ECE 300
Spring 2008
Test 2B

wlg

(1) You are given the following circuit.

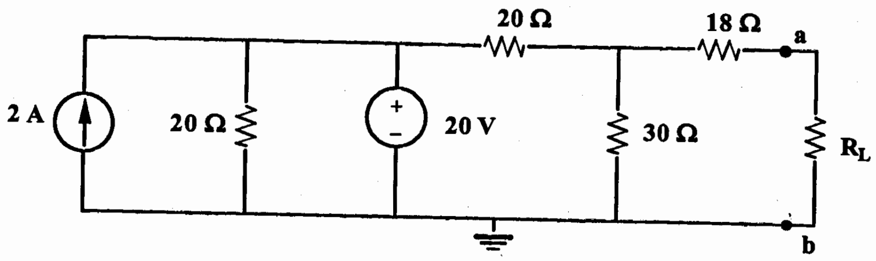
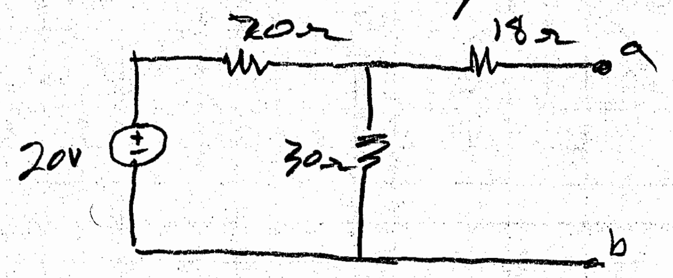


Figure 1: Circuit for Problem 1.

(a) Determine V_{TH} and R_{TH} looking into terminals a-b with R_L removed.
(b) Draw your Thevenin circuit. Show V_{TH} and R_{TH} on the circuit diagram connected to R_L.
(c) Assign a value of R_L that will give maximum power transfer to R_L and determine this value of power.

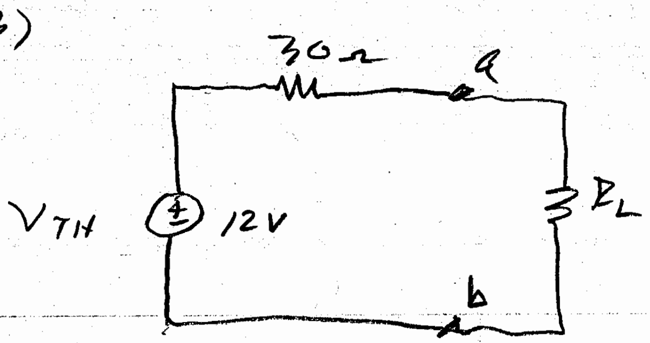
(a) The circuit is equivalent to the following:



$V_{OC} = V_{TH} = \frac{20 \times 30}{20 + 30} = 12 V$

$R_{TH} = 20 \| 30 + 18 = 12 + 18 = 30 \Omega$

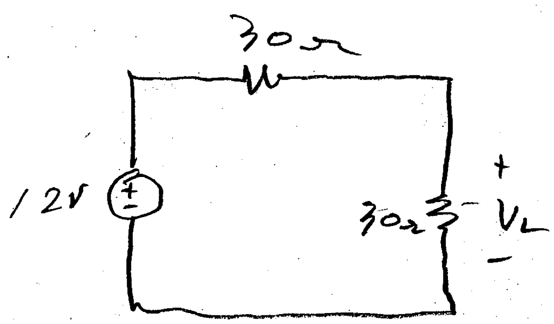
(b)



(1) cont.

(c)

$R_L = R_{TH} = 30\Omega$



$$P_{OUT} = \frac{V_L^2}{30} = \frac{6^2}{30} = 1.2W$$

$P_{OUT} = 1.2W$

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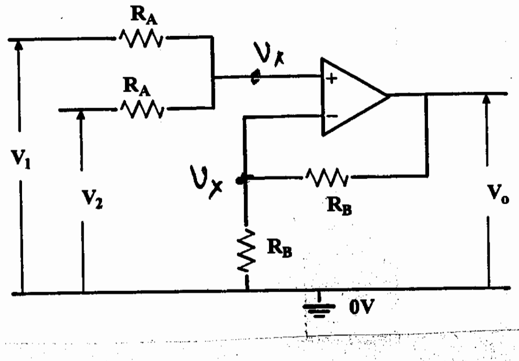
(2) You are given the op amp circuit of Figure 2. Use ideal op amp assumptions in answer the following questions. V_o can be expressed in the following form:

$$V_o = [C]V_1 + [D]V_2$$

(a) Find the coefficients [C] and [D].
(b) If $V_1 = 3$ V and $V_2 = 1$ V, find the value of V_o.



