Dest Copy

ECE 300
HW #13

wlg
Due: December 4, '07 Revision A **Name** wlg

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.

(13.9) $V_X = 2.07\angle 21.1^\circ$ V

(13.15 $I_N = 0.687\angle 6.37^\circ$ A; $Z_N = (1 + j19.5)$ ohms $= 19.53\angle 87^\circ\ \Omega$

(13.18) $Z_{TH} = 11.32\angle 85^\circ$ ohms; $V_{TH} = 174.17\angle 9.76^\circ$ V

(13.21) $I_1 = 4.25\angle\text{-}8.51^\circ$ A; $I_2 = 1.56\angle 27.5^\circ$ A; $P_4 = 4.89$ W

(13.37) (a) $n = 5$; (b) $I_p = I_1 = 104.17$ A; (c) $I_S = I_2 = 20.83$ A

(13.46) (a) $I_1 = 1.07\angle 5.88^\circ$ A; $I_2 = 0.536\angle 185.88^\circ$ A

(b) $I_1 = 0.625\angle 25^\circ$ A; $I_2 = 0.313\angle 25^\circ$ A

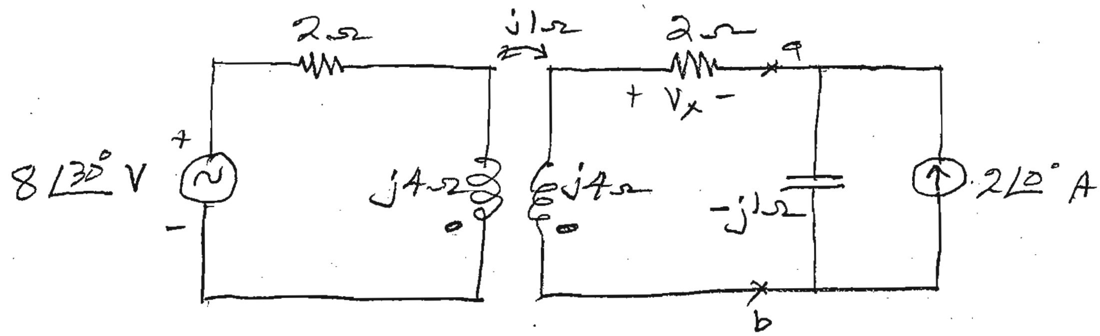
(13.51) $Z_{IN} = (8 - j1.5)$ ohms; $I_1 = 3.95\angle 10.6^\circ$ A

(13.56) $P_{10} = 80$ W

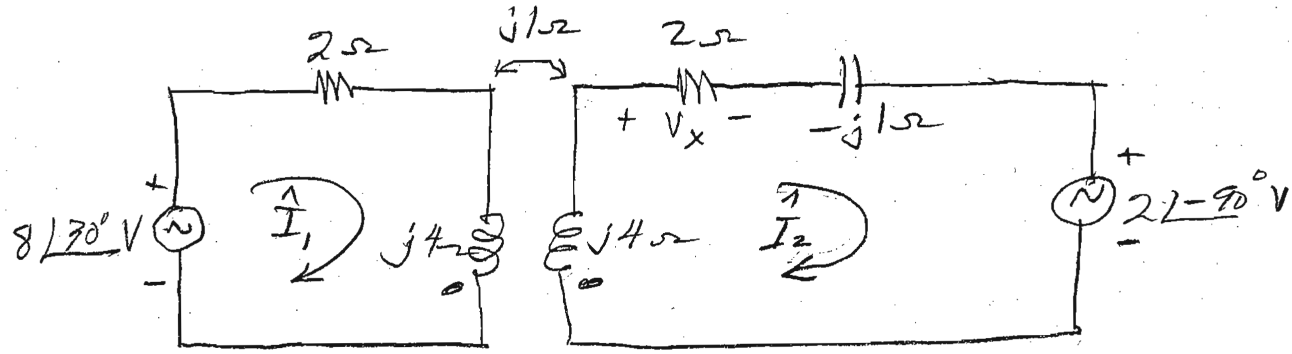
wlg

ECE 300
H.W. #13

(13.9) Find V_x in the network below.



