Desk Copy

wlg

ECE 300
Spring Semester, 2008
HW Set #4

Due: February 19, 2008 **Name**_____
wlg Print (last, first)

Check according to your section: _____ 8:10 AM; _____ 11:10 AM

Use engineering paper. Work only on one side of the paper. Use this sheet as your cover sheet, placed on top of your work and stapled in the top left-hand corner. Number the problems at the top of the page, in the center of the sheet. **Do neat work. Underline your answers. Show how you got your equations. Be sure to show how you got your answers.** Each problem counts 10 points, Except problem 5.12, 5.58, and 5.72 count 15 points each.

5.8 (a) Ans: $v_o = -2$ V, (b) $v_o = -1$ V

5.11 Ans: $v_o = -2$ V, $i_o = -1$ mA

5.12 Ans: $\frac{v_o}{v_{in}} = -5$: Also do this problem by using P-Spice. Assume a 741 op-amp.
Use a 1 volt signal input and show that the output is –5 V.
Include a printout of your simulation to verify the results.

5.19 Ans: $i_o = -0.375$ mA

5.21 Ans: $v_o = -4$ V

5.25 Ans: $v_o = 1.25$ V

5.28 Ans: $v_o = 2.4$ V; $i_o = 120$ μA

5.58 Ans: $i_o = 0.685$ mA: Also simulate with P-Spice. Use a 741 op-amp. Show your simulation diagram with values on the diagram to verify your work.

5.72 Ans: $v_L = -1$ V: Also simulate with P-Spice. Use a 741 op-amp. Show your simulation diagram with values on the diagram to verify your work.

5.73 Ans: $v_L = 10.8$ V

Note: For all problems that require P-Spice, use the μA741 op-amp. This op-amp is found under Add Library/EVAL/μA741 (at the very bottom of the parts list).

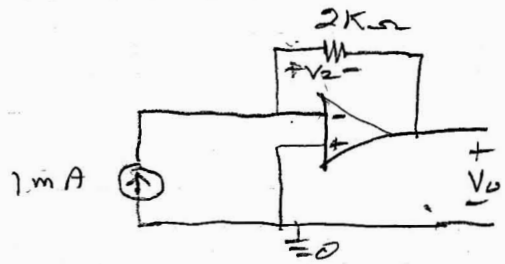
H.W. #4

ECE 300

Spring 2008

WLG

5.8 (a) Obtain V_o for the following op amp.



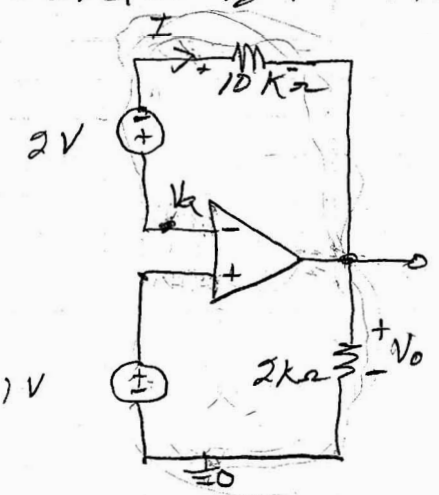
$V_o + V_2 = 0$ but $V_2 = 2V = 1mA \times 2K$

so

$V_o = -V_2$

$\boxed{V_o = -2V}$

(b) Obtain V_o for the following op amp.



$V_a = 1\ V$

$V_a - 2 - I \times 10K - V_o = 0$

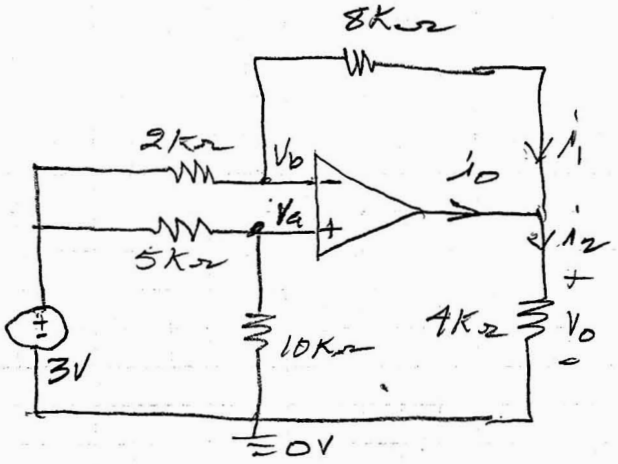
$I = 0$

Then $V_o = V_a - 2 = 1 - 2$

$\boxed{V_o = -1V}$

5.11

FIND V_o and i_o for the following op amp circuit.



