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ECE 300
Test #2
Spring Semester, 2005

wlg

PM Section　　AM Section　　Name Green
Print (last, first)

(1) Develop the Thevenin equivalent circuit as seen looking into terminals a-b of the circuit of Figure 1. Using your Thevenin circuit, connect a 100 Ω resistor between terminals a-b and determine V_{ab}.

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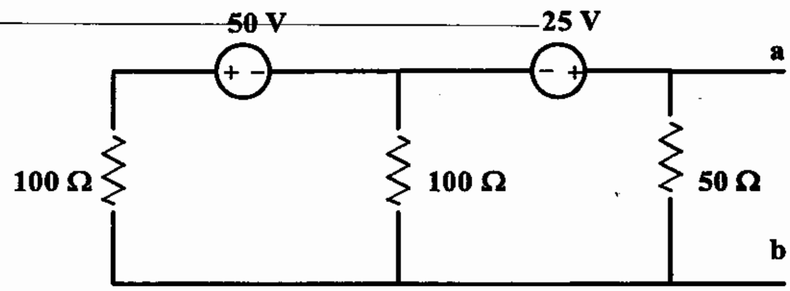

Figure 1: Circuit for problem 1.

(2) Find I_0 in the network of Figure 2 using Thevenin's theorem.

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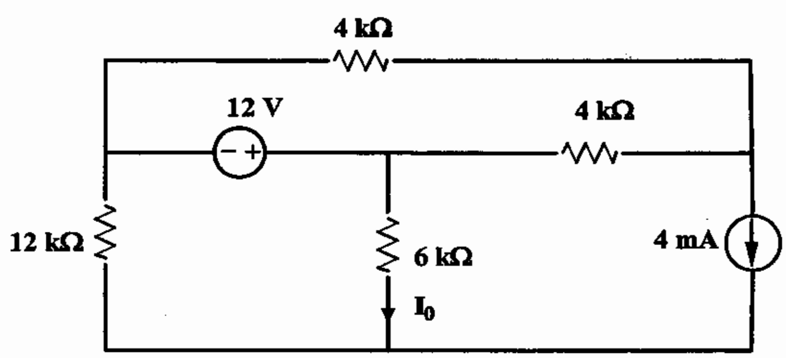

Figure 2: Circuit for problem 2.

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

(a) Place a short across a-b and determine the current flowing from a to b. Call this I_N.

(b) Find the Thevenin resistance looking into terminals a-b.

(c) Draw the Norton equivalent circuit as seen by looking into terminals a-b.

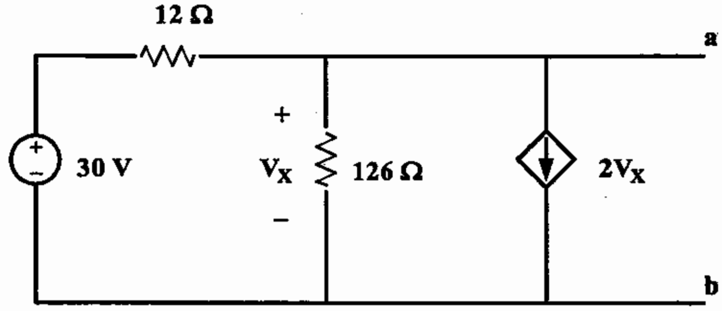

Figure 3: Circuit for problem 3.

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(4) You are given the circuit of figure 4. The circuit is in steady state. In other words, I as shown in the circuit, equal 0. Find v_1, v_2, and v_3. How much energy is stored in the 5 μF capacitor?

