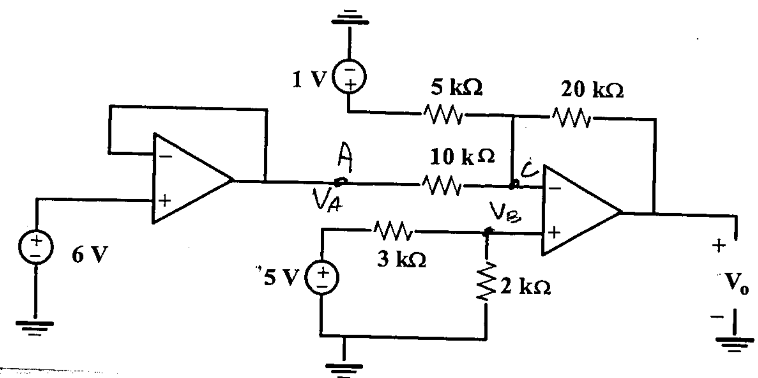
Test B

ECE 301
Test #4B

(1) Find the output voltage, V_o, for the op amp circuit shown in Figure 1.



At "A"; $V_A = 6V$

At V_B

$$V_B = \frac{5 \times 2K}{2K + 3K} = 2V$$

At "C"

$$\frac{V_B - 6}{10K} + \frac{V_B - 1}{5K} + \frac{V_B - V_o}{20K} = 0$$

$$2(2-6) + 4(2-1) + 2 - V_o = 0$$

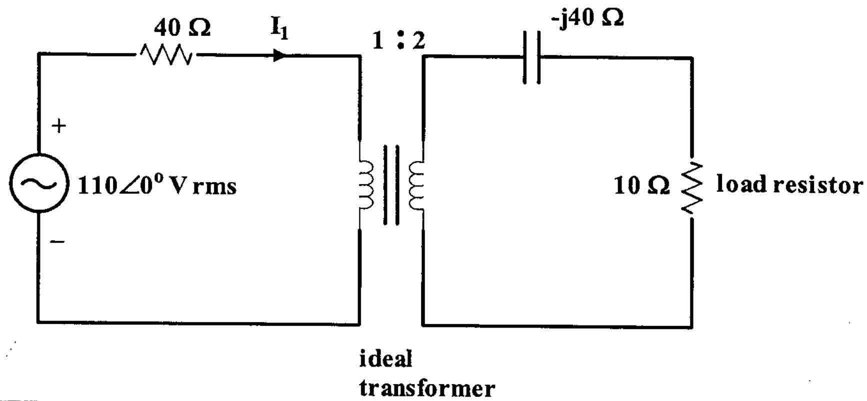
$$-8 + 4 + 2 - V_o = 0$$

$$V_o = -2\ V$$

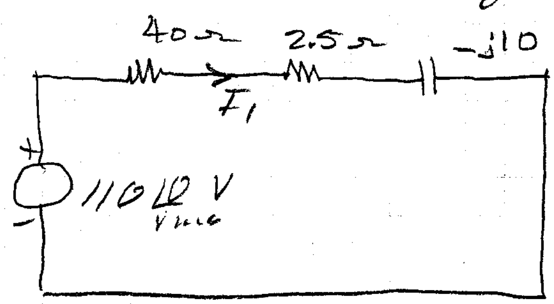
(2) You are given the ideal transformer shown in Figure 2.

(a) Find the phasor current I_1.

(b) Find the power dissipated in the 10 Ω load resistor.



Reflect the secondary to the primary.



