ECE 301
HW #11

wlg
Due: December 4, '07 revision A **Name**____________________

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 15 points.

Linear Transformers

(11.X1) Determine the voltage V_o of the linear transformer given below. Ans: $V_o = 0.6\angle{-90^\circ}$ V

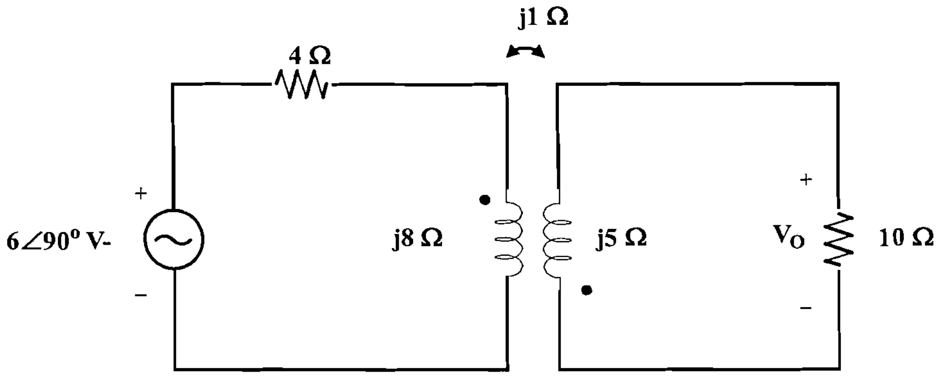


Figure 11.X1: Circuit for problem 11.X1

(11.X2) In the linear transformer circuit below, calculate the input impedance and the current I_1.
Take $Z_1 = (60 - j100)$ ohms, $Z_2 = (30 + j40)$ ohms, and $Z_L = (80 + j60)$ ohms.
Ans: $Z_{IN} = 100.14\angle{-53.1^\circ}$ ohms, $I_1 = 0.5\angle{113.1^\circ}$ A

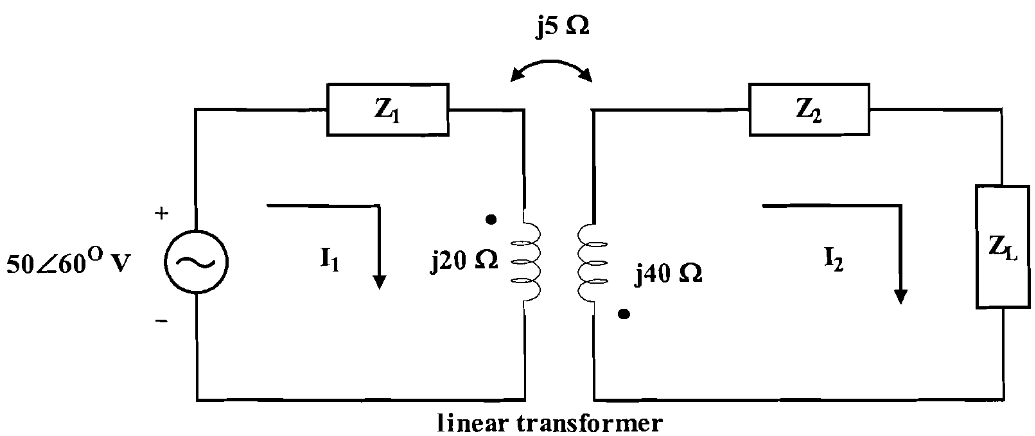


Figure 11.X2: Circuit for problem 11.X2

Ideal Transformers

(15.60) Work for $N_1/N_2 = 10$ only: Ans: $V_{2rms} = 10$ V, $I_{2rms} = 0.1$ A, $P_L = 1$ W

(15.63) (a) $I_1 = 6\angle 30^\circ$ A; $V_2 = 400\angle 0^\circ$ V

(b) $P_{S1} = -519.6$ W $P_{S2} = 519.6$ W
power is taken from the voltage source and delivered to th current source