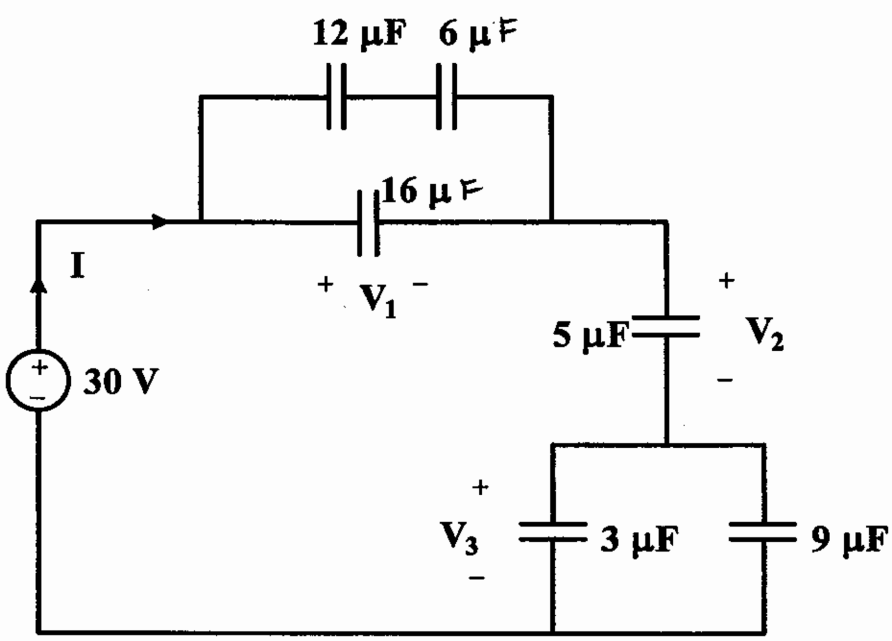

Figure 4: Circuit for problem 4.

(5) Determine the voltage gain of V_{out}/V_{in} for the op amp circuit shown in Figure 5. Your answer should be a function of R_A, R_B, R_C, R_D.

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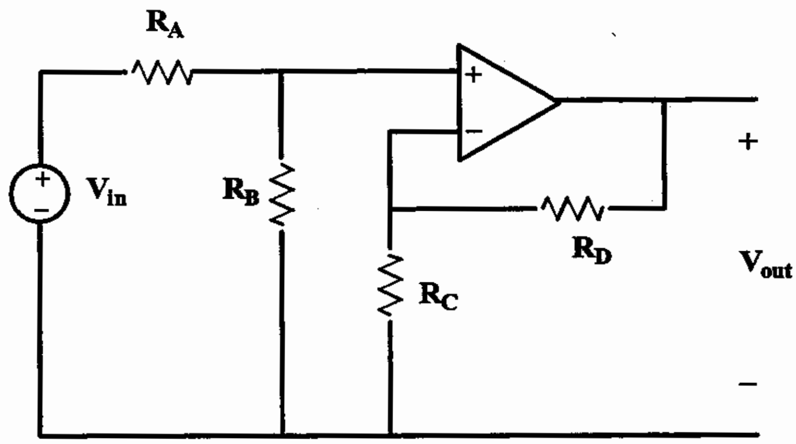

Figure 5: Circuit for problem 5.

(6) For the op amp circuit shown in Figure 6, find the value of R_X that results in $V_{out} = 20V_{in}$.

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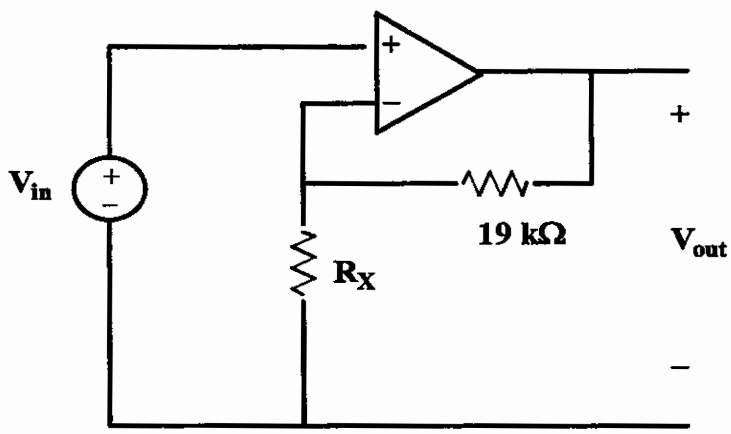
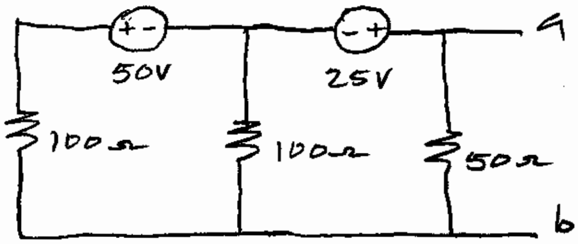