(a)

$$I_1 = \frac{110}{42.5 - j10} = 2.52\angle 13.24^\circ \text{ A rms}$$

(b)

$$\left|\frac{I_1}{I_2}\right| = \frac{N_2}{N_1} = 2$$

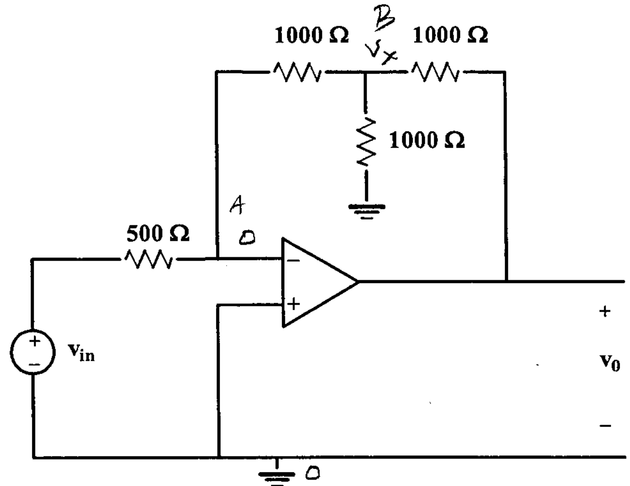
$$|I_2| = \frac{|I_1|}{2} = \frac{2.52}{2} = 1.26 \text{ A rms}$$

$$P_{10} = |I_2|^2 10 = (1.26)^2 \times 10$$

$$P_{10} = 15.88 \text{ W}$$

Version B

(3) Find the output voltage v_0 in terms of the input voltage v_{in} for the op amp circuit of Figure 3.



At A

$$\frac{0 - V_{in}}{500} + \frac{0 - V_x}{1000} = 0$$

$$-2V_{in} - V_x = 0$$

$$V_x = -2V_{in}$$

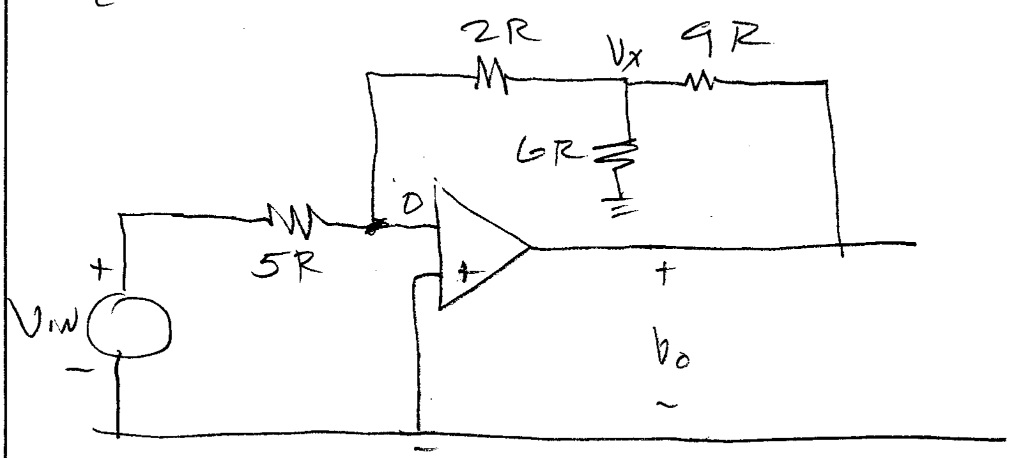
At B

$$\frac{V_x - 0}{1000} + \frac{V_x}{1000} + \frac{V_x - V_o}{1000} = 0$$

$$V_o = 3V_x$$

$$\boxed{V_o = -6V_{in}}$$

Counter Example #3 -



$$-\frac{V_{in}}{5R} + \frac{-V_x}{2R} = 0 \qquad \frac{V_x}{2} = -\frac{V_{in}}{5}$$

$$\left(V_x = -\frac{2}{5} V_{in}\right)$$

$$\frac{V_x}{2R} + \frac{V_x}{6R} + \frac{V_x - V_o}{9R} = 0$$

$$54\left(\frac{V_x}{2R} + \frac{V_x}{6R} + \frac{V_x}{9R} = \frac{V_o}{9R}\right)$$

