ECE 301
Fall Semester, 2005
HW #8

wlg Practice: No turn-in

Name Green
Print (last, first)

(1) You are given the ideal transformer of Figure 1. (a) Find I_1. Ans $I_1 = 3.07\angle 39.81^\circ$ A.
(b) Find V_o. Ans $V_o = 3.07\angle 39.81$ V.

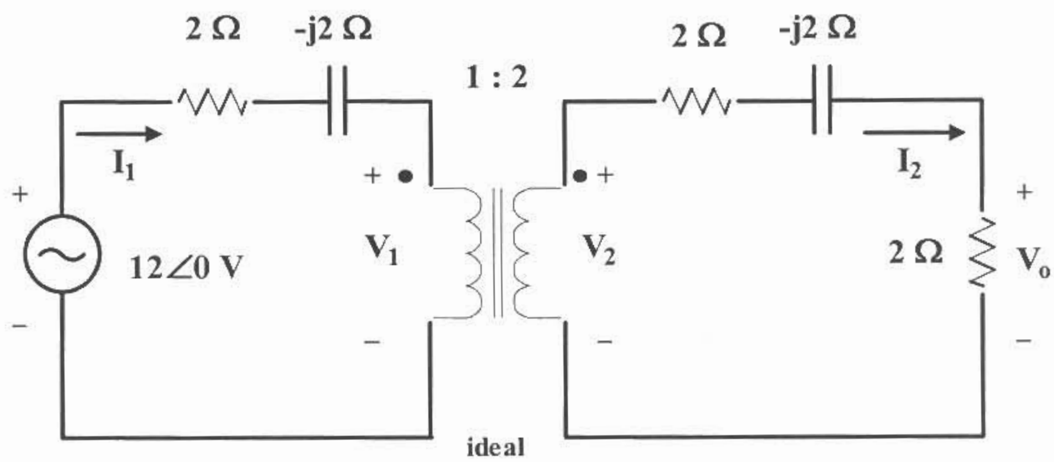


Figure 1: Circuit for problem 1.

(2) Find I_o and Z_{ab} in the linear transformer of Figure 2. Ans: $I_o = 2.2\angle -4.88$ A; $Z_{ab} = 1.5085\angle 17.9^\circ\ \Omega$

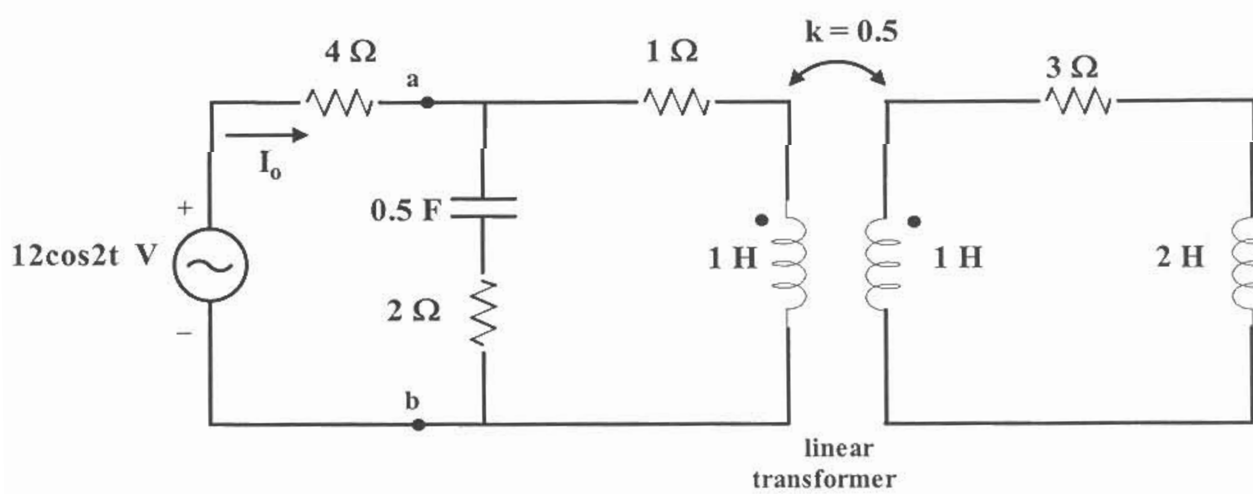


Figure 2: Circuit for problem 2.