$$V_a = \frac{3 \times 10K}{10K+5K} = 2V = V_b$$

At V_o

$$\frac{2-3}{2K} + \frac{2-V_o}{8K} = 0$$

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

$$\boxed{V_o = -2V}$$

$$i_1 = \frac{2-V_o}{8K} = \frac{4}{8K} = 0.5\,mA$$

$$i_2 = \frac{V_o}{4K} = \frac{-2}{4K} = -0.5mA$$

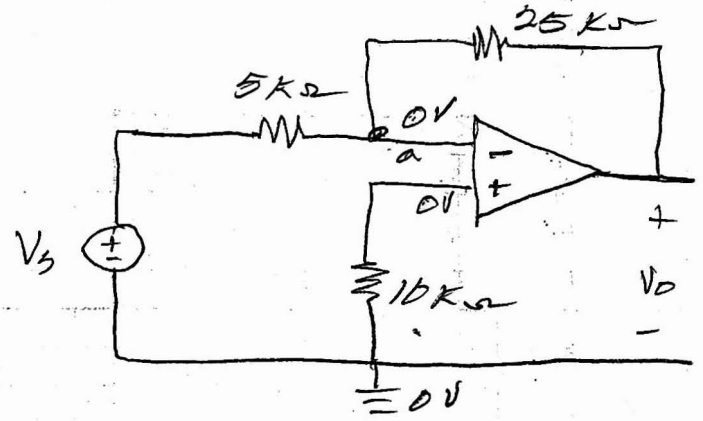
KCL: $i_o + i_1 = i_2$

$$i_o = i_2 - i_1 = -0.5\,mA - 0.5\,mA$$

$$\boxed{i_o = -1\,mA}$$

5.12

Find $\frac{V_o}{V_s}$ for the op amp below.

