ECE 300

Spring Semester, 2006

HW Set #17

Due: April 27, 2006

wlg: Version 2

Name Desk Copy only

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. <u>Be sure to show how you got your answers.</u>** Each problem counts 10 points.

13.37

13.41

13.46 (a) $I_1 = 1.072\angle 5.88^\circ$ A, $I_2 = 0.536\angle 185.9^\circ$ A

(b) $I_1 = 0.625\angle 25^\circ$ A, $I_2 = 0.3125\angle 25^\circ$ A

13.52 $n = 0.5$; $P = 90$ W

13.62 (a) $S = 103\angle 11.85^\circ$ VA

(b) $p = 4.244$ W

ECE 300
H.W. # 17
Ideal Transformers

13.37

A 480/2400 V_{rms} step-up ideal transformer delivers 50 kW to a resistive load. Calculate:

(a) the turns ratio.

$$n = \frac{2400}{480} = 5 = \frac{N_2}{N_1}$$

(b) The primary current

with 2400 V_{rms}, resistive load (P.F. = 1), we can say

$$2400 \times I_{sec} = 50{,}000$$

$$I_{sec} = 20.83 \text{ A}$$

Since

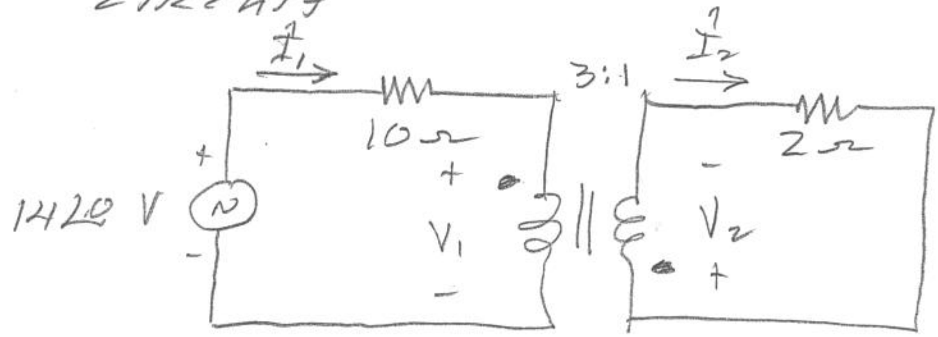
$$\frac{I_1}{I_2} = \frac{I_{prim}}{I_{sec}} = 5$$

$$\underline{\underline{I_{prim}}} = 5 \times 20.83 = \underline{\underline{104.15 \text{ A}_{rms}}}$$

(c) As above, $I_{sec} = 20.83$ A

13.41

Determine $\tilde{I}_1$ and $\tilde{I}_2$ in the following circuit



$n = \frac{1}{3}$

I will work this problem 2 ways:
First, by reflecting the secondary to the primary.
Second, by direct use of equations.

First method:

The 2Ω resistor in the secondary is reflected to the primary as

$$\frac{2}{n^2} = \frac{2}{(1/3)^2} = 9 \times 2 = 18\,\Omega$$

The circuit becomes

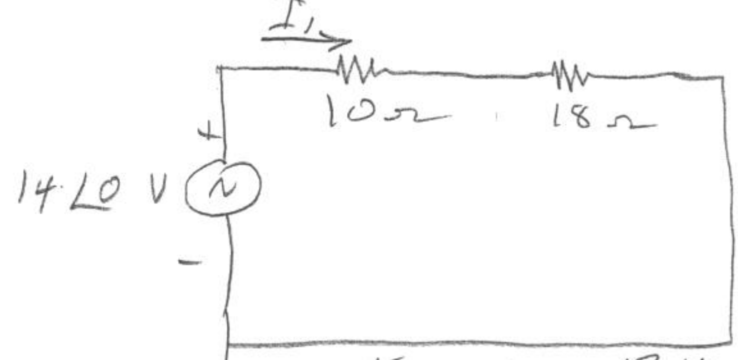


Figure 13.41

$$\begin{array}{cccc} V_1 & V_2 & I_1 & I_2 \end{array}$$
$$\begin{bmatrix} 1 & -3 & 0 & 0 \\ 0 & 0 & 3 & 1 \\ 1 & 0 & 10 & 0 \\ 0 & 1 & 0 & 2 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 14\angle 0 \\ 0 \end{bmatrix}$$

