 0$$

Some Answers.

To find Z-thevenin



Find $\hat{I}_L$: Then $Z_{TH} = \dfrac{1\angle 0}{\hat{I}_L}$

$$(-j4 + j5 + 4 + j6)\hat{I}_1 + j5 I_L + (4 + j6) I_L = 0$$

$$(4 + j7)\hat{I}_1 + (4 + j11)\hat{I}_L = 0$$

13.18 cont

second mesh

$$(j5 + 4 + j6)I_1 + (j2 + j20 + 4 + j6)I_L = 1\angle 0^\circ$$

$$(4 + j11)I_1 + (4 + j28)I_L = 1$$

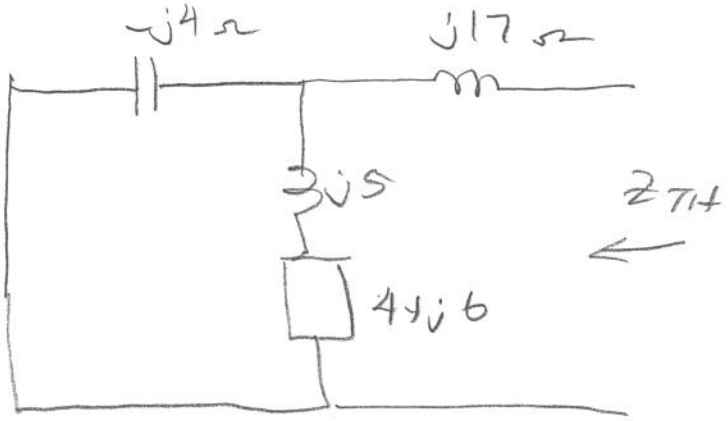
so

$$\begin{bmatrix} 4+j7 & 4+j11 \\ 4+j11 & 4+j28 \end{bmatrix}\begin{bmatrix} I_1 \\ I_L \end{bmatrix} = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$$

$$I_L = 0.0883\angle -85^\circ$$

$$\therefore Z = \frac{1}{I_L} = 11.32\angle 85^\circ \ \Omega$$

Now use the equivalent T circuit.



$$Z_{TH} = j17 + \frac{(4\angle -90)(4+j11)}{(4+j7)}$$

$$Z_{TH} = 11.32\angle 85.0^\circ \ \Omega$$

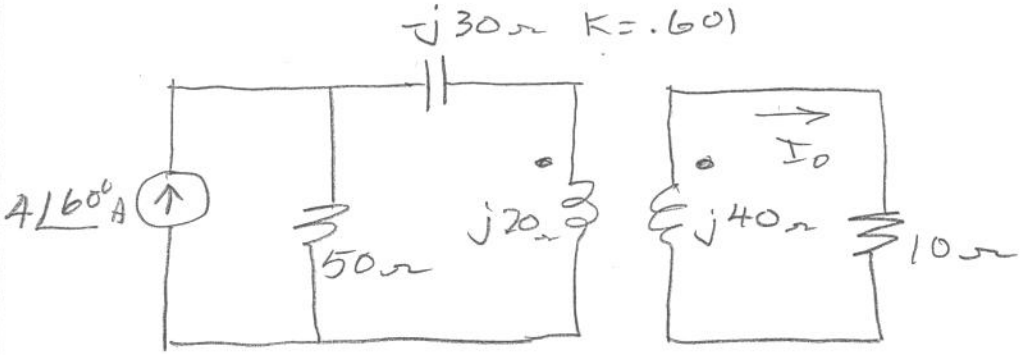
checks with other method.

conclusion:

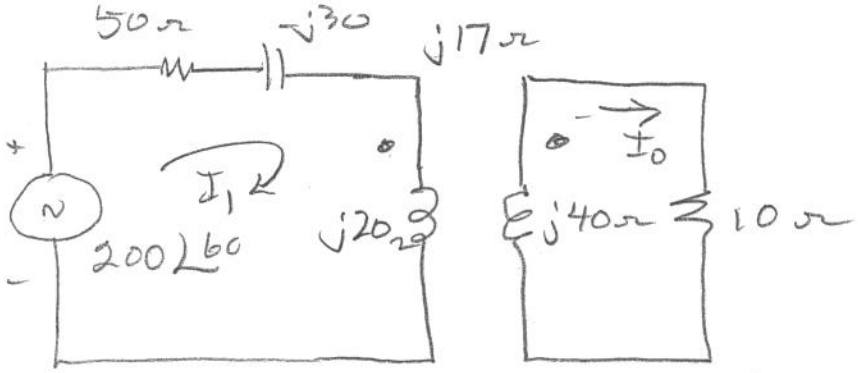
$$V_{TH} = 174.21\angle 5.76^\circ \ V$$

$$Z_{TH} = 11.32\angle 85^\circ \ \Omega$$

13.26 Find I_o in the circuit. Switch the dot on the winding on the right and find I_o again.



$$.60 = \frac{\omega M}{\sqrt{20 \times 40}} \; ; \quad \omega M = 16.97$$



$$(50 - j30 + j20) I_1 - j17 I_o = 200\angle 60$$

$$(50 - j20) I_1 - j17 I_o = 200\angle 60$$

$$-j17 I_1 + (10 + j40) I_o = 0$$

$$I_o = 1.416 \angle 101.44 \text{ A}$$

13.26

Reverse the dot on the right

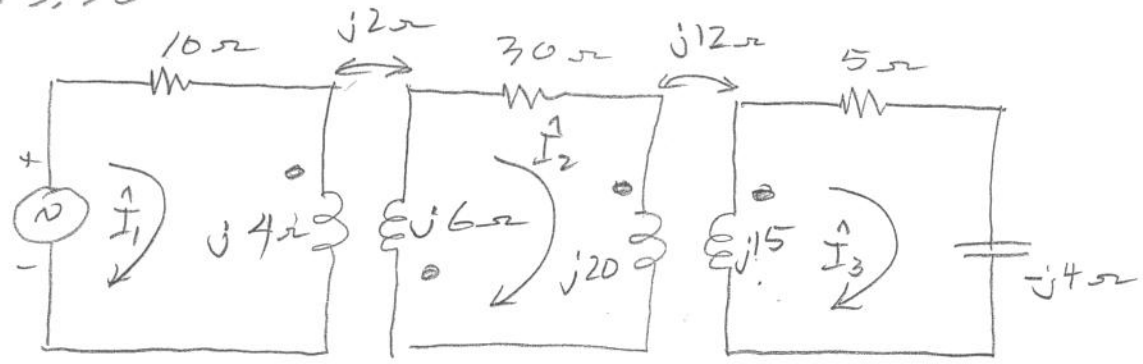
You get

$$(50 - j20)I_1 + j17 I_o = 200\angle 60$$

$$-j17 I_1 + (10 + j40) I_o = 0$$

$$I_o = 1.416 \angle -78.56 \quad A$$

13.35



$$(10+j4)I_1 + j2I_2 + 0I_3 = 16\angle 0$$

$$j2I_1 + (30+j26)I_2 - j12I_3 = 0$$

$$0I_1 - j12I_2 + (5+j11)I_3 = 0$$

$$I_1 = 1.374 - j0.5385$$

$$I_2 = -0.0547 - j0.0549$$

$$I_3 = -0.0268 - j0.0721 = 0.077\angle -110.4^\circ \text{ A}$$