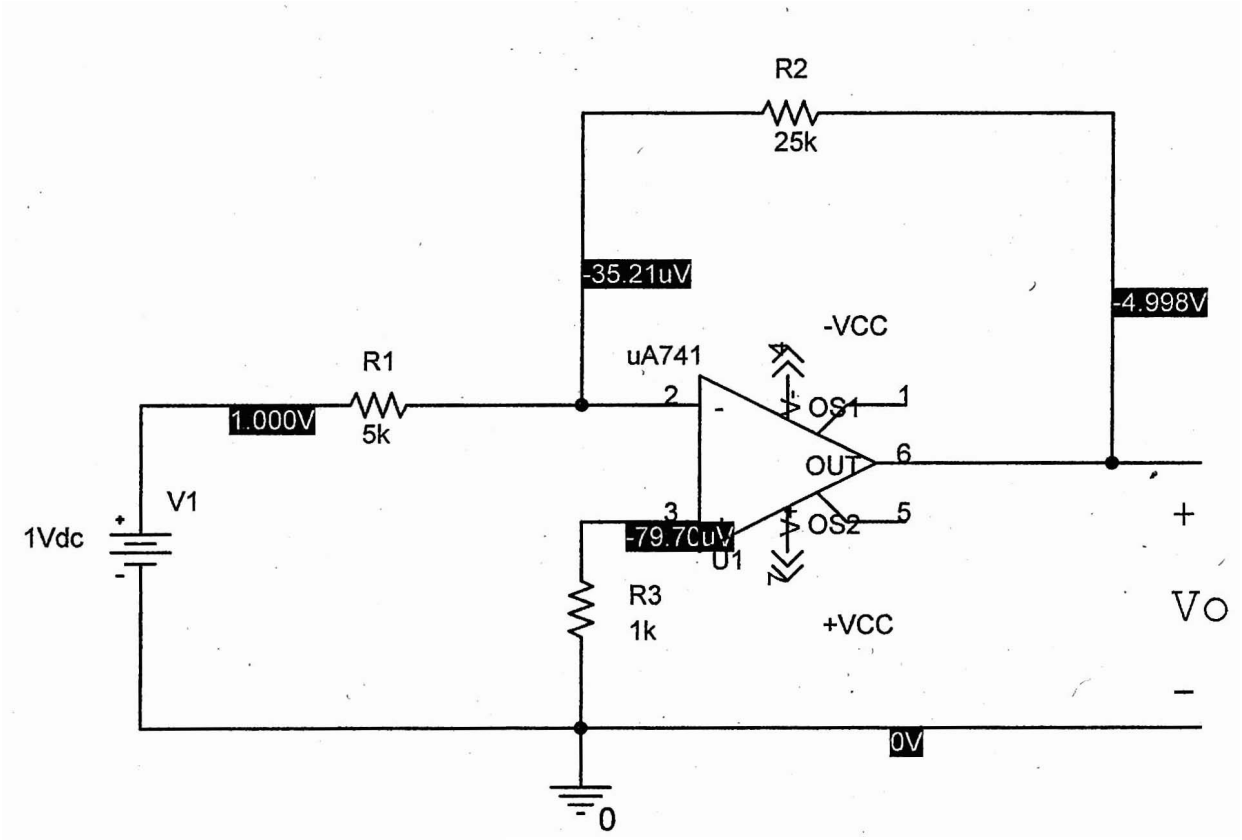


At point a:

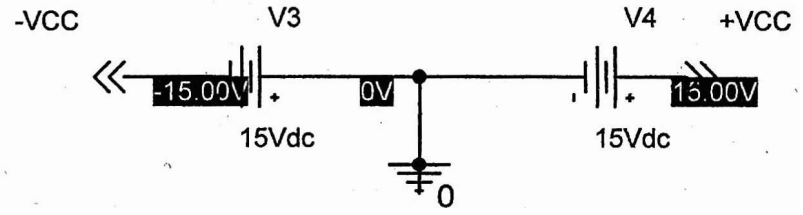
$$\frac{0 - V_s}{5K} + \frac{0 - V_o}{25K} = 0$$

$$-5V_s - V_o = 0$$

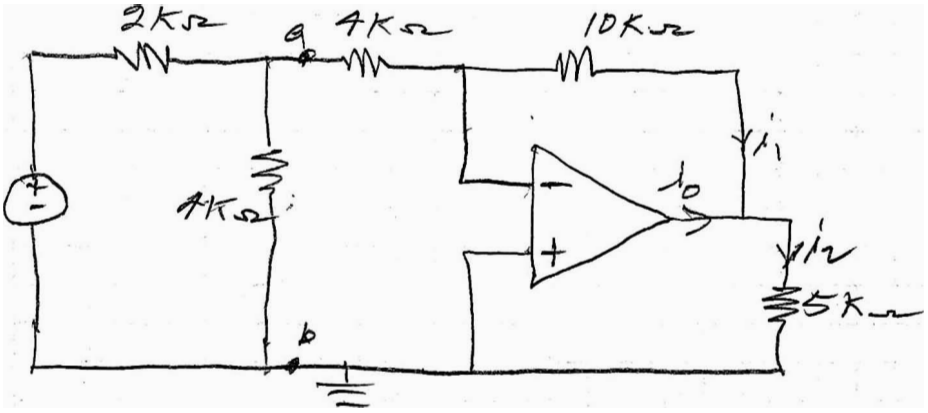
$$\frac{V_o}{V_s} = -5$$



Problem 5_12: Alexander



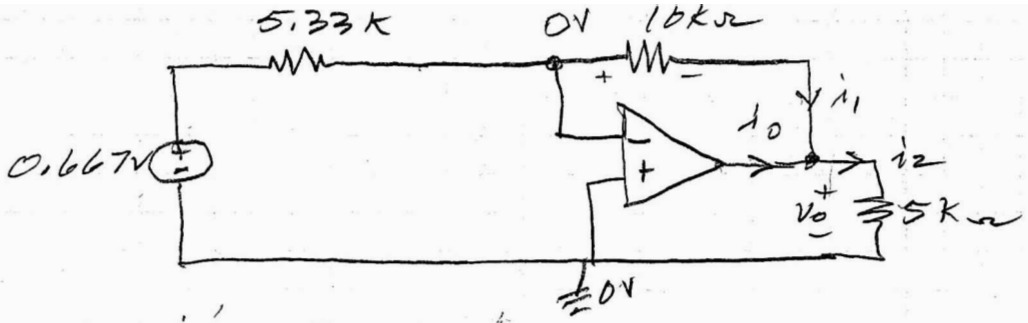
5.19 Determine i_o for the following op amp circuit.