$$27V_x + 9V_x + 6V_x = 6V_o$$

$$42V_x = 6V_o$$

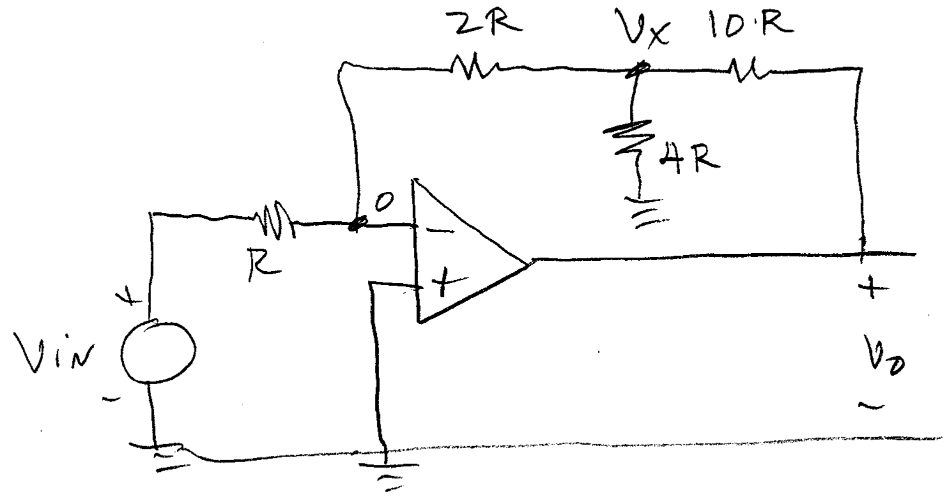
$$\boxed{V_o = \frac{42}{6}\left(\times \frac{-2}{5}\right) V_{in} = \frac{-84}{30} V_{in} = -\frac{14}{5} V_{in}}$$

Other Way

$$\frac{-V_{in}}{5R} + \frac{-V_o}{17R} = 0$$

$$\boxed{V_o = -\frac{17}{5} V_{in}}$$ Does not agree

Counter Example #3



$$-\frac{V_{in}}{R} + \frac{(-V_x)}{2R} = 0 \qquad -2V_{in} - V_x = 0$$

$$\underline{V_x = -2V_{in}}$$

<u>At V_x</u>

$$20\left(\frac{V_x - 0}{2R} + \frac{V_x}{4R} + \frac{V_x - V_o}{10R}\right) = 0$$

$$10V_x + 5V_x + 2V_x - 2V_o = 0$$

$$2V_o = 17V_x = 17(-2V_{in})$$

$$\boxed{V_o = -17V_{in}}$$

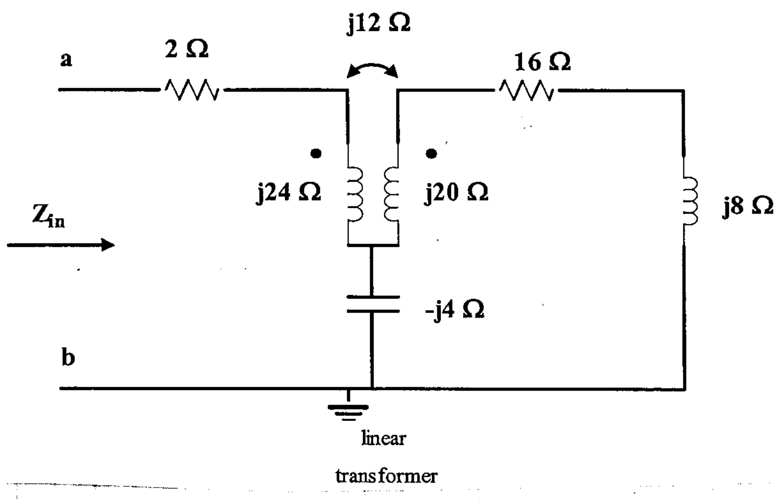
$$-\frac{V_{in}}{R} - \frac{V_o}{16R} = 0$$