(c) $I_1 = 6\angle -150^\circ$ A $V_2 = 400\angle 180^\circ$ V

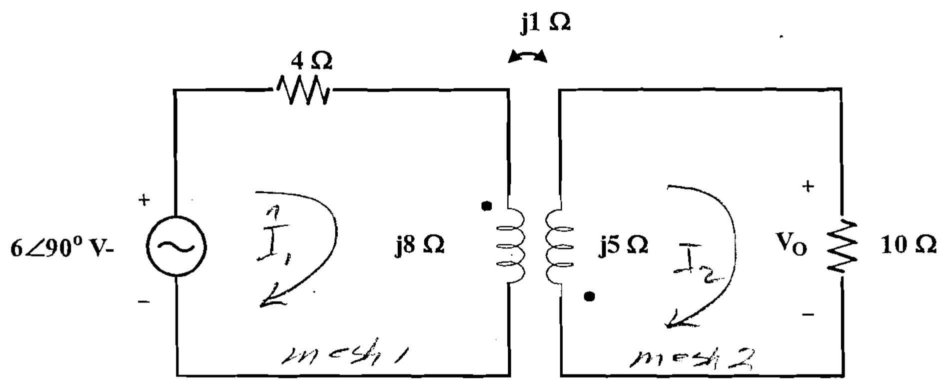
$P_{S1} = 519.6$ W $P_{S2} = -519.6$ W
Power is taken from the current source and delivered to the voltage source

(15.65) (a) $I_1 = 30\angle 0^\circ$ A; (b) $I_1 = 10\angle 0^\circ$ A

ECE 301
H.W. #11

Linear Transformers

(11.X1) Determine the voltage V_o of the linear transformer given below. Ans: $V_o = 0.6\angle{-90^\circ}$ V



Assume currents $\hat{I}_1$ and $\hat{I}_2$ as shown above, Write KVL equations around mesh 1 and mesh 2.

$$(4+j8)\hat{I}_1 + j\hat{I}_2 = 6\angle 90$$

$$j\hat{I}_1 + (10+j5)\hat{I}_2 = 0$$

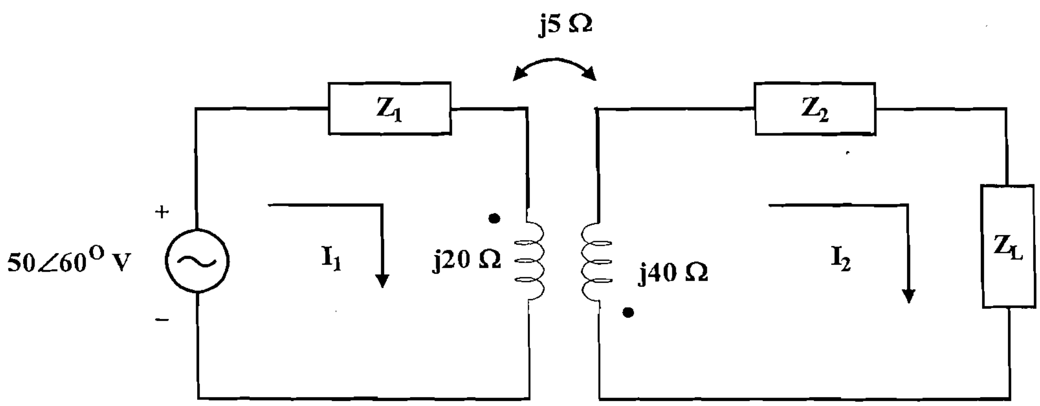
$$\begin{bmatrix} (4+j8) & (0+j1) \\ (0+j1) & (10+j5) \end{bmatrix} \begin{bmatrix} \hat{I}_1 \\ \hat{I}_2 \end{bmatrix} = \begin{bmatrix} 6\angle 90 \\ 0 \end{bmatrix}$$

$$I_2 = 0.06\angle{-89.4^\circ} \text{ A}$$

$$V_o = 10\hat{I}_2$$

$$V_o = 0.6\angle{-89.4^\circ} \text{ V}$$

(11.X2) In the linear transformer circuit below, calculate the input impedance and the current I_1.
Take $Z_1 = (60 - j100)$ ohms, $Z_2 = (30 + j40)$ ohms, and $Z_L = (80 + j60)$ ohms.
Ans: $Z_{IN} = 100.14\angle{-53.1^\circ}$ ohms, $I_1 = 0.5\angle 113.1^\circ$ A