Determine V_{TH} and R_{TH}. Connect the R_{TH} to the 4kΩ resistor and redraw the circuit.

$$V_{TH} = \frac{1 \times 4K}{2K+4K} = \frac{2}{3} V = 0.667V$$

$$R_{TH} = 2k \| 4k = \frac{8K^2}{6K} = \frac{4}{3} k\Omega = 1.33k\Omega$$



$$10K\, i_1 + V_o = 0$$

and $$-0.667 + (15.33K)\, i_1 + V_o = 0$$

$$\begin{bmatrix} 10K & 1 \\ 15.33K & 1 \end{bmatrix} \begin{bmatrix} i_1 \\ V_o \end{bmatrix} = \begin{bmatrix} 0 \\ 0.667 \end{bmatrix}$$

$$i_1 = 0.125mA \; ; \quad V_o = -1.25V$$

5.19 cont.

$$i_2 = \frac{V_o}{5k} = -\frac{1.25}{5k} = -0.25\,mA$$

KCL:

$$i_o + i_1 = i_2$$

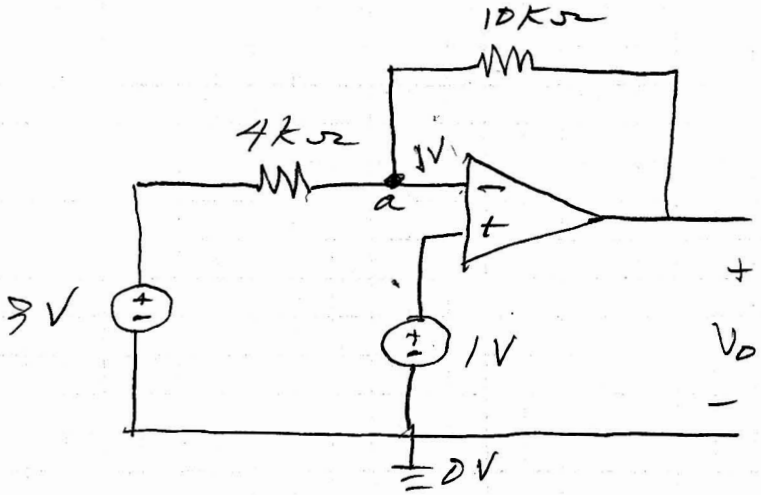
$$i_o = i_2 - i_1$$

$$i_o = -0.25mA - 0.125\,mA$$

$$\boxed{i_o = -0.375\,mA}$$

5.21

Determine V_o in the following op amp circuit.



At point a:

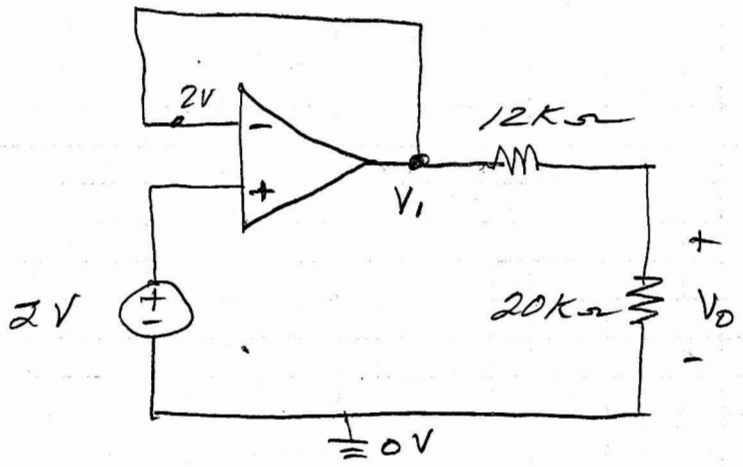
$$20k\left(\frac{1-3}{4k} + \frac{1-V_o}{10k} = 0\right)$$