$V_1 = 9V$, $V_2 = 3V$, $I_1 = 0.5A$, $I_2 = -1.5A$

Probably the first method is easier. You have to be very careful with the second method. It is very easy to make a careless error in filling in the matrix.

13,41
cont.

From the previous circuit,

$$28\,I_1 = 14$$

$$\boxed{I_1 = 0.5\ A}$$

$$\frac{I_1}{I_2} = n = -\frac{1}{3}$$

$$\boxed{I_2 = -3I_1 = -1.5\,A}$$

<u>Second method</u>

Assume V_1 & V_2 as shown 13,41 previous page.

$$\frac{V_2}{V_1} = \frac{1}{3} \longrightarrow \boxed{V_1 - 3V_2 = 0}$$

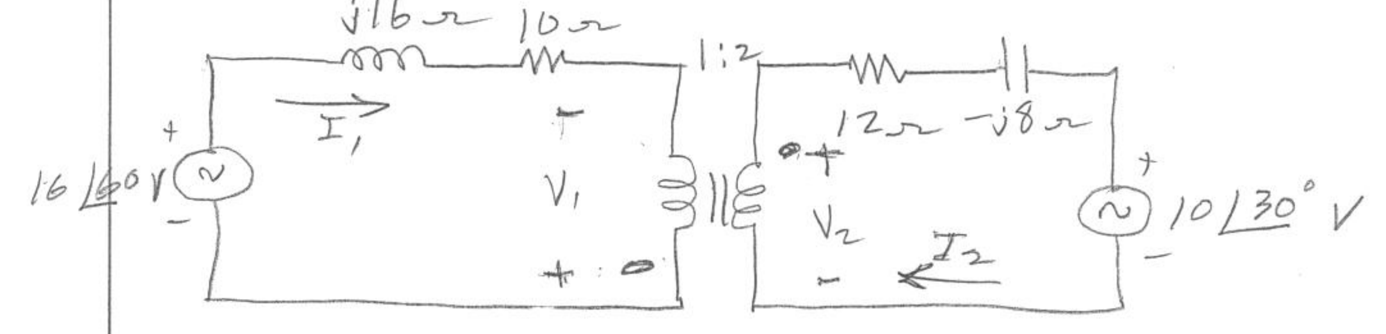
$$\frac{I_1}{I_2} = -\frac{1}{3} \longrightarrow \boxed{3I_1 + I_2 = 0}$$