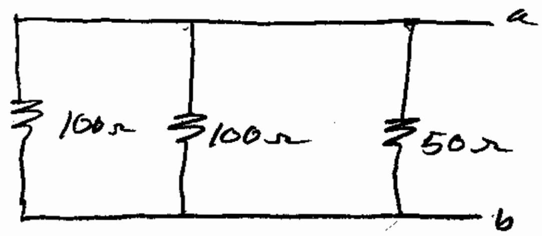
Figure 6: Circuit for problem 6

Test # 2

(1) Find the Thevenin: Attach 100Ω, find V_{ab}



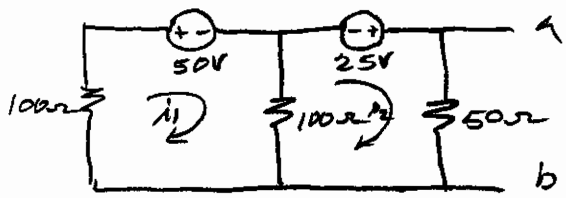
To find R_{TH}: Remove (Deactivate) independent sources.



Practically by inspection

$$R_{TH} = 25\Omega$$

To find V_{TH}:

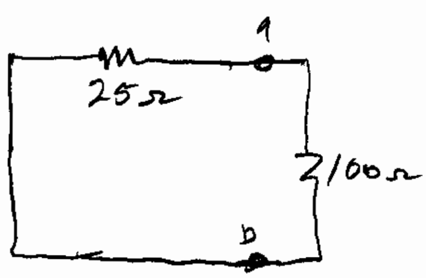


$$\begin{bmatrix} 200 & -100 \\ -100 & 150 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \end{bmatrix} = \begin{bmatrix} -50 \\ 25 \end{bmatrix}$$

$i_1 = -.25\,A$

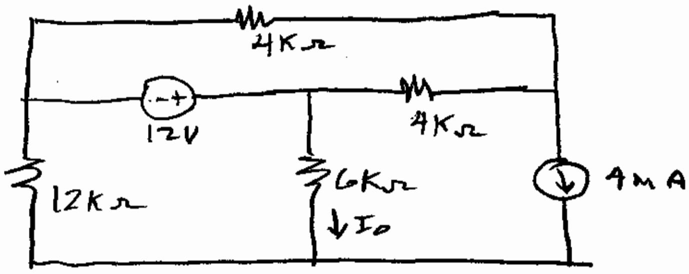
$i_2 = 0$

$$V_{TH} = i_2 \times 50 = 0$$

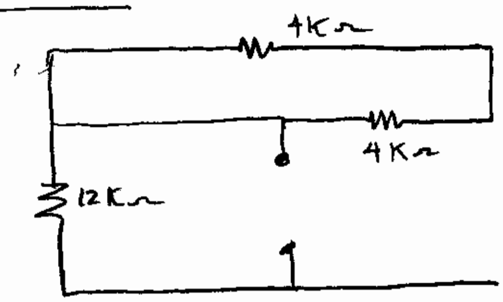


$$V_{ab} = 0$$

(2) Find I_o using Thevenin:



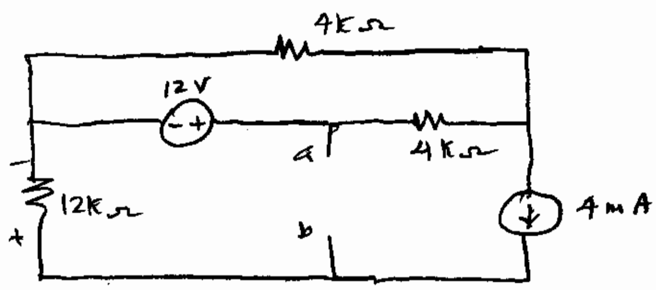
To find R_{TH}



The two 4Ks are shorted out.

