Desk Copy

ECE 300
Spring Semester, 2006
Test #2

wlg Exam A

Name wlg
Print (last, first)

Work the exam on the space provided below the problem. Work on one side of your paper only. Proglems 1 through 4 count 20% each. Problem 5 counts 10%. Take home problem counts 10%.

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

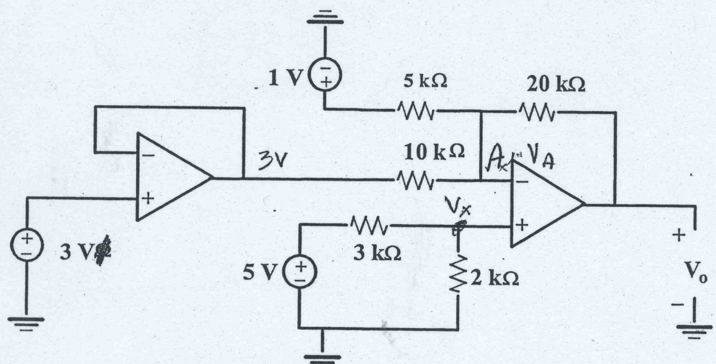


Figure 1: Circuit for problem 1.

$V_x = \frac{5 \times 2K}{3K + 2K} = 2V$; At A, $V_A = V_x = 2V$

At A:

$$\frac{2-3}{10K} + \frac{2-1}{5K} + \frac{2-V_o}{20K} = 0$$

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

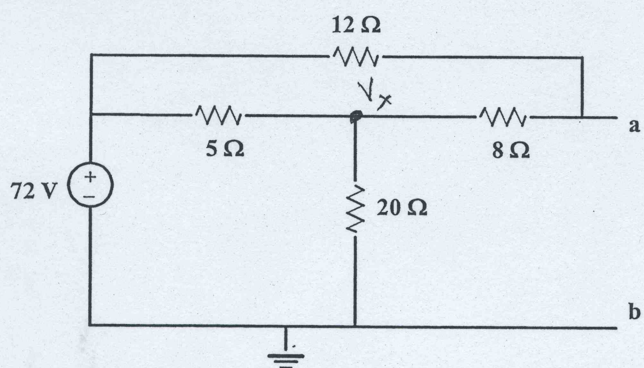
$$V_o = 4V$$

(2) You are given the circuit shown in Figure 2.

(a) Find the Thevenin equivalent circuit, with respect to terminals a-b. Hint: If mesh doesn't work try nodal.

(b) Draw the Thevenin equivalent circuit: include V_{TH} and R_{TH}.

(c) What resistor placed between terminals a-b will give maximum power Transfer to this resistor? Determine the value of this power.



(a)

Figure 2: Circuit for problem 2.

At V_x

40

$$\frac{V_x - 72}{5} + \frac{V_x}{20} + \frac{V_x - V_{ab}}{8} = 0$$

$$8V_x - 576 + 2V_x + 5V_x - 5V_{ab} = 0$$

$$\boxed{15V_x - 5V_{ab} = 576}$$

At a

$$\frac{V_{ab} - V_x}{8} + \frac{V_{ab} - 72}{12} = 0$$

8x12

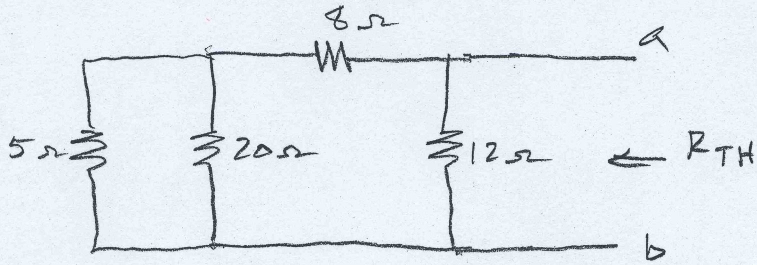
$$12V_{ab} - 12V_x + 8V_{ab} - 576 = 0$$

$$\boxed{-12V_x + 20V_{ab} = 576}$$

$$\begin{bmatrix} 15 & -5 \\ -12 & 20 \end{bmatrix}\begin{bmatrix} V_x \\ V_{ab} \end{bmatrix} = \begin{bmatrix} 576 \\ 576 \end{bmatrix}$$

$V_x = 60\text{V}$ $\quad V_{ab} = \boxed{V_{TH} = 64.8\text{V}}$ Thevenin Voltage