(3) Determine the input impedance looking into terminals a-b of the linear transformer circuit shown in Figure 3. Ans: $Z_{ab} = 0.1989 - j9.7\ \Omega$

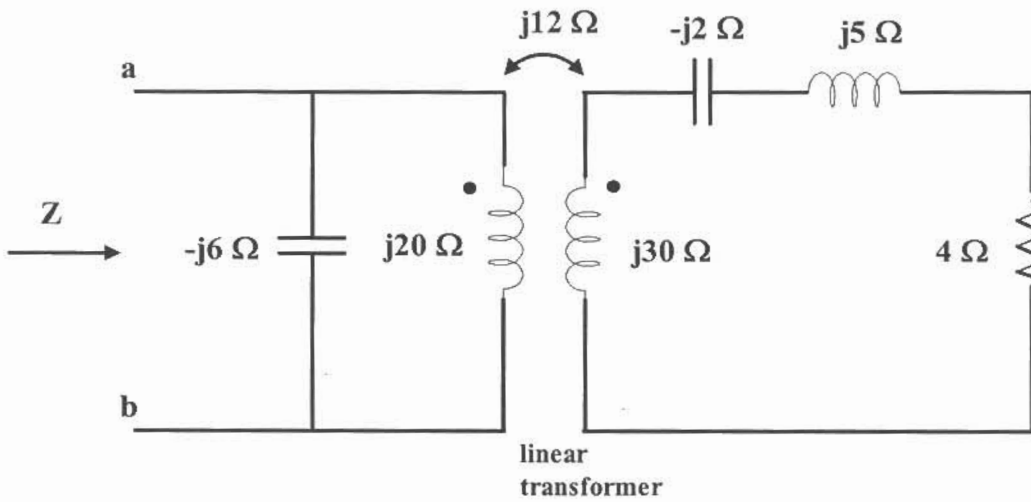


Figure 3: Circuit for problem 3.

(4) (a) Find I_1 and I_2 in the ideal transformer of Figure 4. Ans: $I_1 = 1.07\angle 5.88^\circ$ A, $I_2 = 0.536\angle 185.9^\circ$ A
(b) Switch one of the dots in the circuit of Figure 4. Find I_1 and I_2 again. Ans: $I_1 = 0.625\angle 25^\circ$ A, $I_2 = 0.313\angle 25$ A.