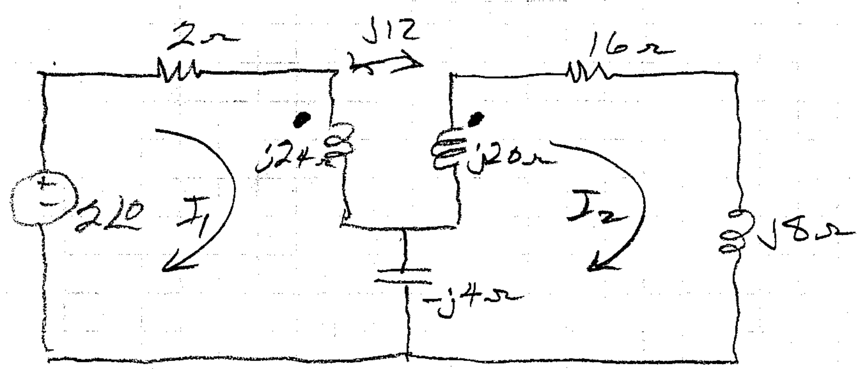
$$V_{in} = -\frac{V_o}{16}$$

$$\boxed{V_o = -16V_{in}}$$ Does not agree

B

(4) You are given the linear transformer circuit shown in Figure 4. Find the input impedance Z_{in} of the circuit.





$(2 + j24 - j4) I_1 + j4 I_2 - j12 I_2 = 2\angle 0$

$(2 + j20) - j8 I_2 = 2\angle 0$

$(-j4 + j20 + 16 + j8) I_2 + j4 I_1 - j12 I_1 = 0$

$-j8 I_1 + (16 + j24) I_2 = 0$

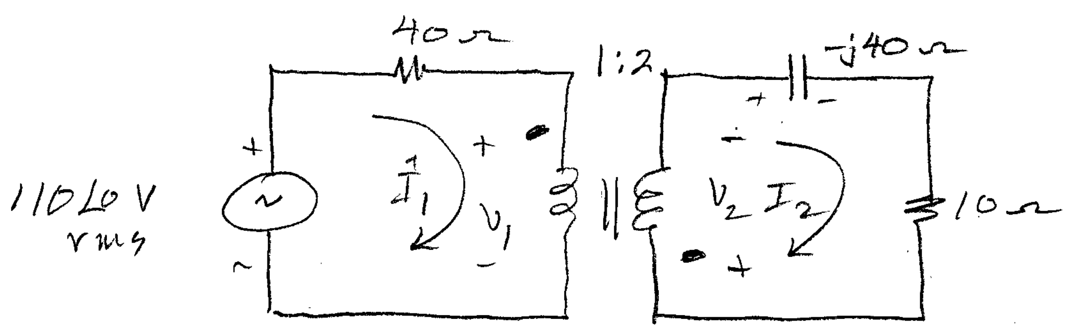
$I_1 = 0.1085 \angle -80$

$$Z_{ab} = \frac{2\angle 0}{0.1085 \angle -80}$$

$Z_{ab} = 18.43 \angle 80^\circ \ \Omega = (3.2 + j18.15)\ \Omega$

(4) This is a tedious and really unnecessary way to work the problem, but I will. One should use reflected impedance

For the answers desired (I_1 & $|I_2|$) it does not matter how I assume dots. I will use the following.



mesh 1

$$V_1 + 40I_1 = 110\angle 0$$

or

$$40I_1 + 0I_2 + V_1 + 0V_2 = 110\angle 0$$

mesh 2

$$(10 - j40)I_2 + V_2 = 0$$

or

$$0I_1 + (10 - j40)I_2 + 0V_1 + V_2 = 0$$

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

or

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

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

or

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

(A) OR

$$\begin{bmatrix} 40 & 0 & 1 & 0 \\ 0, & 10-j40, & 0 & 1 \\ 0 & 0 & 2 & -1 \\ 1 & 2 & 0 & 0 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} 110 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

Need I_1 & I_2

$I_1 = 2.52 \angle 13.2^\circ$ A rms

$I_2 = 1.26 \angle -166.7$ A rms

(b)

$P_{10} = |I_2|^2 \times 10 = (1.26)^2 10$

$P_{10} = 15.88$ W

Real average power always has zero phase angle.