Desk Copy

ECE 300
Spring Semester, 2007
Test #2

wlg **Test A** **Name** Wiley
Print (last, first)

Work the exam on your own engineering paper. Work on one side of your paper only. Attach your work to the back of this exam sheet and staple in the top left hand corner. Each problem percentage credit is indicated out beside the problem.

(1) You are given the circuit of Figure 1.

25%

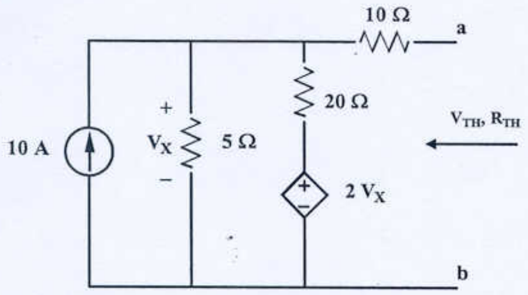


Figure 1: Circuit for problem 1.

(a) Determine the short-circuit current, that is, the current flowing through a wire with zero ohms connected between a-b.

(b) Determine the open-circuit voltage, that is, the voltage between terminals a-b with the short removed.

(c) Determine V_{TH} (Thevenin's voltage) and R_{TH} (Thevenin's resistance) looking into a-b.

(d) Draw your Thevenin circuit showing V_{TH} and R_{TH} and terminals a – b.

(2) You are given the op-amp configuration shown below. Determine V_0.

15%

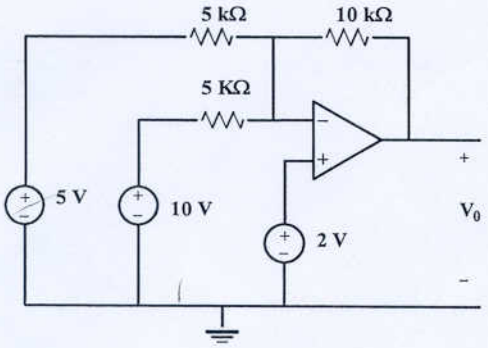


Figure 2: Problem for problem 2.

(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.

20%

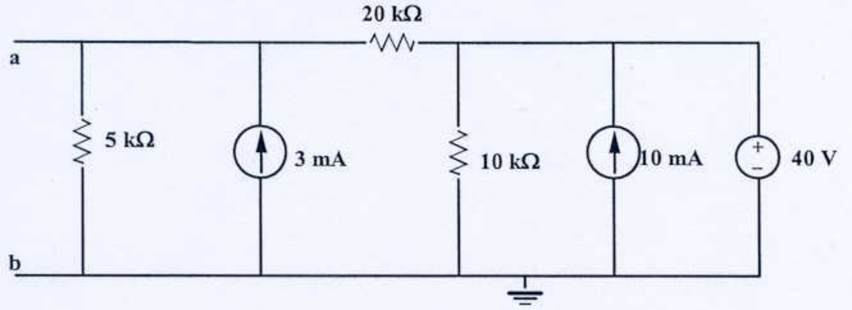


Figure 3: Circuit for problem 3.

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

- (a) Find the Thevenin equivalent circuit to the left of A-B. Draw the circuit.
- (b) Find the value of R_L for maximum power transfer to R_L.
- (c) What is the value of the power delivered to R_L when it has the value found in (b)?

20%

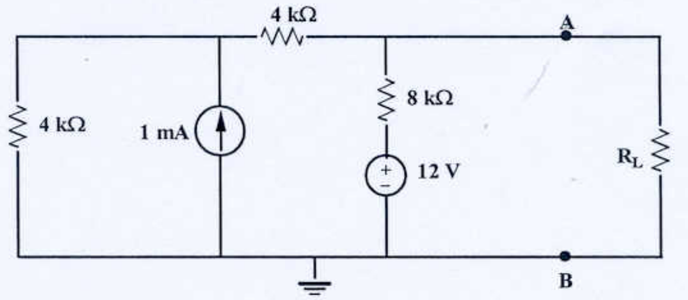


Figure 4: Circuit for problem 4.