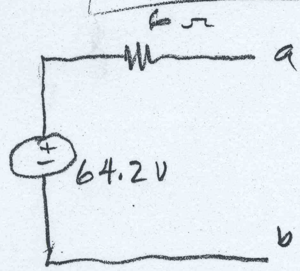
(2) cont. FOR R_{TH}



$5 \| 20 = 4\,\Omega$

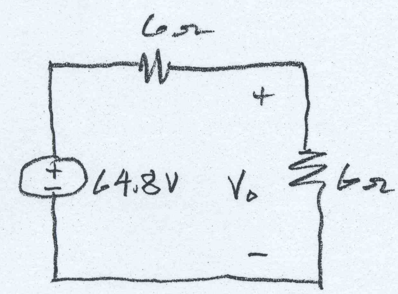
$\therefore$ $R_{TH} = 6\,\Omega$ Thevenin resistance

(b)



Thevenin Circuit

(c)



For maximum power transfer.

$$P_o = \frac{V_o^2}{6}$$

$$V_o = 32.4$$

$$P_o = \frac{(32.4)^2}{6}$$

$$P_o = 175\ W$$ Output power

(3) You are given the circuit of Figure 3.

(a) Find the Norton equivalent circuit with respect to terminals a-b. You are required to find I_{NORTON} by actually finding the short circuit current.

(b) Draw your Norton equivalent circuit showing the I_{NORTON}, R_{TH} and terminals a-b.

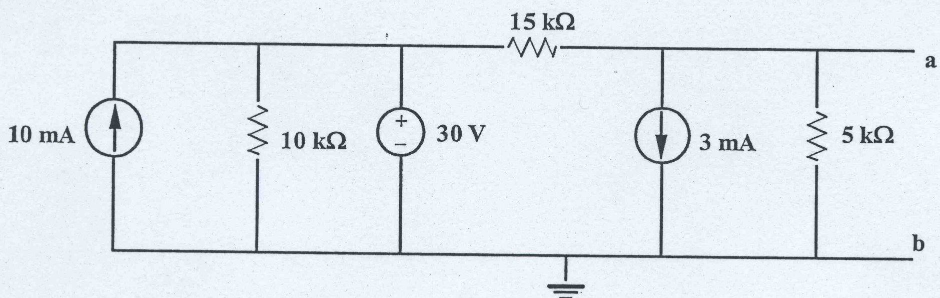
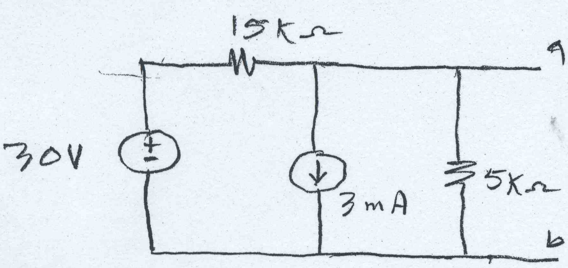


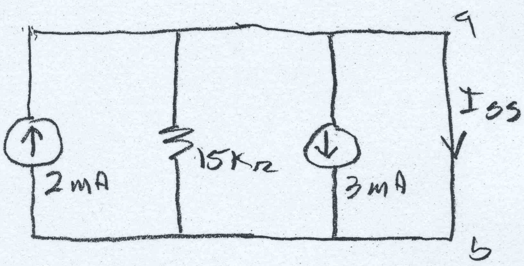
Figure 3: Circuit for problem 3.

(a) The circuit is the same as follows:



(a)

⟹ with output shorted



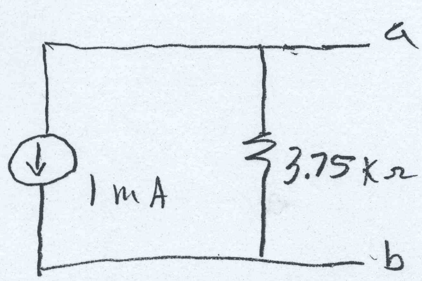
(b) shorting the output, shorts out the 5kΩ resistor

From (b);

$I_{ss} = -1\,mA$; From (a) $R_{TH} = \frac{(5K)(15K)}{5K+15K} = 3.75K\Omega$

$I_{NORTON} = -1\,mA$ | $R_{TH} = 3.75K\Omega$

(b)



Norton Circuit

A

(4) You are given the circuit of Figure 4.

(a) Give the value of the Thevenin voltage seen looking into terminals a-b.

(b) Determine the resistance R_{TH} seen looking into terminals a-b.

(c) Draw your Thevenin equivalent circuit.