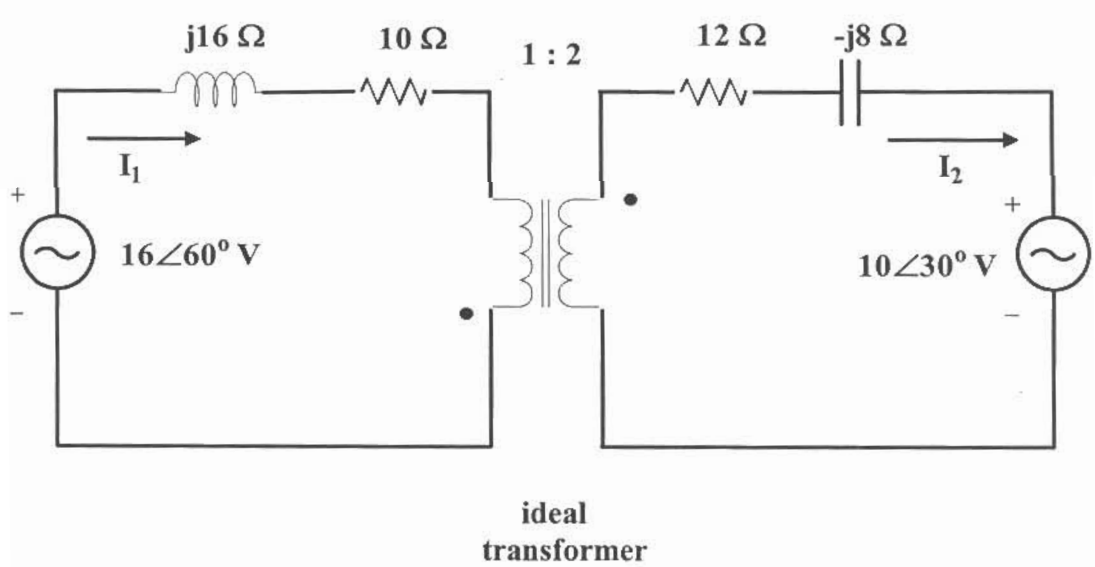


Figure 4: Circuit for problem 4.

(5) A transformer is used to match an amplifier with an 8 Ω speaker load as shown in Figure 5. The Thevenin equivalent of the amplifier is $V_{Th} = 10$ V, $Z_{Th} = 128$ Ω.

(a) Find the required turns ratio for the maximum energy power transfer to the speaker. Ans: $n = 0.25$

(b) Determine the primary and secondary currents. $I_1 = 39.06$ mA, $I_2 = 4xI_1$

(c) Calculate the primary and secondary voltages. $V_1 = 5$ V, $V_2 = 1.25$ V

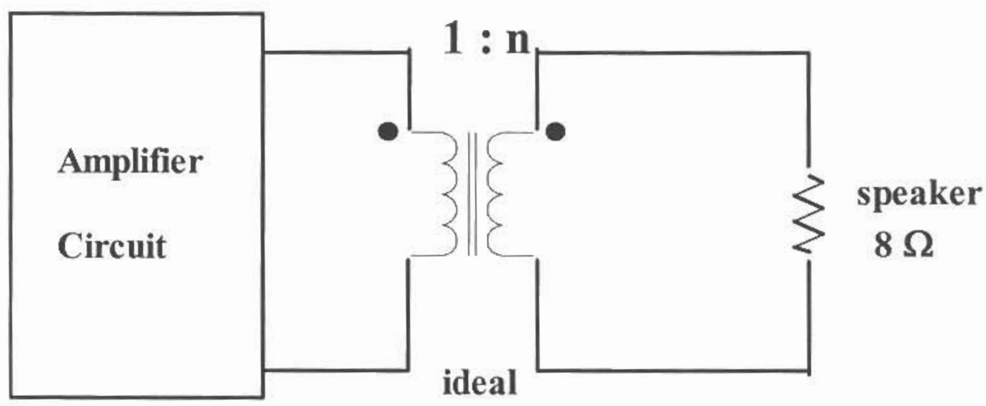
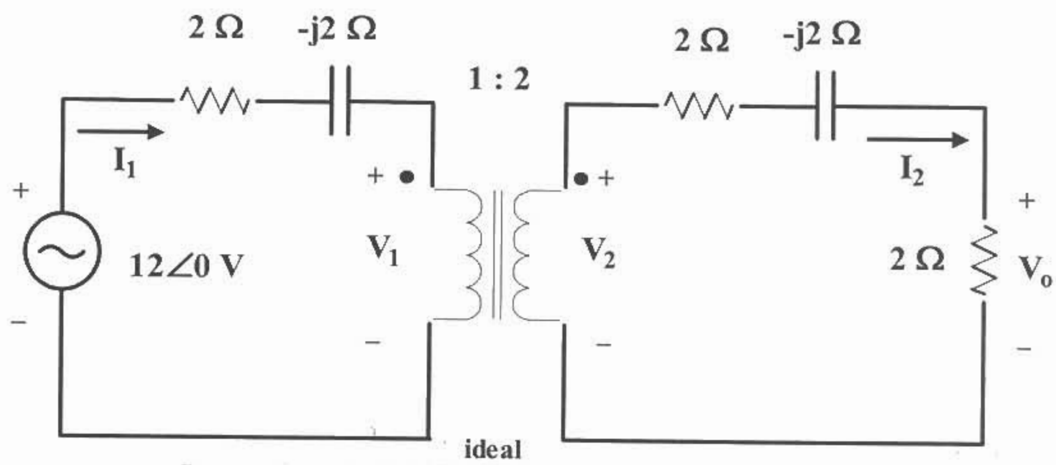