1a) $V_x = \dfrac{V_o R_B}{R_B + R_B} = \dfrac{V_o}{2}$ (1)

Also

$$\frac{V_x - V_1}{R_A} + \frac{V_x - V_2}{R_A} = 0$$

$2V_x - V_1 - V_2 = 0$ (2)

substitute (1) into (2)

$V_o - V_1 - V_2 = 0$

$V_o = V_1 + V_2$ $C = 1$; $D = 1$

1b) $V_o = V_1 + V_2 \Big|_{V_1 = 3V,\ V_2 = 1V}$

$V_o = 3 + 1 = 4V$

$V_o = 4V$

Test 2B

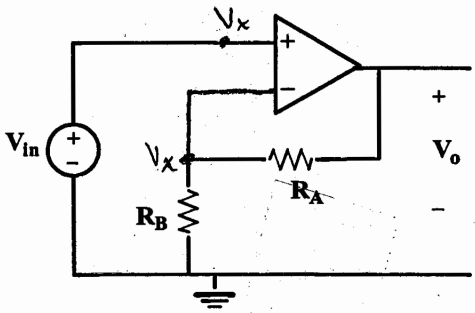
(3) For the following problems assume ideal op amps.

(a) Design an inverting op amp circuit using a single op amp such that the gain is given by

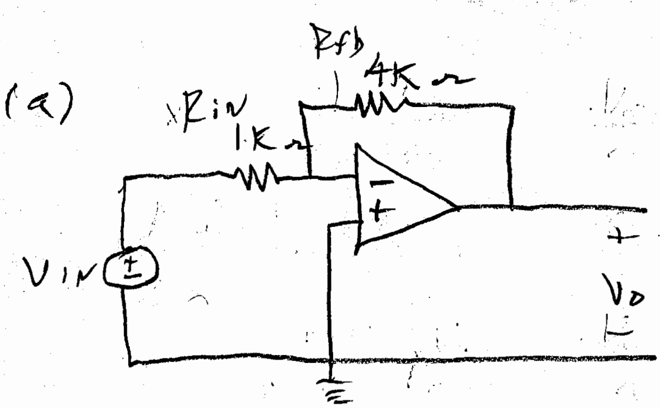
$$\frac{V_o}{V_{in}} = -4$$

Show (draw) your op amp circuit and give the values of all resistors on your circuit diagram. Also, show on your diagram, an appropriate ground along with V_o and V_{in}. You are restricted to resistors of values 1 kΩ, 2 kΩ, 3 kΩ, 4 kΩ and 5 kΩ.

(b) You are given the non-inverting op amp circuit shown in Figure 3(b). Determine values of R_A and R_B so that $V_o = 4V_{in}$. You are restricted to resistors of values 1 kΩ, 2 kΩ, 3 kΩ, 4 kΩ and 5 kΩ.



(a)



$$\frac{V_o}{V_{IN}} = -\frac{R_{fb}}{R_{IN}}$$

$$\frac{V_o}{V_{IN}} = -4$$

(b)

$$V_x = \frac{V_o \times R_B}{R_A + R_B} = V_{IN}$$

$$\frac{V_o}{V_{IN}} = \frac{R_A + R_B}{R_B} = 1 + \frac{R_A}{R_B}$$

$$V_o = \left(1 + \frac{R_A}{R_B}\right) V_{IN} = 4\,V_{IN}$$

$$\frac{R_A}{R_B} = 3 = \frac{3\,k\Omega}{1\,k\Omega}$$

$R_A = 3\,k\Omega$; $R_B = 1\,k\Omega$

Test 2B

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

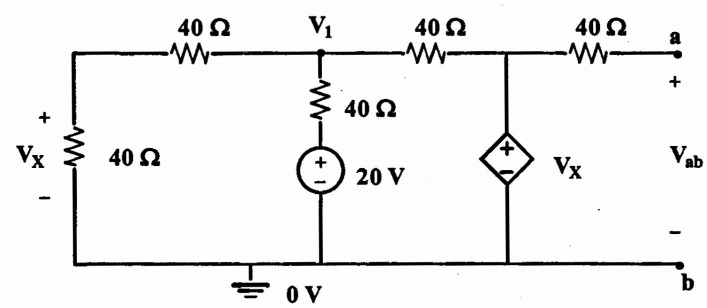


Figure 4 (a): Circuit for Problem 4 (a).

(a) Use the ***nodal analysis method*** to find the open circuit voltage, V_{ab}, as shown in Figure 4 (a).