Look into a-b and change to a Thevenin equivalent. Also assume an $\hat{I}_1$ and $\hat{I}_2$ as shown below.



$$(2+j4)\hat{I}_1 - jI_2 = 8\angle 30^\circ$$

$$(2-j)I_2 + 2\angle{-90} + j4I_2 - jI_1 = 0$$

$$-j\hat{I}_1 + (2+j3)\hat{I}_2 = -2\angle{-90} = 2\angle 90$$

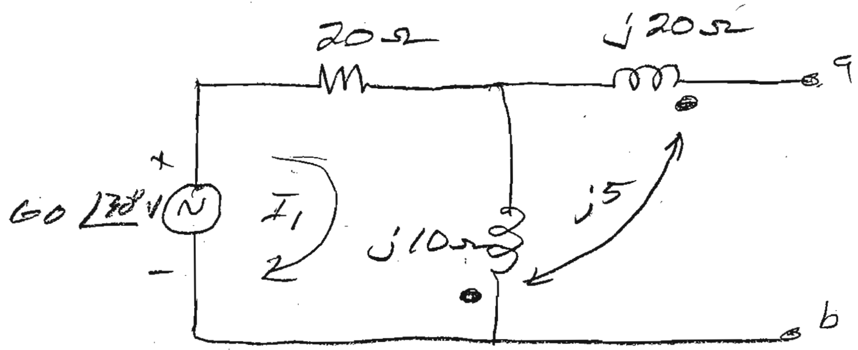
$$\begin{bmatrix} (2+j4), & (0-j) \\ (0-j) & (2+j3) \end{bmatrix} \begin{bmatrix} \hat{I}_1 \\ \hat{I}_2 \end{bmatrix} = \begin{bmatrix} 8\angle 30 \\ 2\angle 90 \end{bmatrix}$$

$\hat{I}_2 = 1.04\angle 21.1^\circ$ A

$$\boxed{V_x = 2 \times \hat{I}_2 = 2.08\angle 21.1^\circ \text{ V}}$$

(13.15)

Find the norton equivalent at terminals a-b for the following circuit.



The approach. Find V_{ab}, open-circuit. Then find I_{ab} short circuit

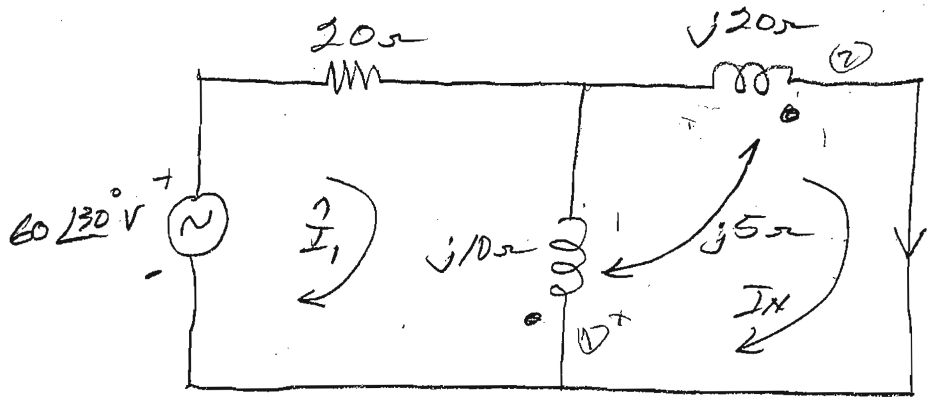
$$(20+j10)I_1 = 60\angle 30$$

$$I_1 = 2.68\angle 3.43^\circ \text{ A}$$

$$V_{ab} = (j10)I_1 - j5 I_1 = j5 I_1$$

$$V_{ab} = V_{TH} = 13.42\angle 93.4^\circ \text{ V}$$

Now for I_N:



(13.15) cont.