$R_{TH} = 12K\Omega$

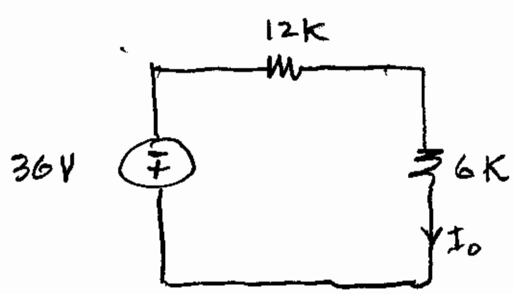
To Find V_{TH}



$V_{TH} = V_{ab}$

$-V_{ab} + 12 - (12K)(4K^{-1}) = 0$

$V_{ab} = 12 - 48 = -36V$

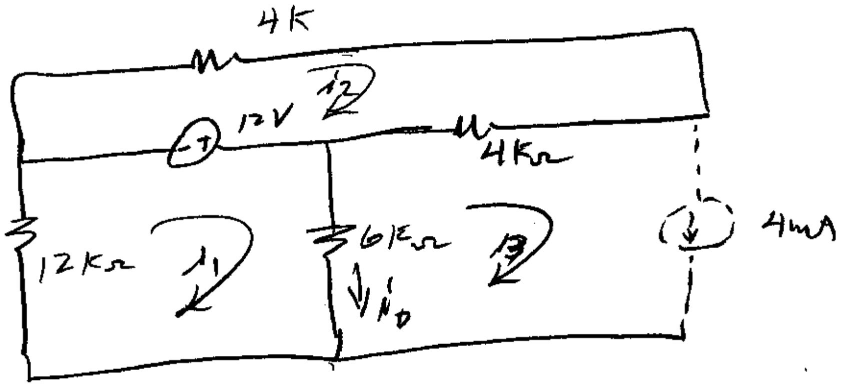


$I_o = \frac{-36}{18K}$

$I_o = -2\ mA$

(2) Alternate Solution for checking purposes

mesh



$$18Ki_1 + 0i_2 - 6K\,i_3 = 12$$

$$0i_1 + 8Ki_2 - 4K\,i_3 = -12$$

$$0i_1 + 0i_2 + i_3 = 4\,mA$$

$i_1 = .002\ A$

$i_2 = .0005\ A$

$i_3 = .004\ A$

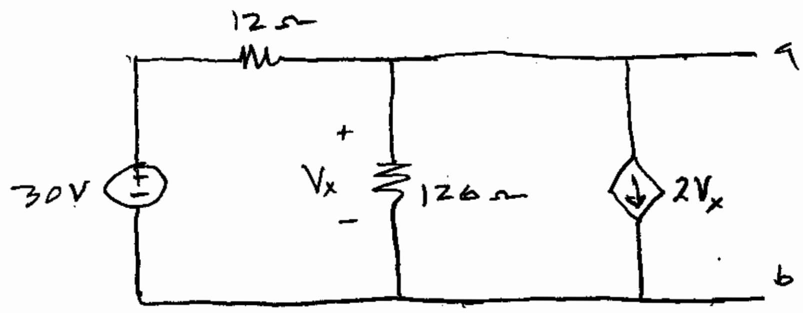
$i_0 = i_1 - i_3 = .002 - .004$

$i_0 = -2\ mA$ check

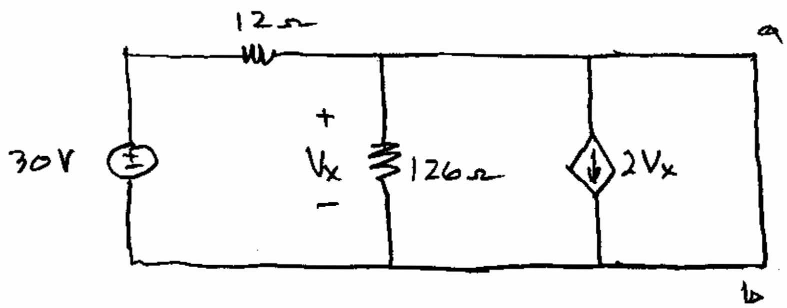
(3) (a) Determine I_{ss}

(b) Find Thevenin resistance.

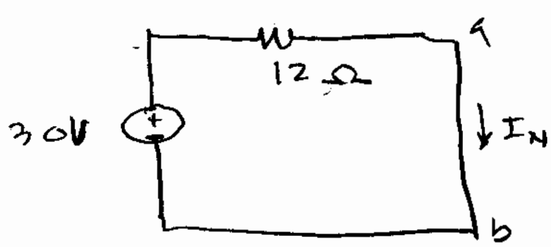
(c) Draw Norton ckt looking into a-b



<u>To determine I_{ss}</u>



Placing a short from a to b causes the 126 Ω resistor to be shorted, which in turn makes $V_x = 0$. If $V_x = 0$ the current source is zero, which means opened. The circuit becomes as below:



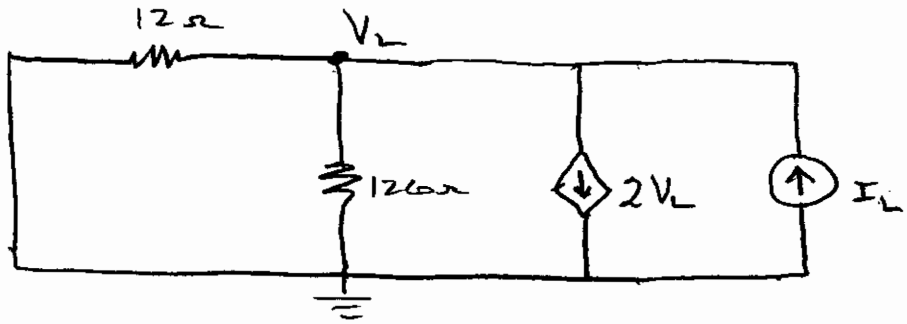
$$I_N = \frac{30}{12} = 2.5\,A$$

(3) continued

To find R_{TH}

Deactivate all independent sources. Since we are left with a dependent source, we must place either a voltage (V_L) or current source (I_L) at the load and solve for $\frac{V_L}{I_L}$.

In this case $V_L = V_x$, by inspection



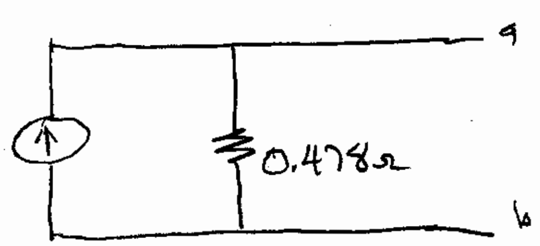
Writing a nodal equation at V_L gives

$$\frac{V_L}{12} + \frac{V_L}{126} + 2V_L = I_L$$

$$126\,V_L + 12\,V_L + 3024\,V_L = 1512\,I_L$$

$$\frac{V_L}{I_L} = \frac{1512}{3162} = 0.478\ \Omega$$

$\therefore$ $\boxed{R_{TH} = 0.478\ \Omega}$



Norton Circuit

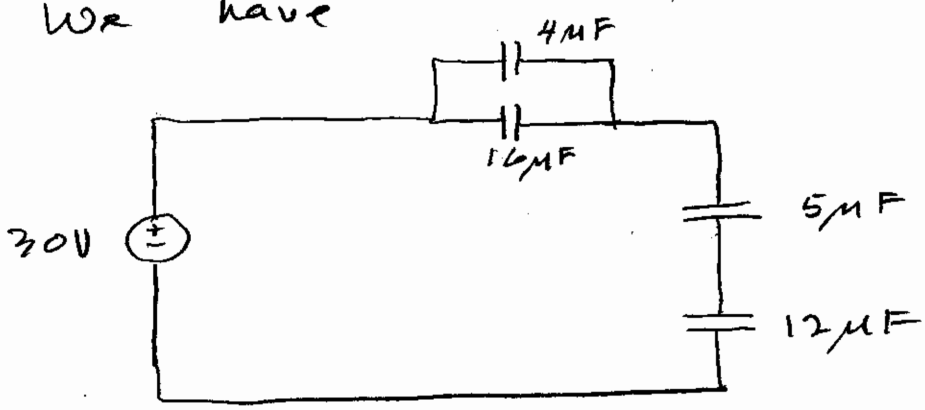
(4) Doing capacitance reduction;

12 μF in series with 6 μF

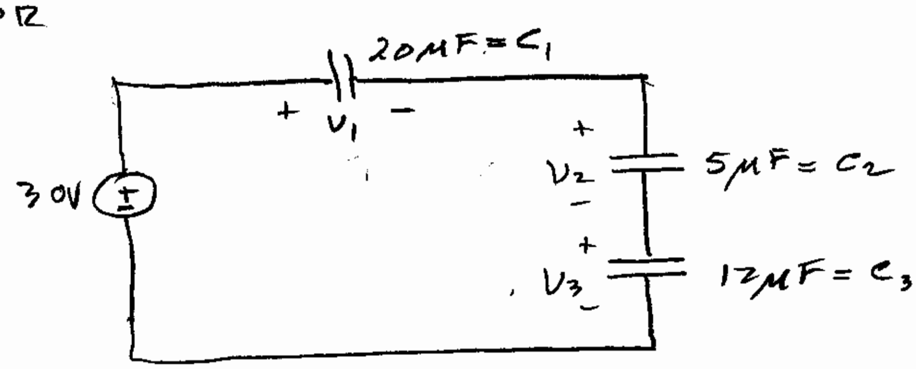
$$\frac{12 \times 6\,\mu F}{18} = 4\,\mu F$$