(b) Place a short circuit from terminals a to b of the circuit shown in Figure 4 (a). Use the ***nodal analysis method*** to find I_{SC} as shown in Figure 4 (b).

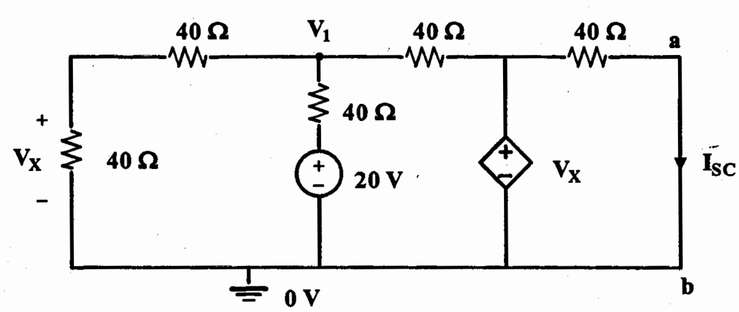


Figure 4 (b): Circuit for Problem 4 (b).

(c) Using the information of 4 (a) and 4 (b), determine the Norton equivalent circuit. Draw the circuit showing I_{Norton} and R_{Norton} and terminals a-b.

(a) $\frac{V_1}{80} + \frac{V_1 - 20}{40} + \frac{V_1 - V_x}{40} = 0$

$V_1 + 2V_1 - 40 + 2V_1 - 2V_x = 0$

$5V_1 - 2V_x = 40$

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

$4V_1 = 40$

$V_1 = 10\text{ V}$

$V_x = 5V = V_{oc} = V_{TH}$

(4)

(b) For I_{sc}

$$\frac{V_1}{80} + \frac{V_1 - 20}{40} + \frac{V_1 - V_x}{40} = 0$$

same as in part (a)

$\therefore$

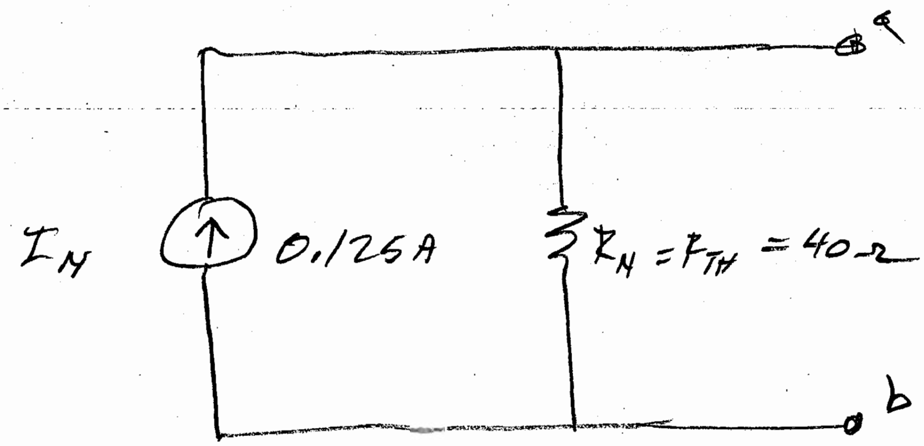
$$V_1 = 10V$$

$$V_x = \frac{V_1}{2} = 5V$$

$$I_{sc} = \frac{V_x}{40} = \frac{5}{40} = 0.125A$$

(c)

$$R_{TH} = R_N = \frac{V_{oc}}{I_{sc}} = \frac{5}{.125} = 40\Omega$$



(5) Assume the circuit shown in Figure 5 is in steady state.

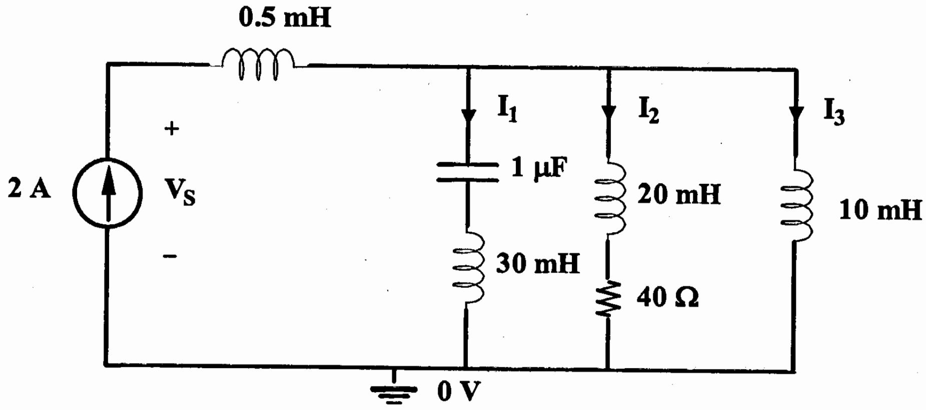
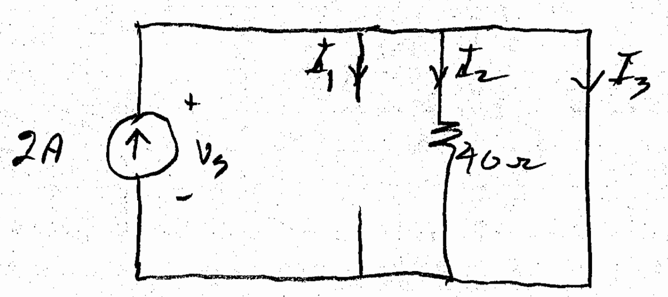