$$\boxed{10\,I_1 + V_1 = 14\angle 0}$$

$$\boxed{V_2 + 2I_2 = 0}$$

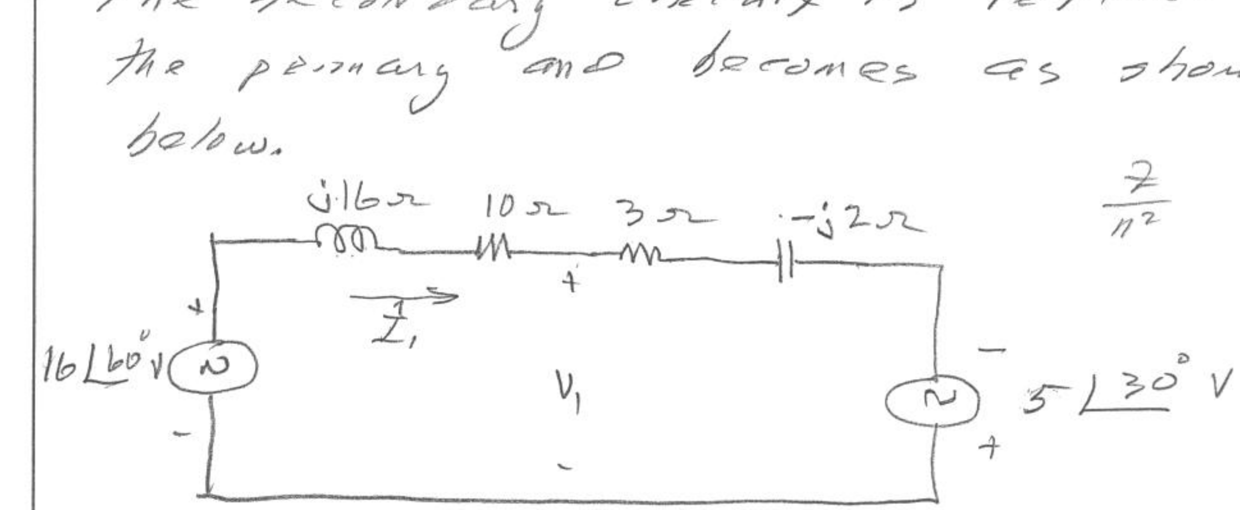
13.46

Find $\hat{I}_1$ and $\hat{I}_2$ in the following circuit.



The secondary circuit is reflected to the primary and becomes as shown below.

$\frac{Z}{n^2}$ $\frac{V}{n}$



$$(13 + j14)\hat{I}_1 = ((16\angle 60) + (5\angle 30^\circ))$$

$$\boxed{\hat{I}_1 = 1.07\angle 5.87^\circ \text{ A}}$$

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

$$\boxed{\hat{I}_2 = 0.535\angle -174.13^\circ \text{ A}}$$

When you switch the dot:

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

$$\boxed{\hat{I}_1 = 0.6247\angle 24.97^\circ \text{ A}}$$

13.46

As a check:

$$\frac{V_2}{V_1} = 2 \longrightarrow \boxed{2V_1 - V_2 = 0}$$

$$\frac{I_1}{I_2} = -2 \longrightarrow \boxed{I_1 + 2I_2 = 0}$$

$$\boxed{(10 + j16)I_1 - V_1 = 16\angle 60^\circ}$$

$$\boxed{(12 - j8)I_2 - V_2 = -10\angle 30}$$

$$\begin{array}{c} \begin{array}{cccc} V_1 & V_2 & I_1 & I_2 \end{array} \\ \underbrace{\begin{bmatrix} 2 & -1 & 0 & 0 \\ 0 & 0 & 1 & 2 \\ -1 & 0 & (10+j16) & 0 \\ 0 & -1 & 0 & (12-j8) \end{bmatrix}}_{A} \end{array} \underbrace{\begin{bmatrix} V_1 \\ V_2 \\ I_1 \\ I_2 \end{bmatrix}}_{S} = \underbrace{\begin{bmatrix} 0 \\ 0 \\ 16\angle 60 \\ -10\angle 30^\circ \end{bmatrix}}_{B} \begin{array}{l} \\ \\ 8+j13.86 \\ -8.66-j5 \end{array}$$