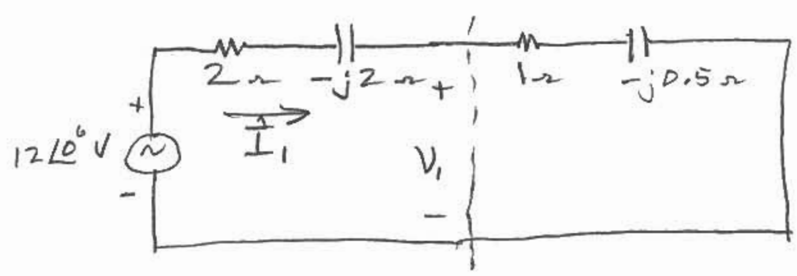
Figure 5: Diagram for problem 5.

(1) You are given the ideal transformer of Figure 1. (a) Find I_1. Ans $I_1 = 3.07\angle 39.81°$ A.
(b) Find V_o. Ans $V_o = 3.07\angle 39.81$ V.



Reflect secondard to primary

$$\frac{4-j2}{2^2} = (1-j0.5)\,\Omega$$



$$-12\angle 0 + (3-j2.5)I_1 = 0$$

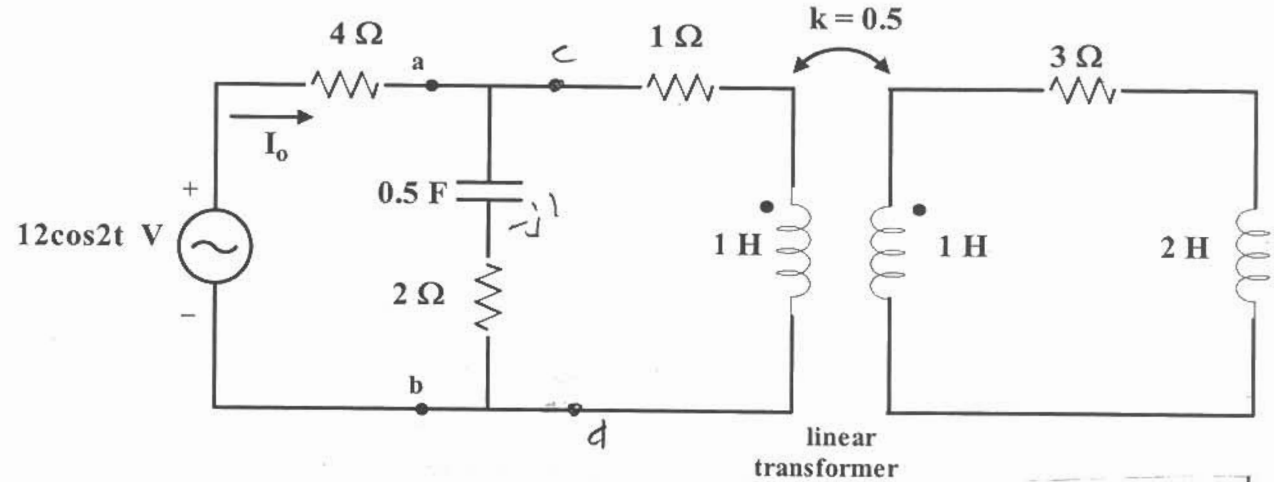
$$\hat{I}_1 = \frac{12\angle 0}{3-j2.5} = 3.07\angle 39.8°\ \text{A}$$

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

$$\hat{V}_o = 2\times\hat{I}_2 = 2\times\frac{\hat{I}_1}{2}$$

$$\hat{V}_o = 3.07\angle 39.8°\ \text{V}$$

(2) Find I_o and Z_{ab} in the linear transformer of Figure 2. Ans: $I_o = 2.2\angle{-4.88}$ A; $Z_{ab} = 1.5085\angle 17.9^\circ\ \Omega$