$$-10 + 2 - 2V_o = 0$$

$$2V_o = -8$$

$$\boxed{V_o = -4\,V}$$

5.25 Find V_o in the following op amp circuit.



By inspection, $V_1 = 2V$

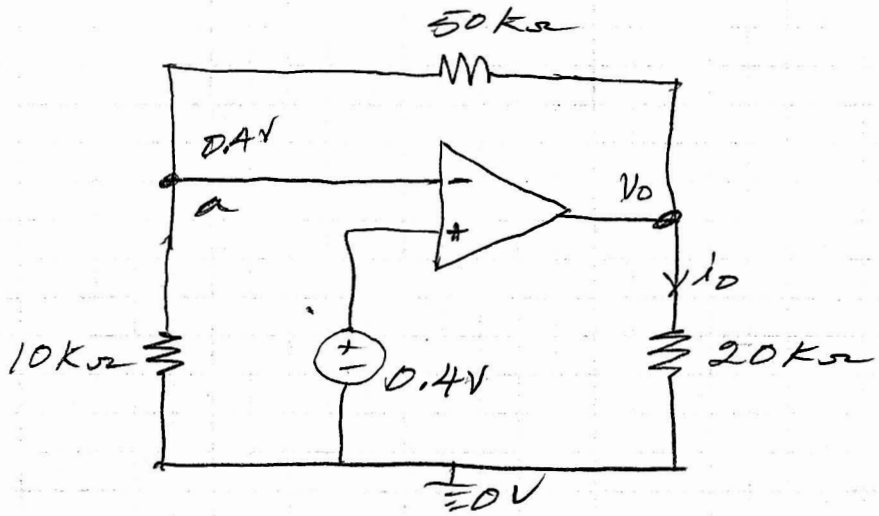
By voltage division;

$$V_o = \frac{V_1 \times 20k}{20k+12k} = \frac{2 \times 20}{32}$$

$$V_o = 1.25V$$

5.28

Find i_o in the op amp circuit below.



At a:

$$50k\left(\frac{0.4}{10k} + \frac{0.4 - V_o}{50k} = 0\right)$$

$$2 + 0.4 - V_o = 0$$

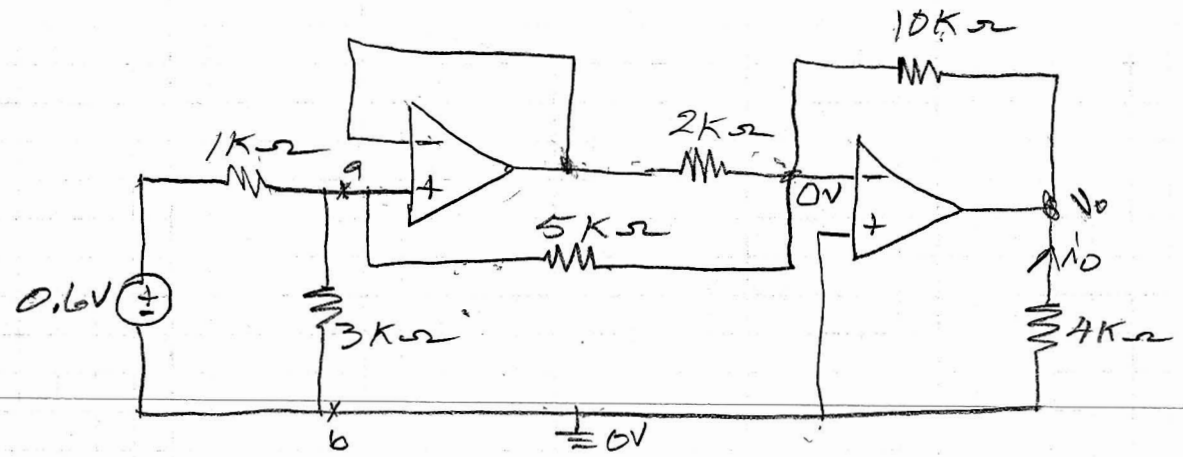
$$\boxed{V_o = 2.4V}$$

$$i_o = \frac{V_o}{20k}$$

$$i_o = \frac{2.4}{20k}$$

$$\boxed{i_o = 120\mu A}$$

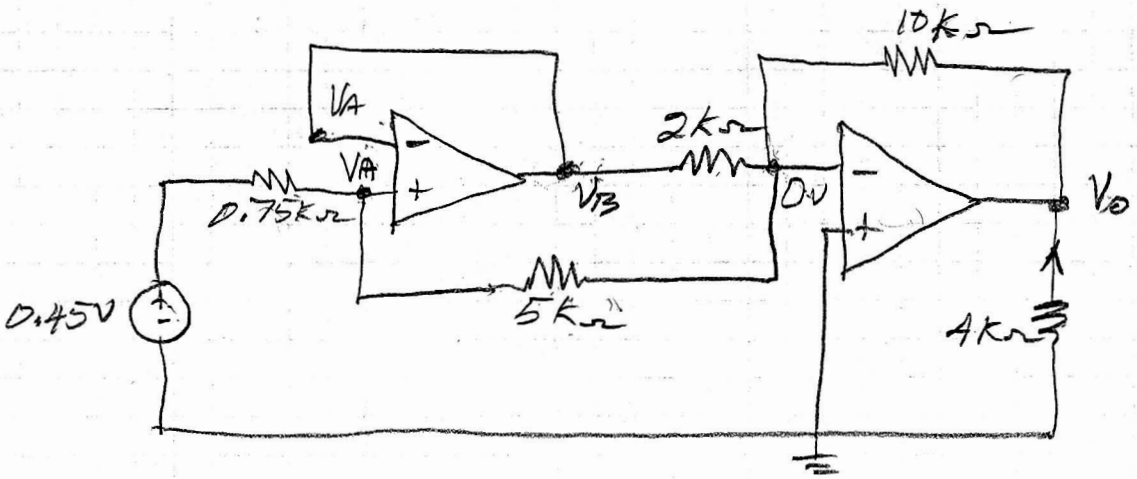
5.56 Calculate v_o in the op amp circuit below. Also simulate with P-spice, verify your answer.



Make a Thevenin equivalent to the left of a-b.

$$V_{TH} = \frac{.6 \times 3K}{4K} = 0.45V$$

$$R_{TH} = (3K) \| (1K) = 0.75K\Omega$$



$$V_A = \frac{0.45 \times 5K}{5K + 0.75K} = 0.3913V$$

$$V_B = V_A$$

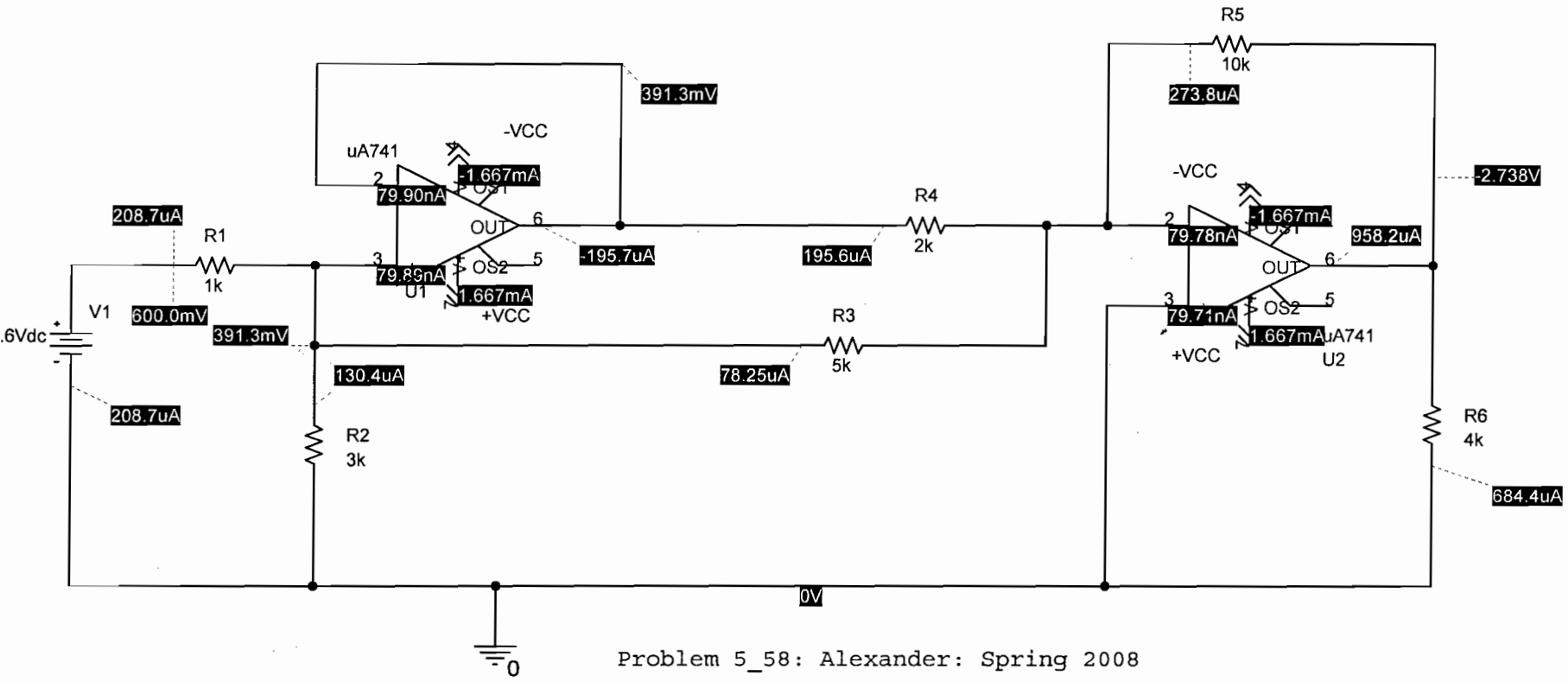
$$V_o = -\frac{10K}{2K} \times V_B - \frac{10K}{5K} V_B$$