using MATLAB

$S = A^{-1}B$ PROb_13_46.m

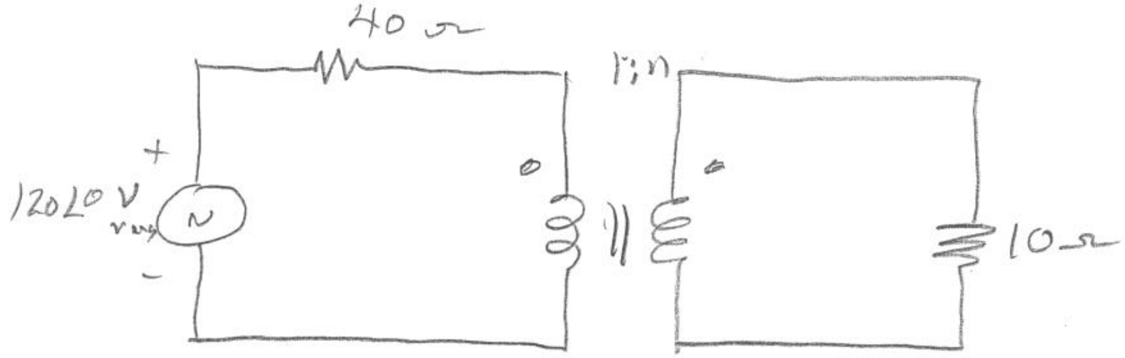
See Attachments. Answers agree

```
>> prob_13_46

A =

   2.0000             -1.0000                  0                  0
        0                   0             1.0000             2.0000
  -1.0000                   0            10.0000 +16.0000i        0
        0             -1.0000                  0            12.0000 - 8.0000i


B =

        0
        0
   8.0000 +13.8600i
  -8.6600 - 5.0000i


S =

   0.9105 + 4.3041i
   1.8210 + 8.6081i
   1.0667 + 0.1098i
  -0.5333 - 0.0549i

>>
```

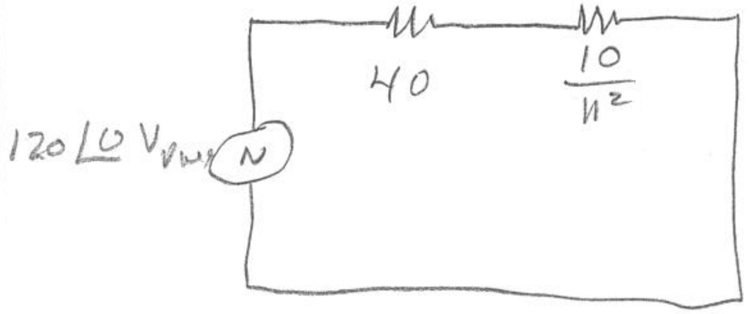
```
% Solving simultaneous equations 4th order complex coefficients
   program name:  prob_13_46.m

A = [2 -1 0 0; 0 0 1 2; -1,0 10+i*16, 0; 0 -1 0 12-i*8]
B = [0;0;8+i*13.86;-8.66-i*5]
S = inv(A)*B
```

13.52

Determine the turns ratio that will cause maximum power transfer to the load. Determine this power.



Reflecting the secondary to the primary gives;



We want $\frac{10}{n^2} = 40$

$n^2 = \frac{1}{4}$ $\quad \boxed{n = \frac{1}{2} = 0.5}$

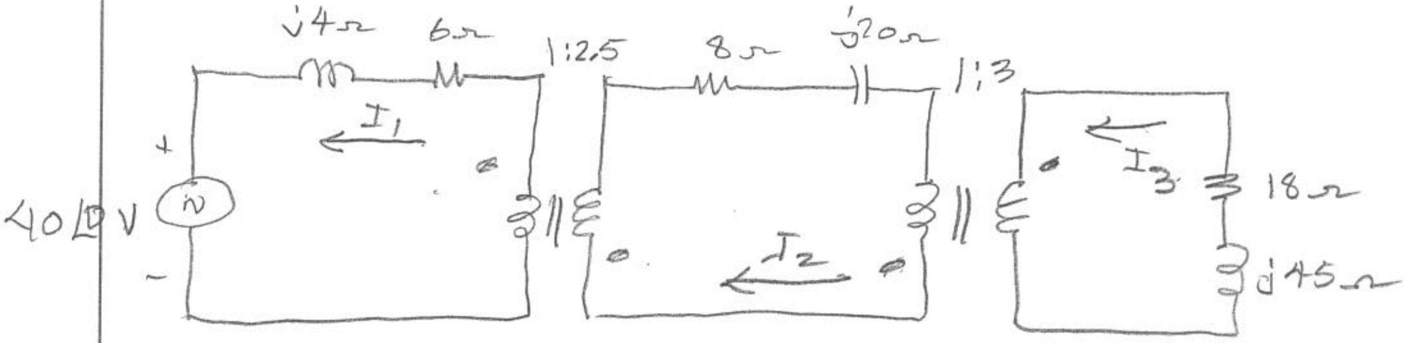
$$\boxed{P = \frac{V^2}{R} = \frac{60^2}{40} = 90\,W}$$