The impedance seen looking to the right of c-d is

$$Z_{cd} = 1 + j2 \quad \frac{\omega^2 M^2}{R_2 + Z_L + j\omega L_2}$$

$$Z_L = j\omega 2 = j\,2\times 2 = j4$$

$$k = \frac{M}{\sqrt{L_1 L_2}}$$

$$M = 0.5\sqrt{1\times 1} = 0.5\ H$$

$$Z_{cd} = 1 + j2 + \frac{2^2\times(0.5)^2}{3 + j4 + j2} = \left((1+j2) + \frac{1}{(3+j6)}\right)$$

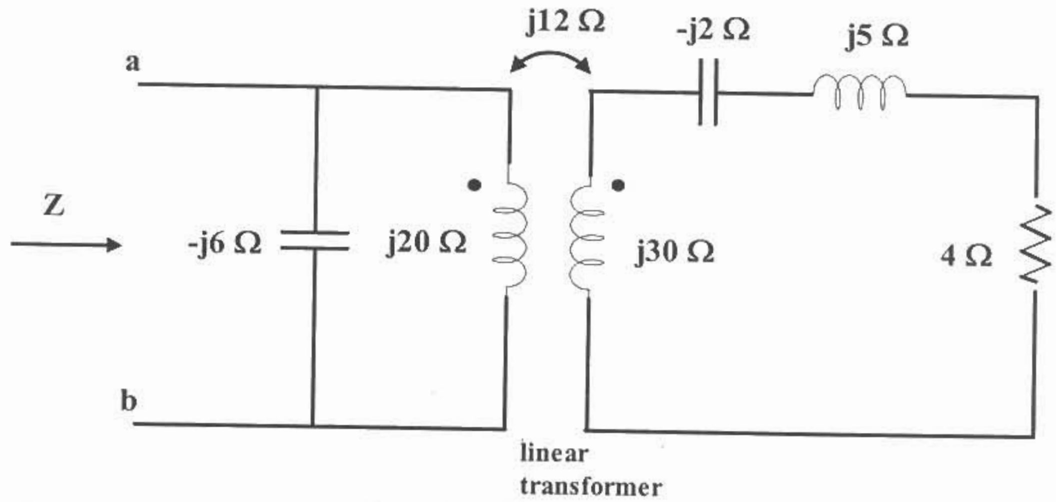
$$Z_{cd} = 2.15\angle 60.3^\circ\ \Omega$$

$$Z_{ab} = (2-j)(2.15\angle 60.3)/((2.15\angle 60.3) + (2-j1))$$

$$Z_{ab} = 1.509\angle 17.9^\circ\ \Omega$$

$$\hat{I}_o = \frac{12\angle 0}{4 + 1.509\angle 17.9} = 2.2\angle{-4.88^\circ}\ A$$

(3) Determine the input impedance looking into terminals a-b of the linear transformer circuit shown in Figure 3. Ans: $Z_{ab} = 0.1989 - j9.7\ \Omega$