$$(20+j10)I_1 - j10 I_N \underset{\text{induced}}{+ j5 I_N} = 60\angle 30$$

$$\boxed{(20+j10)\hat{I}_1 - j5\hat{I}_N = 60\angle 30^\circ}$$

$$(j10+j20)I_N - j10 I_1 \underset{\substack{\text{induced}\\ \text{to ①}}}{- j5 I_N} \underset{\substack{\text{induced}\\ ②}}{- (I_N - I_1) j5} = 0$$

$$\boxed{(0-j5)\hat{I}_1 + j20 I_N = 0}$$

$$\begin{bmatrix} (20+j10) & (0-j5) \\ (0-j5) & (0+j20) \end{bmatrix} \begin{bmatrix} \hat{I}_1 \\ \hat{I}_N \end{bmatrix} = \begin{bmatrix} 60\angle 30 \\ 0 \end{bmatrix}$$

$$\hat{I}_N = 0.687\angle 6.37^\circ$$

$$Z_{TH} = \frac{V_{oc}}{I_N} = \frac{13.42\angle 93.4}{0.687\angle 6.37} =$$

$$Z_{TH} = 19.53\angle 87\ \Omega$$

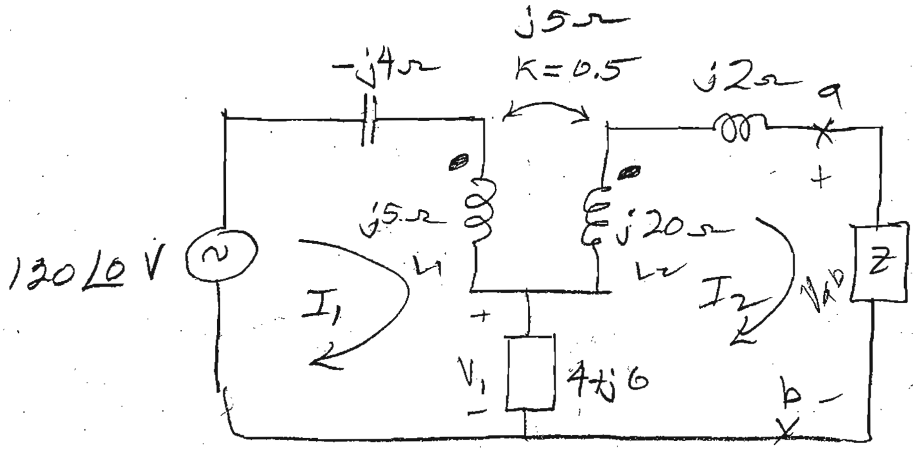
So:

$$\boxed{I_N = 0.687\angle 6.37^\circ\ A}$$

$$\boxed{Z_{TH} = 19.53\angle 87^\circ\ \Omega}$$

(3.18)

Find the Thevenin equivalent to the left of the load Z_2 in the following circuit.



$$K = 0.5 = \frac{M}{\sqrt{L_1 L_2}} = \frac{\omega M}{\sqrt{\omega L_1 \omega L_2}} = \frac{\omega M}{\sqrt{5 \times 20}}$$

$$\omega M = 0.5\sqrt{100} = 5$$

Find the open circuit voltage at a-b. Remove Z in doing this.

$$(-j4 + j5 + 4 + j6) I_1 = 120\angle 0 \quad (\text{No } I_2\text{, open})$$

$$\hat{I}_1 = \frac{120\angle 0}{4 + j7} = 14.88\angle{-60.26^\circ}\ A$$

$$V_{ab} = V_1 + j5 I_1 = (\underbrace{14.88\angle{-60.26}}_{\hat{I}_1})[(4 + j6) + j5]$$

$$V_{ab} = (14.88\angle{-60.26}\,(4 + j11))$$

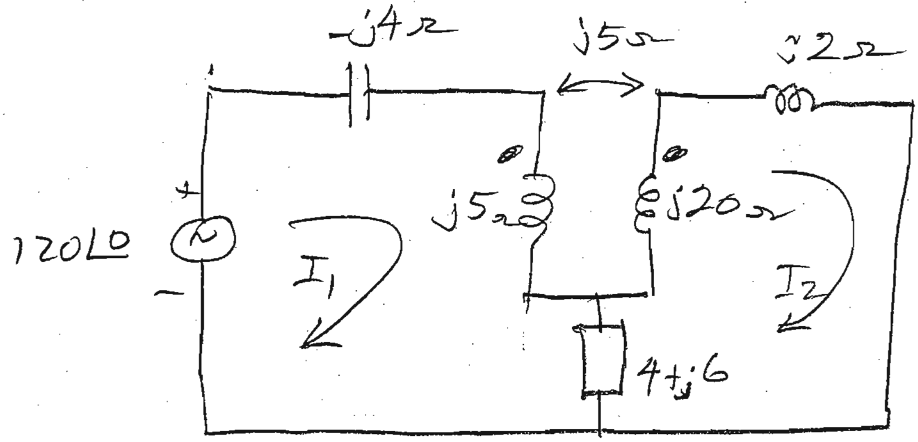
$$V_{ab} = V_{TH} = 174.17\angle 9.76^\circ\ V$$