13.62

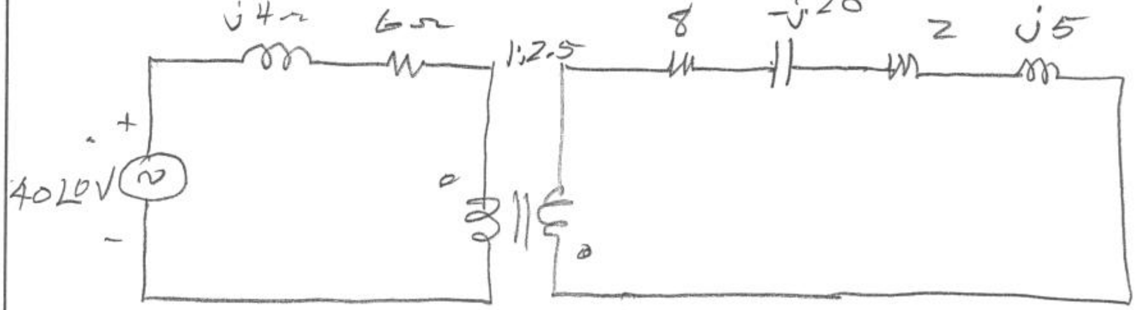
Given the circuit shown below. Find

(a) the complex power supplied by the source,

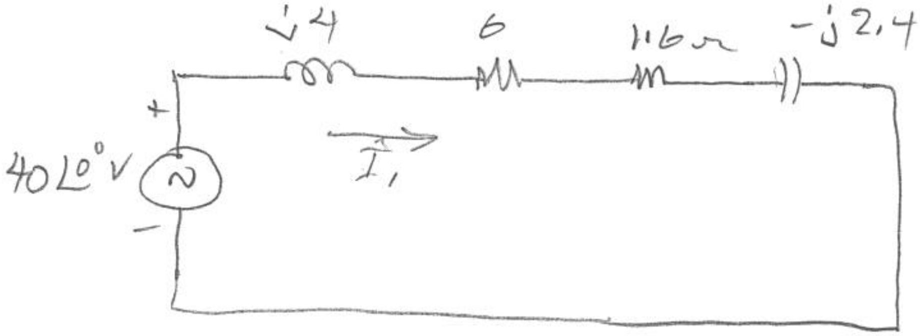
(b) the average power delivered to the 18 Ω resistor.



First reflection gives



Second Reflection:



$$\hat{I}_1 = \frac{40\angle 0}{(7.6 + j\,1.6)} = 5.15\angle -11.89°\ A$$

13.62

$$\vec{S} = \frac{\vec{V}\vec{I}^*}{2} = \frac{40 \times 5.15 \angle 11.89}{2}$$

$$\vec{S} = 103 \underline{\angle 11.89^\circ} \text{ VA}$$

(b) Refer to the first diagram

$$\frac{I_1}{I_2} = 2.5$$

$$\frac{I_2}{I_3} = 3$$

$$\frac{I_1}{\cancel{I_2}} \times \frac{\cancel{I_2}}{I_3} = 2.5 \times 3$$

$$\frac{I_1}{I_3} = 7.5$$

$$\vec{I}_3 = \frac{\vec{I}_1}{7.5} = \frac{5.15 \angle -11.89}{7.5}$$

$$|I_3| = 0.6867 \text{ A}$$

$$\boxed{P_{18} = \frac{|I_3|^2}{2} \times 18 = 4.244 \text{ W}}$$