$Z = -j6 \parallel Z_o$

where

$$Z_o = j20 + \frac{(\omega M)^2}{j30 - j2 + j5 + 4}$$

$j\omega M = j12$

$\omega M = 12$

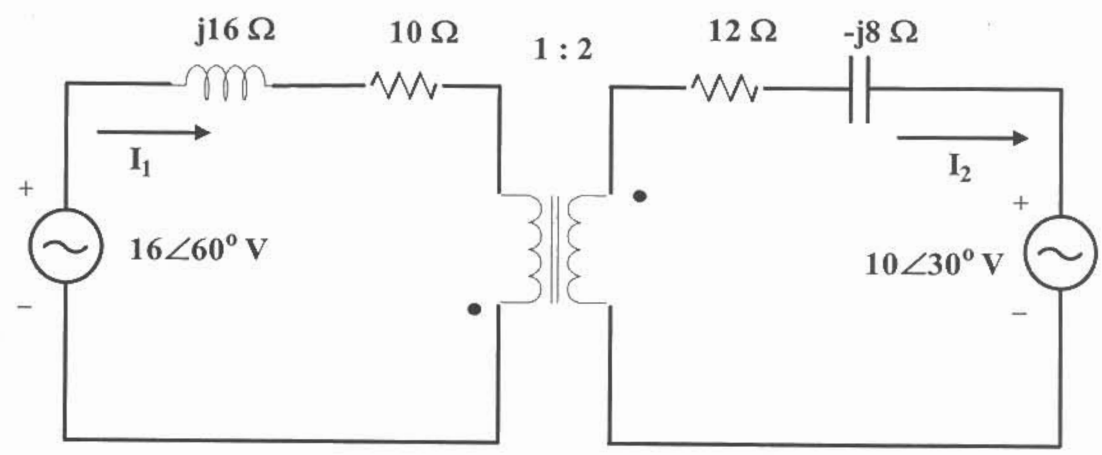
$$Z_o = \left((j20) + \frac{144}{(4 + j33)}\right) = 15.71\angle 88.1^\circ\ \Omega$$

$$Z = (6\angle -90)(15.71\angle 88.1)/((6\angle -90) + (15.71\angle 88.1))$$

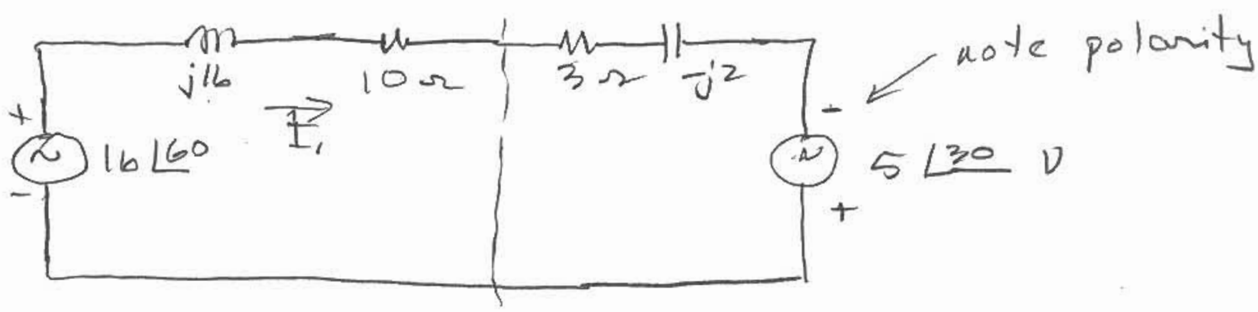
$$Z = (0.1987 - j9.7)\ \Omega$$

(4) (a) Find I_1 and I_2 in the ideal transformer of Figure 4. Ans: $I_1 = 1.07\angle 5.88^\circ$ A, $I_2 = 0.536\angle 185.9^\circ$ A

(b) Switch one of the dots in the circuit of Figure 4. Find I_1 and I_2 again. Ans: $I_1 = 0.576\angle -17.1^\circ$ A, $I_2 = 0.288\angle -17.1$ A.



The secondary reflected to the primary:



$$\frac{12 - j8}{4} = 3 - j2 \qquad \frac{10\angle 30}{2} = 5\angle 30$$

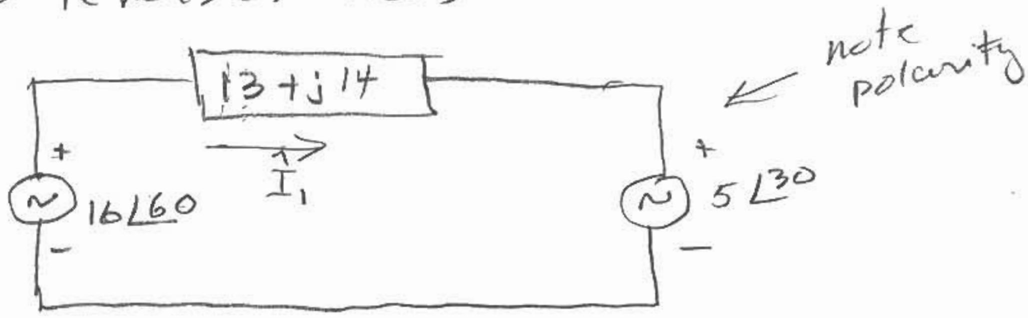
$$\hat{I}_1 = \frac{((16\angle 60) + (5\angle 30))}{(13 + j14)} = 1.07\angle 5.87^\circ \text{ A}$$