Figure 5: Circuit for Problem 5.

(a) Determine the steady state values of the currents I_1, I_2, and I_3.
(b) Determine the steady state value of the voltage V_S.
(c) Determine the energy stored in the magnetic field of the 10 mH inductor.

(a) In steady state the circuit becomes



$I_1 = 0$, $I_2 = 0$, $I_3 = 2A$

(b) $V_s = 0$

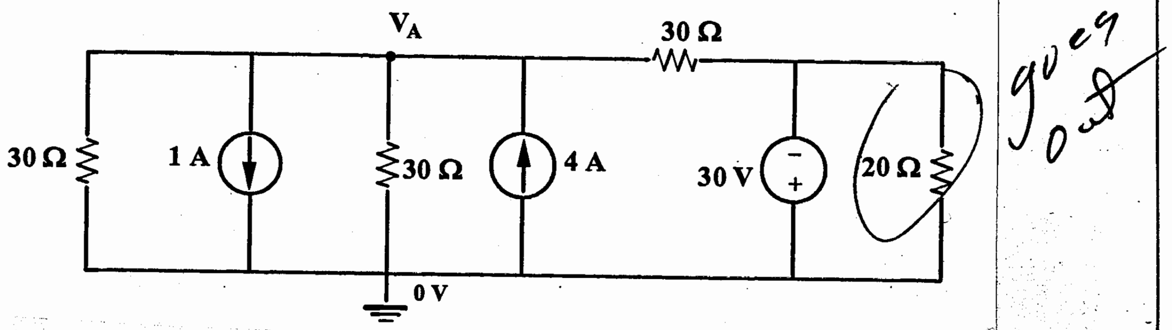
(c) $W_{10mH} = \frac{1}{2} L I_3^2 = \frac{1}{2} \times .01 \times 2^2$

$W = .02 J$

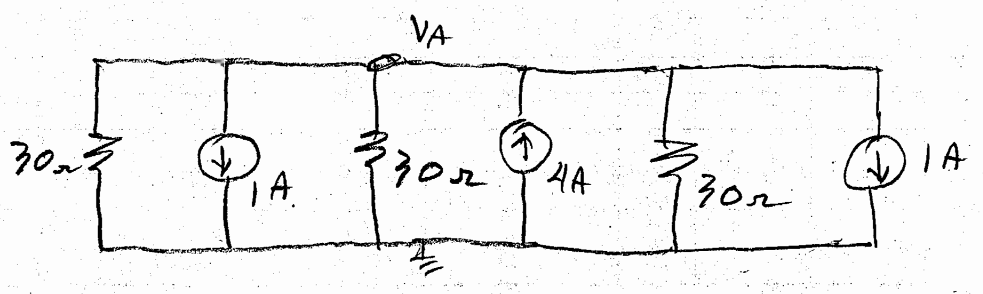
Test 2B

(6) Use any method you desire to find the voltage V_A in the circuit of Figure 6.

15%

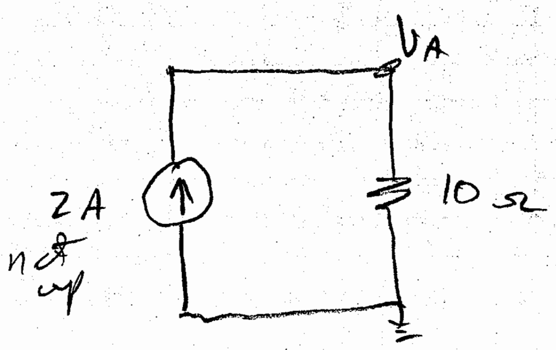


Circuit becomes;



Reduces to

3, 30Ω resistor in ∥ $= \frac{30}{3} = 10\Omega$



$V_A = 20\,V$