(5) Consider the circuit shown in Figure 5. The switch is closed at t = 0 and has been closed long enough for the circuit to reach steady state; that is, all currents and voltages in the circuit have reached constant values. C_1 and R are unknown. Under these conditions determine the

- (a) currents I_1 and I_2,
- (b) the capacitor voltage V_c,
- (c) the energy stored in the 4µF capacitor.

20%

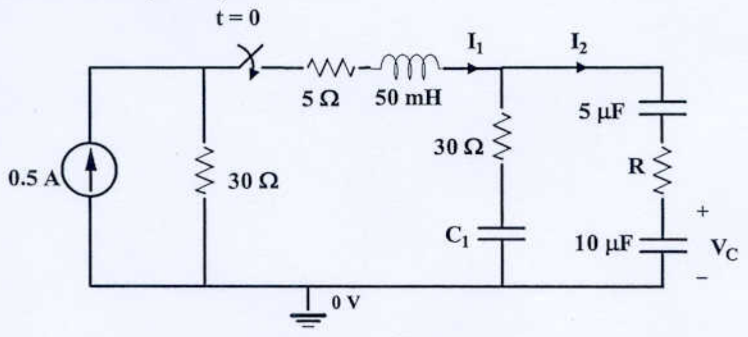


Figure 5: Circuit for problem 5.

Test 2A

(1) You are given the circuit of Figure 1.

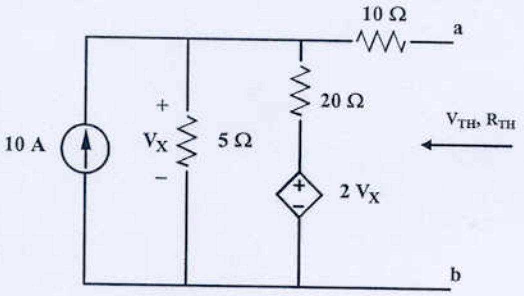


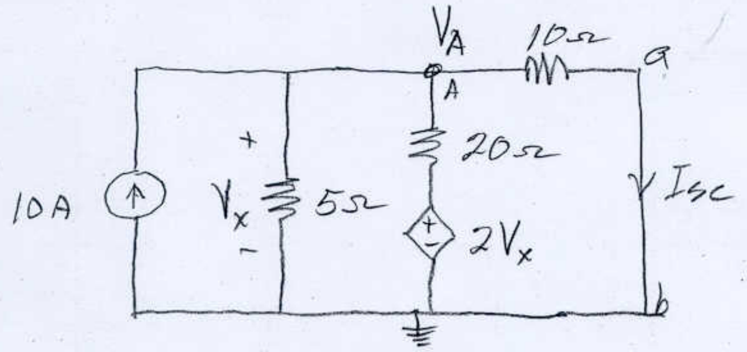
Figure 1: Circuit for problem 1.

(a) Determine the short-circuit current, that is, the current flowing through a wire with zero ohms connected between a-b.

(b) Determine the open-circuit voltage, that is, the voltage between terminals a-b with the short removed.

(c) Determine V_{TH} (Thevenin's voltage) and R_{TH} (Thevenin's resistance) looking into a-b.