$$I_2 = -\frac{I_1}{n} = \frac{-1.07\angle 5.87}{2} = 0.535\angle 185.9 \text{ A}$$

$$\hat{I}_2 = 0.535\angle 185.9 \text{ A}$$

(4) Continued

Changing one of the dots causes the polarity of the secondary to reverse. Thus



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

$$\boxed{\hat{I}_1 = 0.625\angle 25^\circ \text{ A}}$$

$$\hat{I}_2 = +\frac{\hat{I}_1}{n} = \frac{\hat{I}_1}{2}$$

$$\boxed{I_2 = 0.283\angle 25^\circ \text{ A}}$$

(5) A transformer is used to match an amplifier with an 8 Ω speaker load as shown in Figure 5. The Thevenin equivalent of the amplifier is $V_{Th} = 10$ V, $Z_{Th} = 128$ Ω.

(a) Find the required turns ratio for the maximum energy power transfer to the speaker. Ans: n = 0.25

(b) Determine the primary and secondary currents. $I_1 = 39.06$ mA, $I_2 = 4xI_1$

(c) Calculate the primary and secondary voltages. $V_1 = 5$ V, $V_2 = 1.25$ V

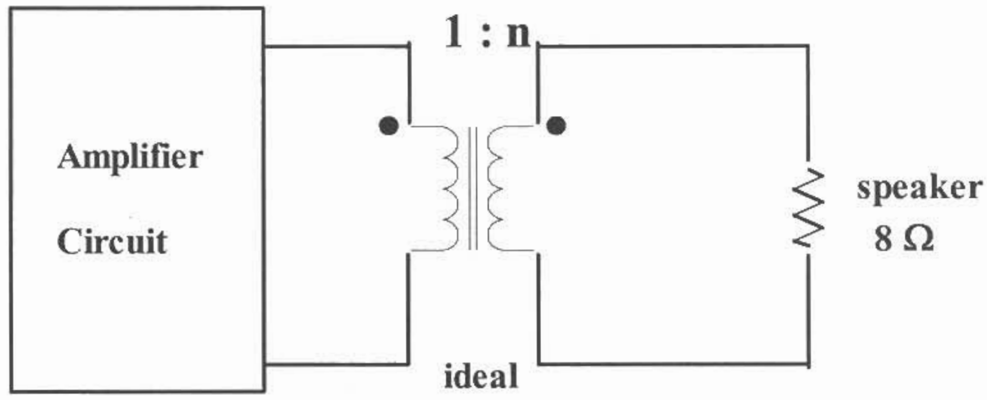
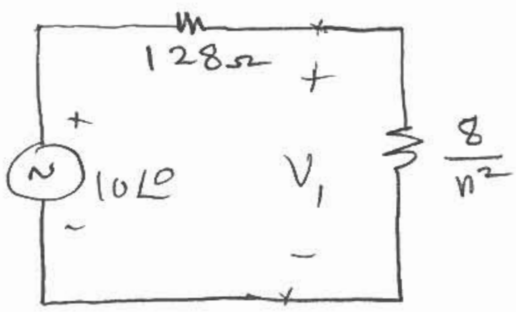


Figure 5: Diagram for problem 5.



(a) For maximum power transfer, we want

$\frac{8}{n^2} = 128$ $n^2 = \frac{8}{128}$ $n = \sqrt{\frac{8}{128}}$

$n = 0.25$

(b) $I_1 = \frac{10\angle 0}{2 \times 128} = 39.06$ mA ; $I_2 = 4 \times I_1$

(c) $V_1 = 5V$ (voltage division)

$V_2 = nV_1 = 0.25 \times 5 = 1.25V$