linear transformer

We have shown that

$$Z_{IN} = Z_1 + j20 + \frac{(\omega M)^2}{j40 + Z_2 + Z_L}$$

$$Z_{IN} = 60 - j100 + j20 + \frac{25}{j40 + 30 + j40 + 80 + j60}$$

$$Z_{IN} = 60 - j80 + \frac{25}{110 + j140}$$

$$Z_{IN} = 100.14\angle{-53.1^\circ}\ \Omega$$

$$I_1 = \frac{50\angle 60}{100.14\angle{-53.1}} = 0.5\angle 113.1^\circ\ A$$

Ideal Transformers

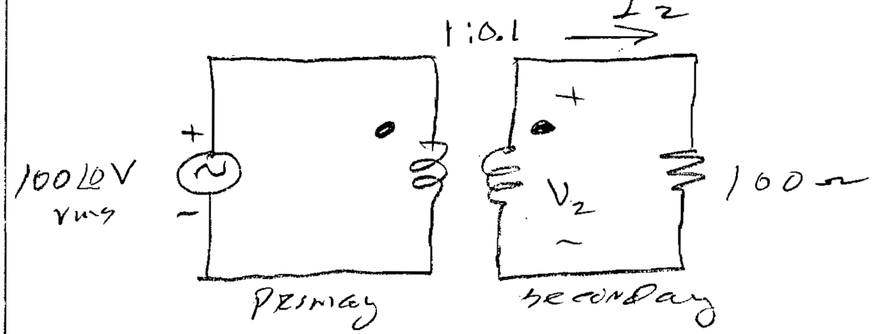
(15.60)

Consider the circuit below

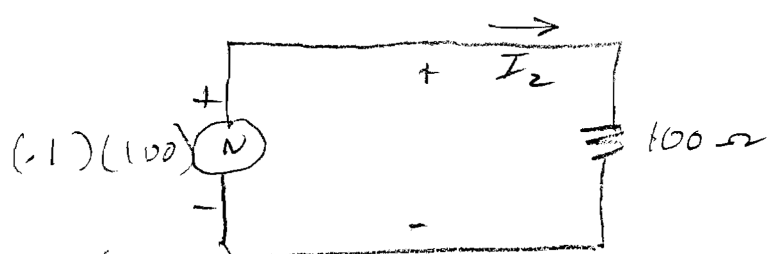
(a) Find the secondary voltage V_{2rms},

Find the secondary current I_2.

P_{100} if $N_1 / N_2 = 10$



Reflect the primary to the secondary



$V_{2rms} = 10\angle 0 \; V_{rms}$

$I_{2rms} = \frac{10\angle 0}{100} = 0.1\angle 0^\circ \; A_{rms}$

$P_{100} = |I_{2rms}|^2 \times 100 = (.1)^2 \times 100$

$P_{100} = 1 \; W$

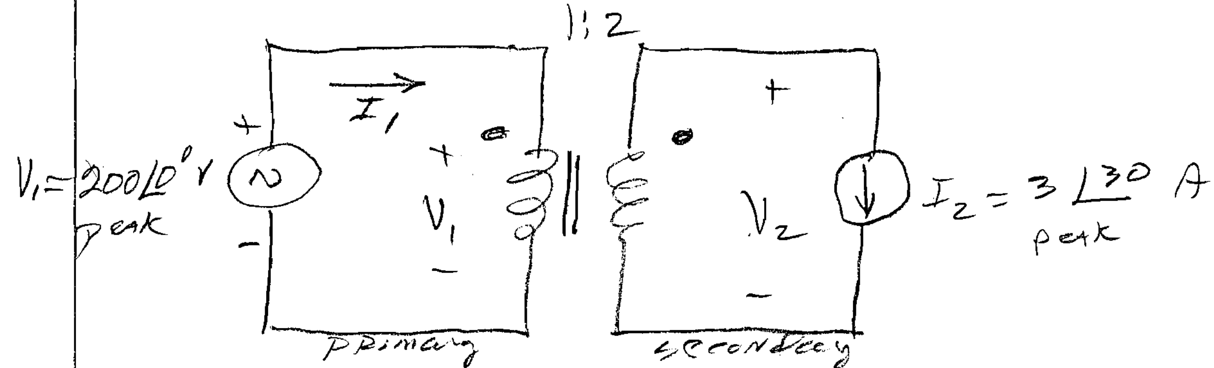
(15.63)

Consider the circuit shown in the diagram below.

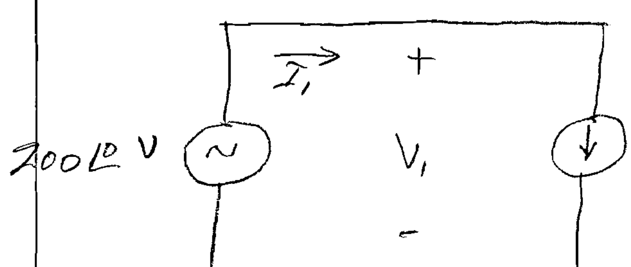
(a) Determine the values of $\vec{I}_1$ & $\vec{V}_2$.