(3.18)

To find Z_i use

$$V_{TH} = I_{sc} Z$$

$Z = \dfrac{V_{TH}}{I_{sc}}$. We need to solve for I_{sc} in the following circuit.



$$I_2 = I_{sc} = I_N$$

$$(-j4 + j5 + 4 + j6)I_1 - (4+j6)I_2 - j5 I_2 = 120\angle 0$$

$$(4+j7)\hat{I}_1 + (-4-j11)I_2 = 120\angle 0^\circ$$

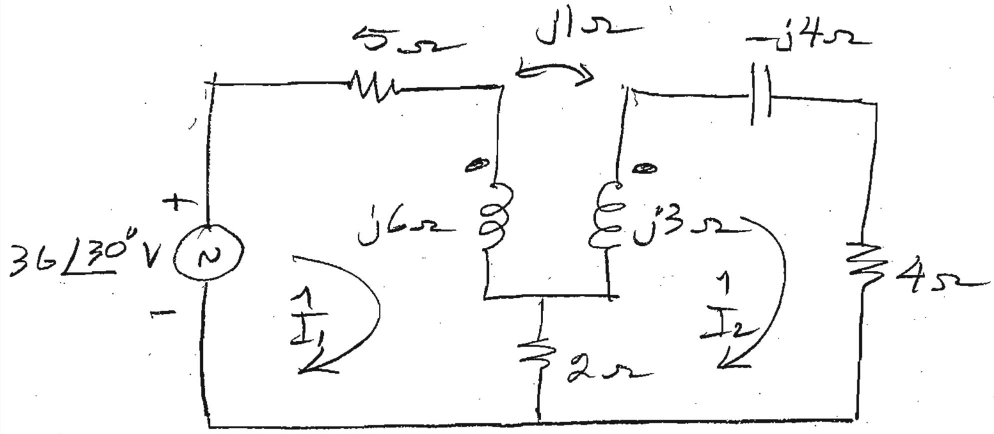
$$(4+j6)(I_2 - I_1) + j22 I_2 - j5 I_1 = 0$$

$$(-4-j11)\hat{I}_1 + (4+j28)\hat{I}_2 = 0$$

$$I_2 \simeq I_N = I_{sc} \simeq 15.39\angle -75.24$$

$$Z_{TH} = \frac{174.17\angle 9.76}{15.39\angle -75.24} = 11.32\angle 85^\circ\ \Omega$$

(13.21) Find $\vec{I}_1$ and $\vec{I}_2$ in the following circuit. Calculate the power absorbed by the 4Ω resistor.



Mesh 1

$$(7+j6)\vec{I}_1 - 2\vec{I}_2 - jI_2 = 36\angle 30$$

$$(7+j6)I_1 + (-2-j)\vec{I}_2 = 36\angle 30^\circ$$

Mesh 2

$$2(I_2 - I_1) + (j3 - j4 + 4)\vec{I}_2 - jI_1 = 0$$

$$(-2-j)\vec{I}_1 + (6-j)\vec{I}_2 = 0$$

$$\begin{bmatrix} 7+j6 & (-2-j) \\ (-2-j) & (6-j) \end{bmatrix} \begin{bmatrix} \hat{I}_1 \\ \hat{I}_2 \end{bmatrix} = \begin{bmatrix} 36\angle 30 \\ 0 \end{bmatrix}$$