With the terminals a-b shorted



Using nodal analysis at A:

$$\frac{V_A}{5} + \frac{V_A - 2V_x}{20} + \frac{V_A}{10} = 10$$

$$4V_A + V_A - \cancel{2V_x} + \cancel{2V_A} = 200$$

but $V_x = V_A$

Clearing above; $5V_A = 200$

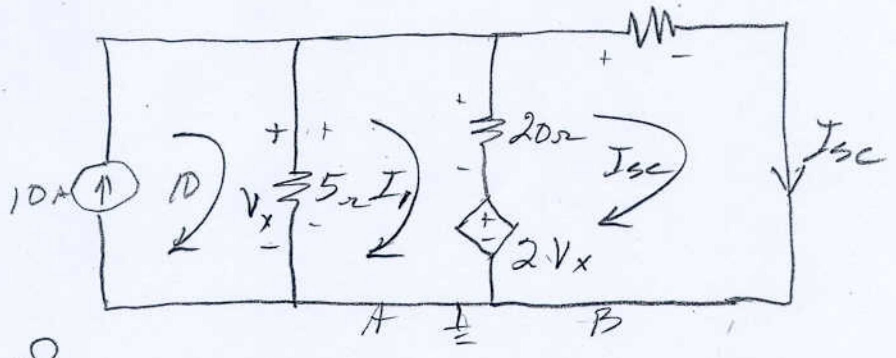
$$V_A = 40V$$

(1) cont.

$$\therefore \quad I_{sc} = \frac{V_A}{10} = \frac{40}{10}$$

$$\boxed{I_{sc} = 4A}$$

A second method for finding I_{sc}



Around mesh A
$$-5(10-I_1) + 20(I_1-I_{sc}) + 2V_x = 0$$

but $V_x = 5(10-I_1)$

so
$$-50+5I_1+20I_1-20I_{sc}+100-10I_1 = 0$$

$$\boxed{15I_1 - 20I_{sc} = -50}$$

Around Mesh B
$$-2V_x - 20(I_1-I_{sc}) + 10I_{sc} = 0$$
$$-10(10-I_1) - 20I_1 + 20I_{sc} + 10I_{sc} = 0$$

$$\boxed{-10I_1 + 30I_{sc} = 100}$$

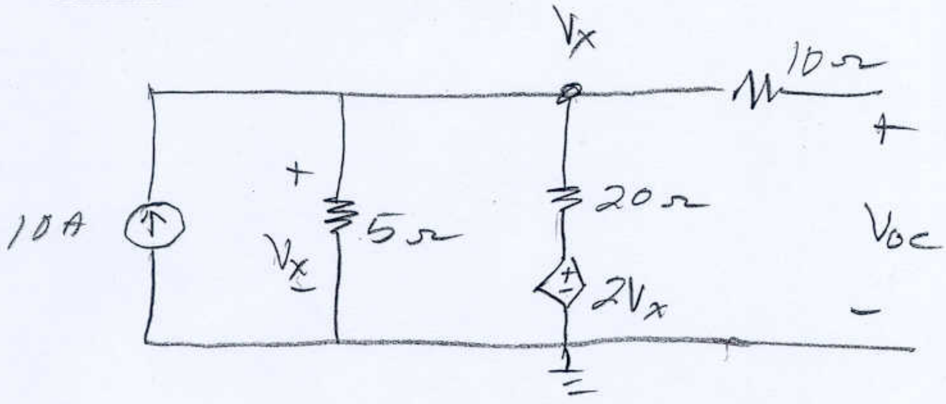
$$\begin{bmatrix} 15 & -20 \\ -10 & 30 \end{bmatrix}\begin{bmatrix} I_1 \\ I_{sc} \end{bmatrix} = \begin{bmatrix} -50 \\ 100 \end{bmatrix}$$