(b) For each of the sources, determine the average power and state whether the power is delivered by or absorbed by the source

(c) Move the dot on the secondary to the bottom end of the coil and repeat (a) and (b).



Reflect the secondary to the primary



$n \times I_2 = 6\angle 30^\circ$ A

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

$I_1 = 6\angle 30^\circ$ A $\quad V_2 = 2 \times V_1 = 400\angle 0$ V

15.63 continued

(b) $P_{s_1 \text{ supplied}} = \frac{200 \times 6 \times \cos 30}{2} = 519.6\,W$

$P_{s_2 \text{ supplied}} = -\frac{400 \times 6 \times \cos 30}{2} = -519\,W$

This means that source 1 is supplying 519 W to the current source.

(c) Reverse one of the dots. This make the current source arrow point up but still has value of $6\angle 30°$.

(a) so $I_1 = -6\angle 30 = 6\angle -150°\,A$

$V_2 = -2V_1 = -400\,V = 400\angle 180$

(b) $P_{s_1 \text{ supplied}} = \frac{200 \times 6}{2} \times \cos(-150) = -519.6\,W$

$P_{s_2 \text{ supplied}} = \frac{400 \times 6}{2} \cos(180 - (-150°)) = 519.6\,W$

Source 2 supplies 519.6 W to source 1.

Alternate

(15.63) Another way to find I_1 and V_2 is straight analysis, no reflections.

Looking at the original transformer we have for both dots up and V_1, V_2, I_1, I_2 as indicated

$V_1 = 200\angle 0^\circ$ V

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

or

$V_2 = 2V_1 = 400\angle 0^\circ$ V

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

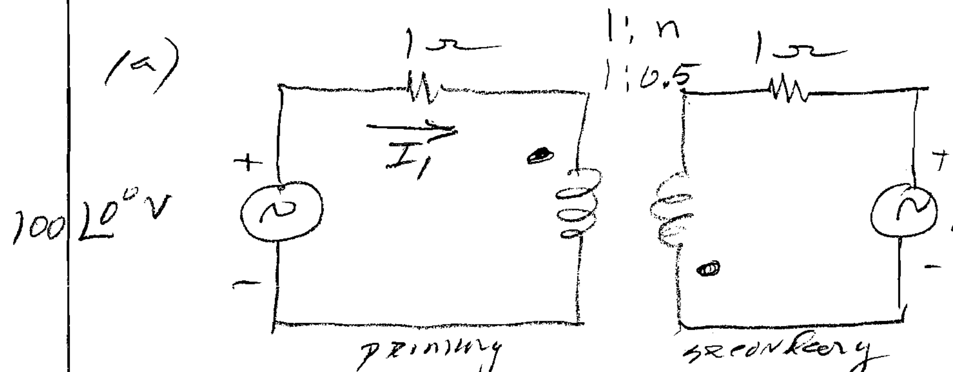
$I_1 = 2I_2 = 6\angle 30^\circ$ A

(15.65)

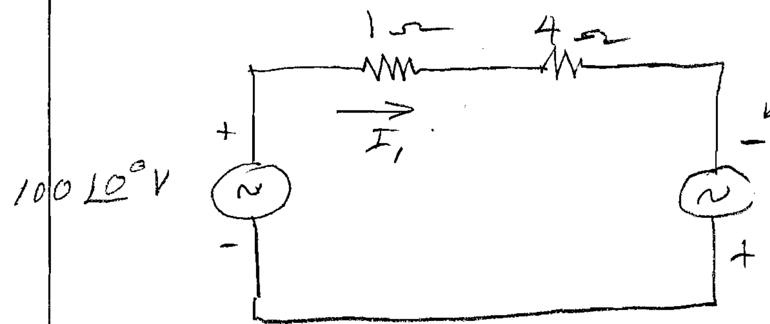
(a) Reflect the resistance and voltage source to the left, in the circuit below, and find $\vec{I}_1$.

(b) Repeat (a) but with one of the dots reversed.

(a)



$1\Omega \rightarrow \frac{1}{n^2} = \frac{1}{.25} = 4$



$\frac{25\angle 0}{n} = 50\angle 0°\ V$

$$\vec{I}_1 = \frac{100\angle 0 + 50\angle 0}{5} = 30\angle 0°\ A$$

(b) Reversing one of the dots changes the polarity of the 25∠0 voltage source.

$$\vec{I}_1 = \frac{100\angle 0 - 50\angle 0}{5} = 10\angle 0°\ A$$