$\vec{I}_1 = 4.25\angle -8.5^\circ A$ / $\vec{I}_2 = 1.56\angle 27.5^\circ A$

$$P_A = \frac{|I_2|^2}{2} \times 4 = 4.87W$$

(13.37) A 480/2400 V rms step-up ideal transformer delivers 50kW to a resistive load. Calculate

(a) the turns ratio.

$$\frac{V_2}{V_1} = \frac{N_2}{N_1} = n$$

$$\frac{2400}{480} = n$$

so $\underline{\underline{n = 5}}$

(b) the primary current

$$V_2 I_2 = 50kW$$

$$I_2 = \frac{50{,}000}{2400} = 20.83\ A$$

$$\frac{I_1}{I_2} = n = 5$$

$$I_1 = 5 \times I_2 = 5 \times 20.83$$

$$I_1 = 104\ A$$

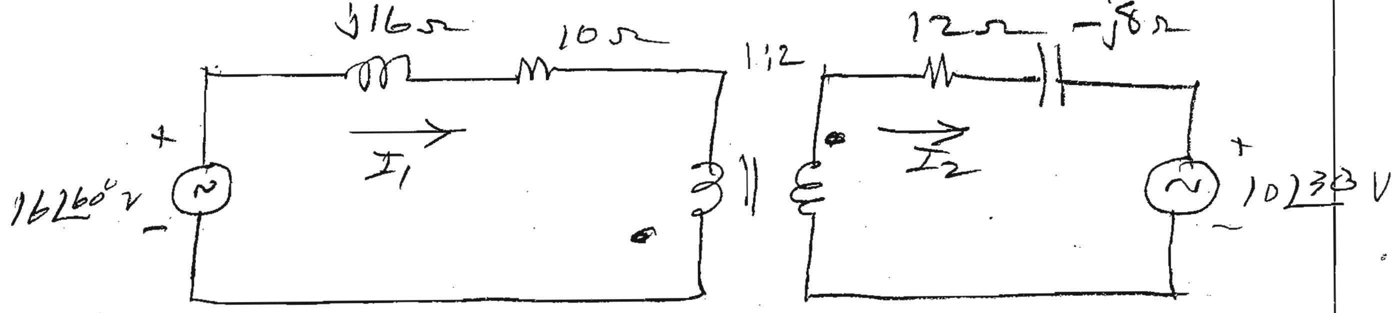
(c) the secondary current

$$I_2 = \frac{I_1}{5} = \frac{104}{5}$$

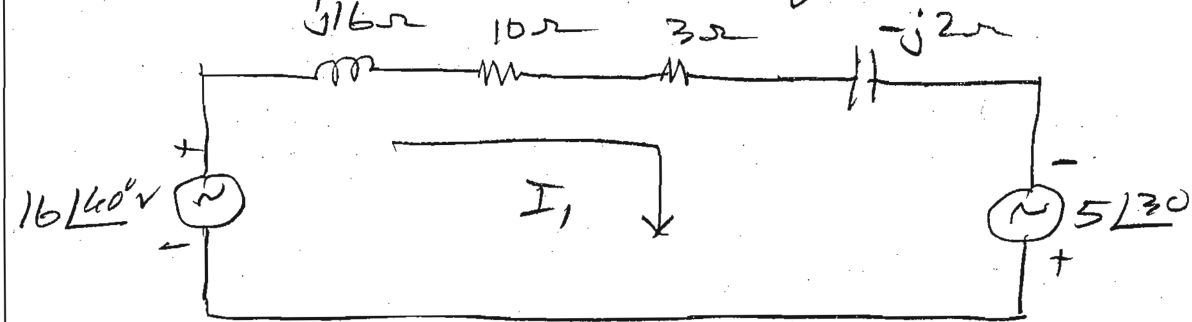
$$I_2 = 20\ A$$

(13,46)