$\underline{I_{sc} = 4A}$

checks

(b) cont,

Find V_{oc}



Note that $V_x = V_{oc}$; using nodal

$$\frac{V_x}{5} + \frac{V_x - 2V_x}{20} = 10$$

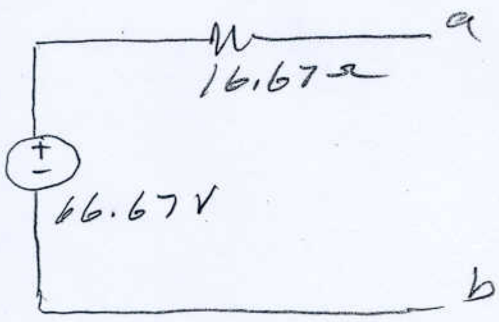
$$4V_x - V_x = 200$$

$$V_x = \frac{200}{3} = V_{oc}$$

(c) $V_{TH} = \left(\frac{200}{3}\right)V = 66.67\ V$

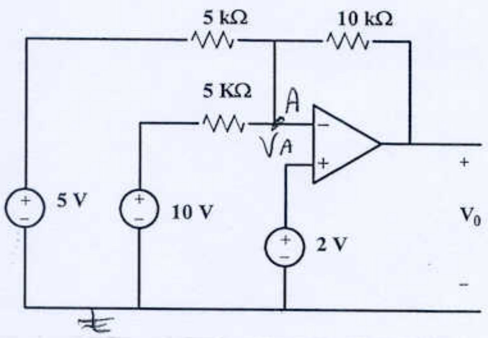
$$R_{TH} = \frac{V_{TH}}{I_{sc}} = \frac{200}{3\times 4} = 16.67\Omega$$

$$R_{TH} = 16.67\Omega$$



Test 2A

(2) You are given the op-amp configuration shown below. Determine V_0.



At A

$V_A = 2$ V

$$\frac{2-10}{5K} + \frac{2-5}{5K} + \frac{2-V_0}{10K} = 0$$

$$-16 - 6 + 2 - V_o = 0$$

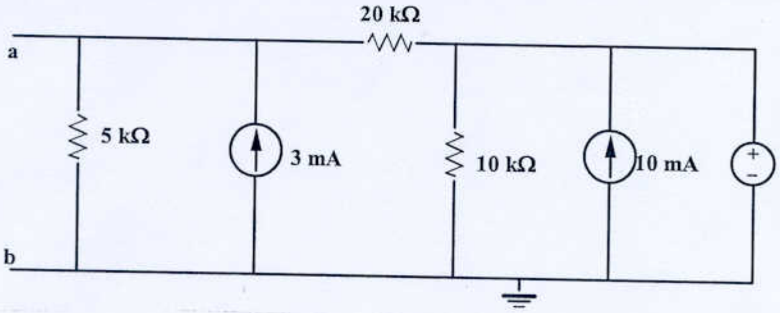
$$\boxed{V_0 = -20\text{ V}}$$

Test 2A

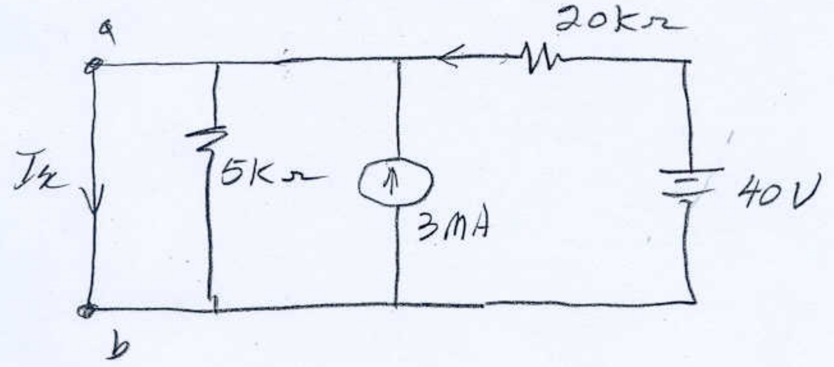
(3). You are given the circuit of Figure 3.