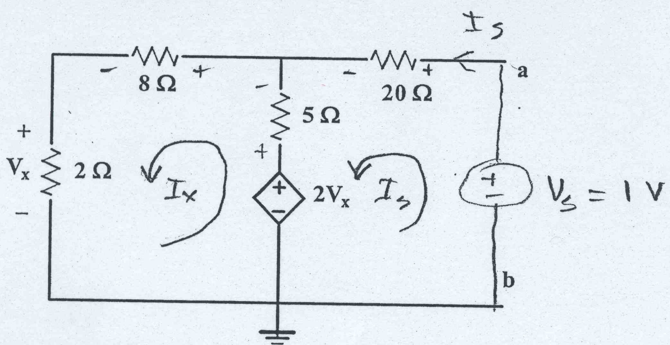


Figure 4: Circuit for problem 4.

(a) Since there are no independent source, $V_{TH} = 0$. (It is a dead circuit).

(b) Apply a source voltage of 1V at terminals a-b. Determine I_s as shown; $R_{TH} = \frac{V_s}{I_s} = \frac{1}{I_s}$

Writing mesh equations.

mesh I_x

$$-2V_x + 5(I_x - I_s) + 10 I_x = 0 \qquad (1)$$

but $V_x = 2I_x$ (2) Substitute (2) into (1), clear

$$11 I_x - 5 I_s = 0 \qquad (3)$$

mesh I_s

$$-1 + 20 I_s - 5(I_x - I_s) + 2V_x = 0 \qquad (4)$$

Substitute (4) into (2), clear

$$-I_x + 25 I_s = 1 \qquad (5)$$

$-5I_x$
$+4I_x$

(4) continued

FROM (3) and (5)

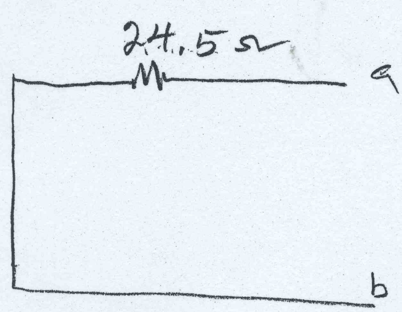
$$\begin{bmatrix} 11 & -5 \\ -1 & 25 \end{bmatrix} \begin{bmatrix} I_x \\ I_s \end{bmatrix} = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$$

$I_s = 0.04074$

$R_{TH} = \frac{V_s}{I_s} = \frac{1}{.04071} = 24.5\Omega$

$\boxed{R_{TH} = 24.5\Omega}$

(c)



Thevenin Circuit

A

(5) Find the voltage across each capacitor in the circuit show in in Figure 5.

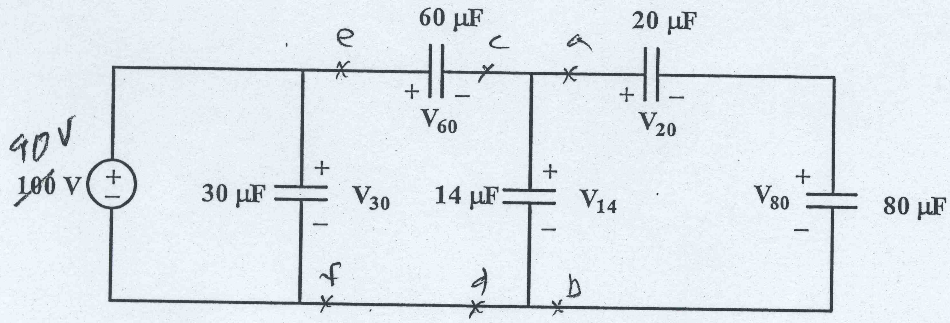


Figure 5: Circuit for problem 5.

To the right of a-b; $C_{ab} = \frac{20 \times 80}{20 + 80} = 16\mu F$

To the right of cd; $C_{cd} = (14 + 16)\mu F = 30\mu F$

To the right of e-f; $C_{ef} = \frac{60 \times 30}{60 + 30}\mu F = 20\mu F$

$V_{30} = 90V$

$V_{60} = \frac{90 \times 30}{30 + 60} = 30V$

$V_{14} = 60V$ KVL

$V_{20} = \frac{60 \times 80}{80 + 20} = 48V$

$V_{80} = 12V$

100V

$V_{60} = \frac{100 \times 30}{90} = 33.3\,V$ $V_{14} = \frac{100 \times 60}{90} = 66.6\,V$

$V_{20} = \frac{66.6 \times 80}{100} = 53.28V$ $V_{80} = \frac{66.6 \times 20}{100} = 13.32V$