(a) Find I_1 and I_2 in the following circuit



Reflect the secondary to the primary



$$(j16 + 10 + 3 - j2) I_1 = 16\angle 60 + 5\angle 30$$

$$(13 + j14) I_1 = (16\angle 60 + 5\angle 30°)$$

$$\boxed{\vec{I}_1 = 1.07\angle 5.87°}$$

$$\frac{\vec{I}_1}{\vec{I}_2} = -2$$

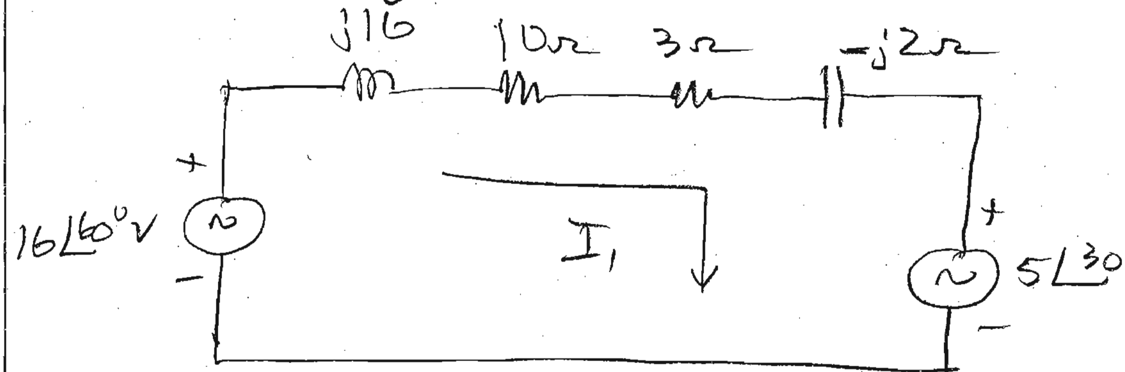
$$\boxed{I_2 = \frac{1.07\angle 5.87}{-2} = 0.535\angle 185.87° \text{ A}}$$

13.46-2

(13.46) continued

(b) Switch the dot on one winding and find $\vec{I_1}$ and $\vec{I_2}$.

Switching the one dot reverses the polarity of the $5\angle 30^\circ$ source



$$(13+j14)I_1 = (16\angle 60^\circ) - (5\angle 30^\circ)$$

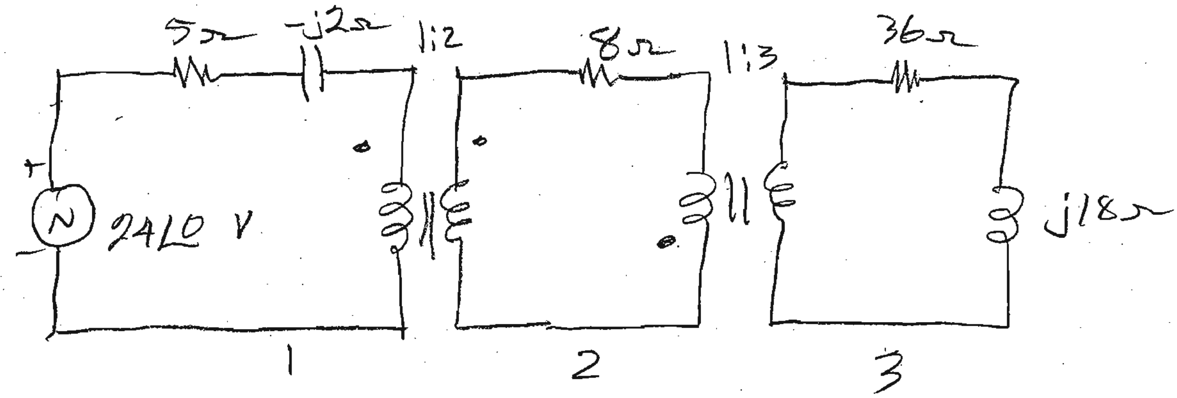
$$I_1 = 0.625\angle 24.97^\circ \text{ A}$$