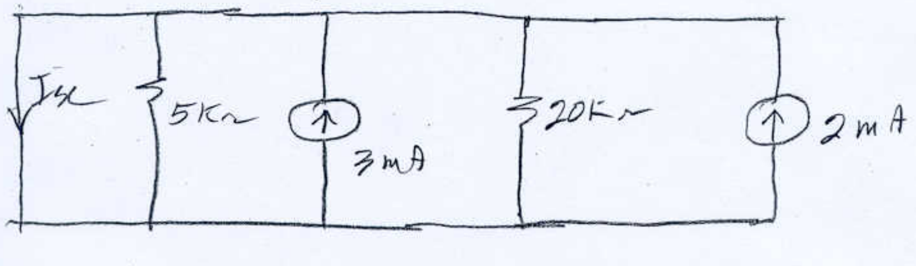
(a) Find the Norton equivalent circuit with respect to terminals a-b. You are required to find I_{NORTON} by actually finding the short circuit current.

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



The circuit is equivalent to



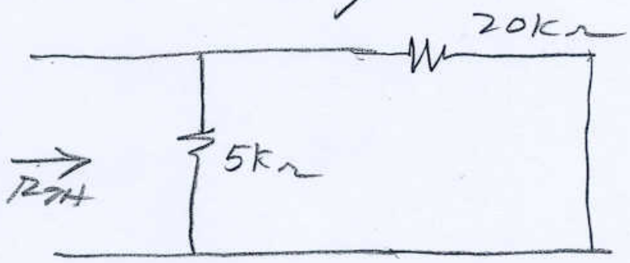


All the current from the current sources will go through the short,

$\therefore \quad I_N = I_{sc} = 5 \, mA$

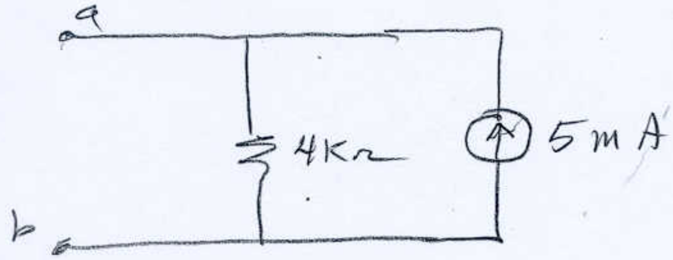
(3) cont

looking in a-b with the independent sources de-energized gives



$R_{TH} = 5K \parallel 20K = 4K$

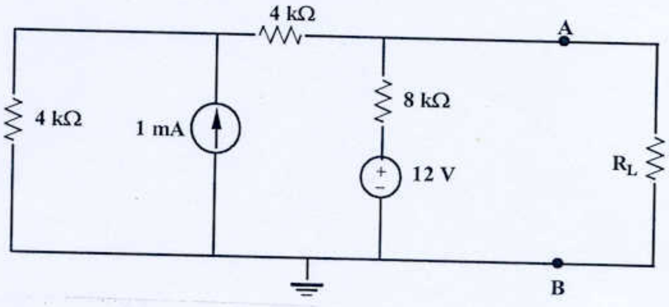
(b)



2A

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

(a) Find the Thevenin equivalent circuit to the left of A-B. Draw the circuit.
(b) Find the value of R_L for maximum power transfer to R_L.
(c) What is the value of the power delivered to R_L when it has the value found in (b)?

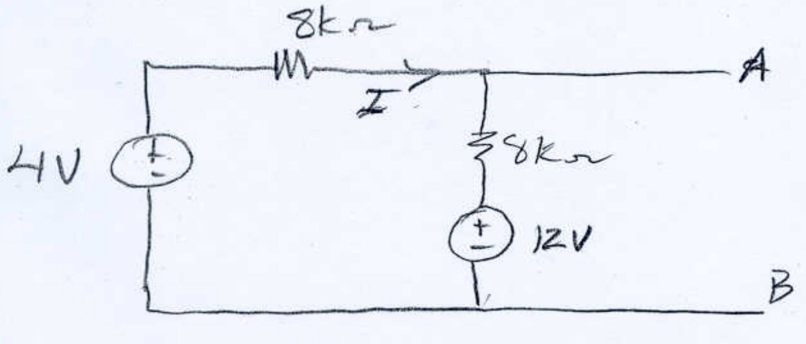


(a) Find the R_{TH}

Looking into a-b with R_L removed and independent sources de-energized:

$R_{TH} = 8K // (4k + 4k) = 4k\Omega$

Find V_{Ab} with R_L removed:
Using source transformation gives



$I = \frac{4-12}{16K} = \frac{-8}{16K} = -.5\text{ mA}$

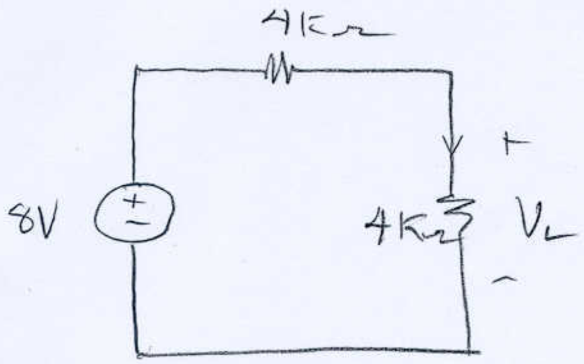
$V_{AB} = 12 - (8k)(.5\text{mA}) = 8V$

(4) cont

(b) The value of R_L for max power transfer is

$$R_L = 4K$$

(c) To find P_{LOAD}



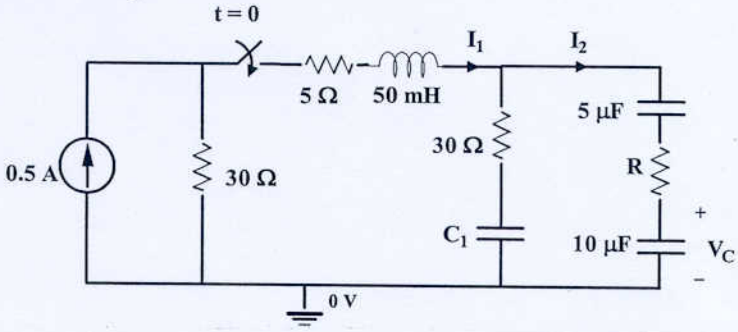
$$P_L = \frac{V_L^2}{R_L} = \frac{(4)^2}{4K}$$

$$\boxed{P_L = 4\,mW}$$

2X

(5) Consider the circuit shown in Figure 5. The switch is closed at t = 0 and has been closed long enough for the circuit to reach steady state; that is, all currents and voltages in the circuit have reached constant values. C_1 and R are unknown. Under these conditions determine the

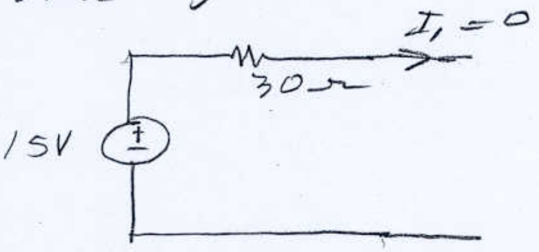
(a) currents I_1 and I_2,
(b) the capacitor voltage V_c, 5μF
(c) the energy stored in the 4μF capacitor.



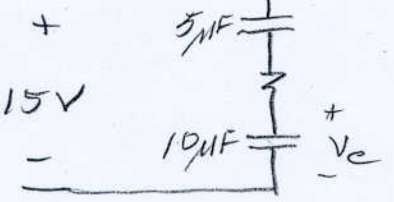
(a) Since the capacitors act like open-circuits in steady state;

$I_1 = I_2 = 0$

(b) The current source and 30Ω resistor give



The voltage across the load



$V_c = \frac{15 \times 5\mu}{5\mu + 10\mu}$

$V_c = 5V$

(c) The voltage across the 5μF capacitor is 15−5=10V

∴ $W_{C_5} = \frac{1}{2} 5 \times 10^{-6} \times 10^{2} = 250 \times 10^{-6}$ Joules