3 μF in parallel with 9 μF = 12 μF

We have



or



$$\frac{1}{C_{eq}} = \frac{1}{20} + \frac{1}{5} + \frac{1}{12}$$

$$\frac{60}{C_{eq}} = 3 + 12 + 5 = 20$$

$$C_{eq} = 3\,\mu F$$

$$Q = C_{eq} V = (3\,\mu F)(30\,V) = 90 \times 10^{-6}\,C$$

(4) continued

$$V_1 = \frac{Q}{C_1} = \frac{90\times10^{-6}}{20\times10^{-6}} = 4.5\ V$$

$$V_2 = \frac{Q}{C_2} = \frac{90\times10^{-6}}{5\times10^{-6}} = 18\ V$$

$$V_3 = \frac{Q}{C_3} = \frac{90\times10^{-3}}{12\times10^{-6}} = 7.5\ V$$

$$V_1 + V_2 + V_3 = 4.5 + 18 + 7.5$$

$$= 30\ V \quad \text{(encouraging)}$$

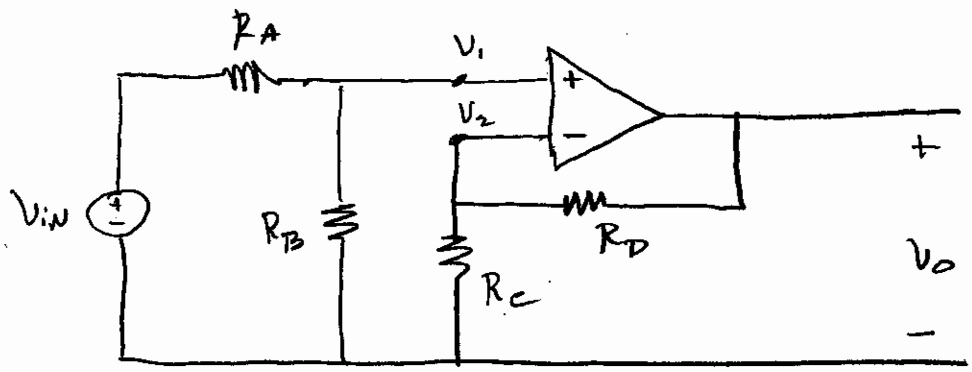
Energy stored in the $5\mu F$ capacitor

$$W_5 = \frac{1}{2} C_2 V_2^2$$

$$W_5 = \frac{1}{2} \times 5\times10^{-6} (18)^2 =$$

$$W_5 = 0.81\ mJ$$

(5) Determine V_{OUT}/V_{IN} for the following op-amp circuit.



$$V_1 = \frac{V_{IN} R_B}{R_A + R_B}$$

$$V_2 = \frac{V_o R_c}{R_c + R_D}$$

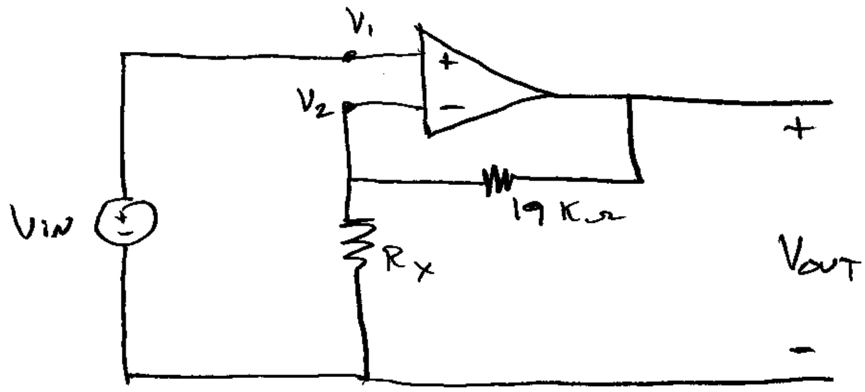
Now $V_1 = V_2$

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

so

$$\frac{V_o}{V_{IN}} = \frac{R_B (R_c + R_D)}{R_c (R_A + R_B)}$$

(b) Find R_x that results in $V_{OUT} = 20 V_{IN}$



$$V_2 = \frac{V_o \times R_x}{R_x + 19K}$$

$$V_1 = V_{in}$$

but $V_1 = V_2$

$$\frac{V_o R_x}{R_x + 19K} = V_{in}$$

$$V_o = \left(\frac{R_x + 19K}{R_x}\right) V_{in}$$

make

$$\frac{R_x + 19K}{R_x} = 20$$

$$R_x + 19K = 20 R_x$$

$$19 R_x = 19K$$

$$R_x = 1 K\Omega$$