$$\frac{I_1}{I_2} = +2$$

$$\boxed{I_2 = \frac{I_1}{2} = 0.313\angle 25^\circ \text{ A}}$$

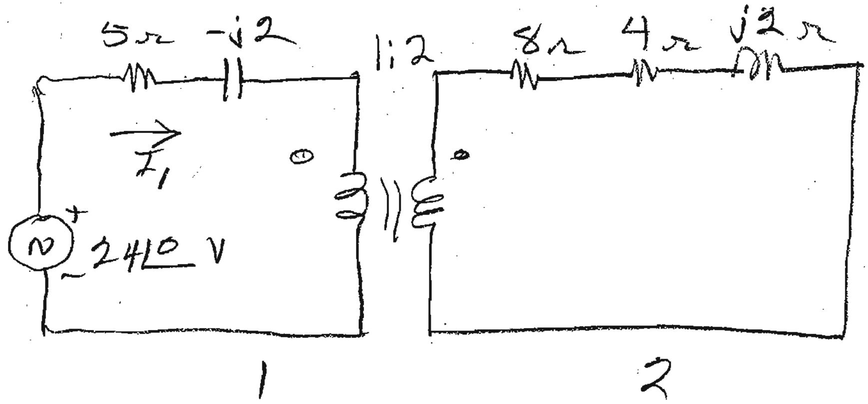
(13.51)

Use the concept of reflected impedance to find the input impedance and $\mathbf{I}_1$ in the following circuit.

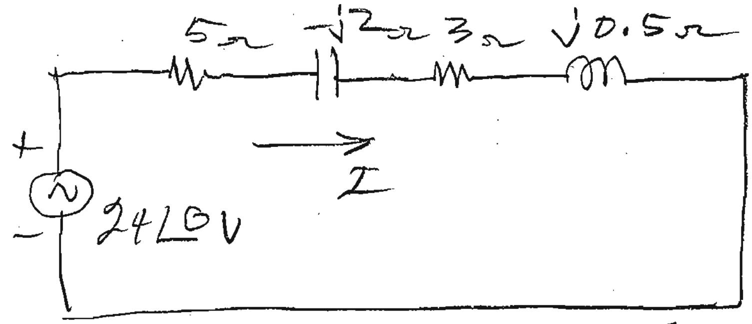


Reflecting 3 to 2 we have

$$\frac{36+j18}{n^2} = \frac{36+j18}{9} = 4+j2$$



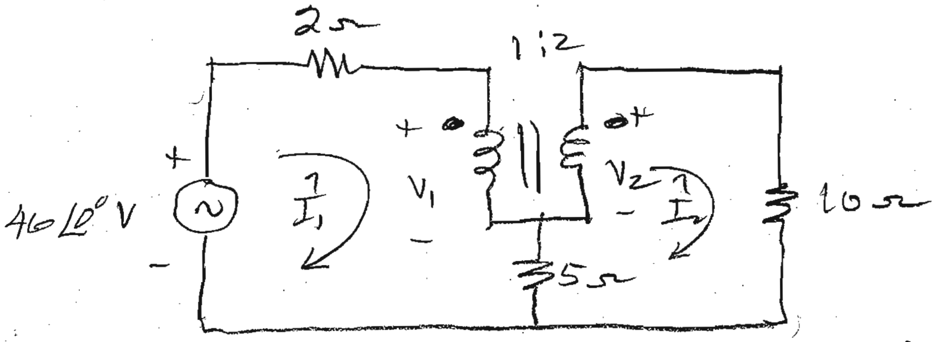
Reflecting 2 to 1



$$Z_{in} = (8 - j1.5)\,\Omega; \quad \mathbf{I}_1 = \frac{24\angle 0}{8 - j1.5} = 2.95\angle 10.6^\circ \text{ A}$$

(13:56)

Find the power absorbed by the 10Ω resistor in the ideal transformer circuit below.



Find I_2; then $P_{10} = \frac{|I_2|^2}{2} \times 10$

Mesh1

$$7I_1 - 5I_2 + V_1 + 0V_2 = 46\angle 0$$

$$-5I_1 + 15I_2 + 0V_1 - V_2 = 0$$

$$\frac{V_2}{V_1} = 2$$

$$0I_1 + 0I_2 + 2V_1 - V_2 = 0$$

$$\frac{I_1}{I_2} = 2$$

$$I_1 - 2I_2 + 0V_1 + 0V_2 = 0$$

$$\begin{bmatrix} 7 & -5 & 1 & 0 \\ -5 & 15 & 0 & -1 \\ 0 & 0 & 2 & -1 \\ 1 & -2 & 0 & 0 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} 46 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

$I_2 = 4$; $\boxed{P_{10} = \frac{4^2}{2} \times 10 = 80\text{ W}}$