5.56 cont

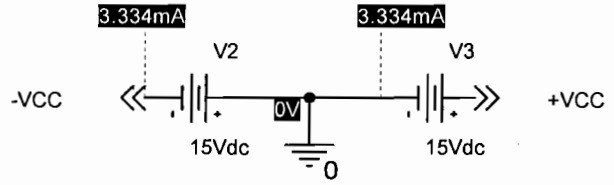
$$v_o = -0.3913(5+2) = -2.739 V$$

$$i_o = -\frac{v_o}{4K} = +\frac{2.739}{4K}$$

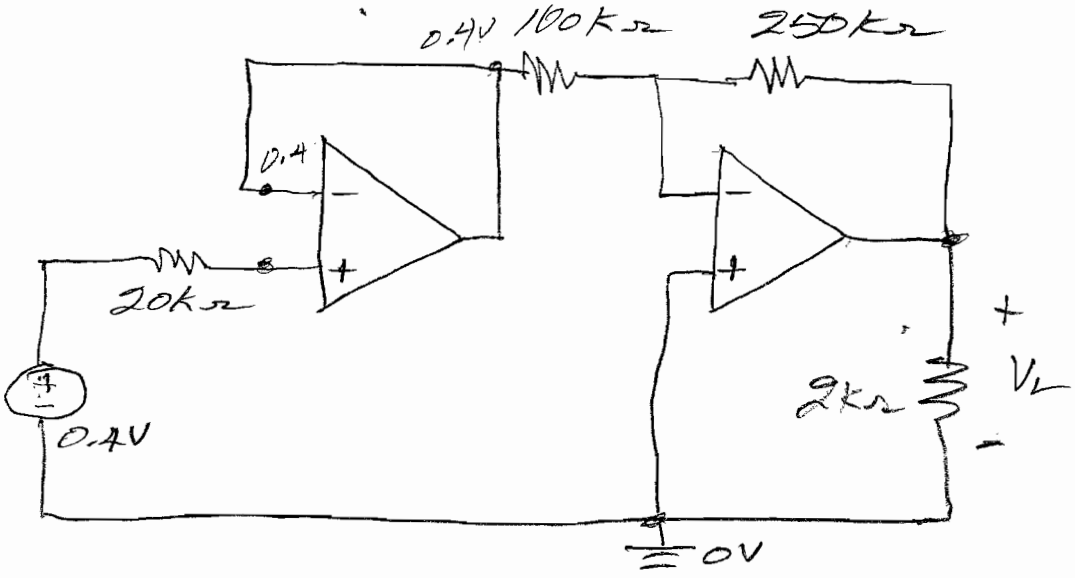
$$i_o = 0.685 \text{ mA}$$



Problem 5_58: Alexander: Spring 2008

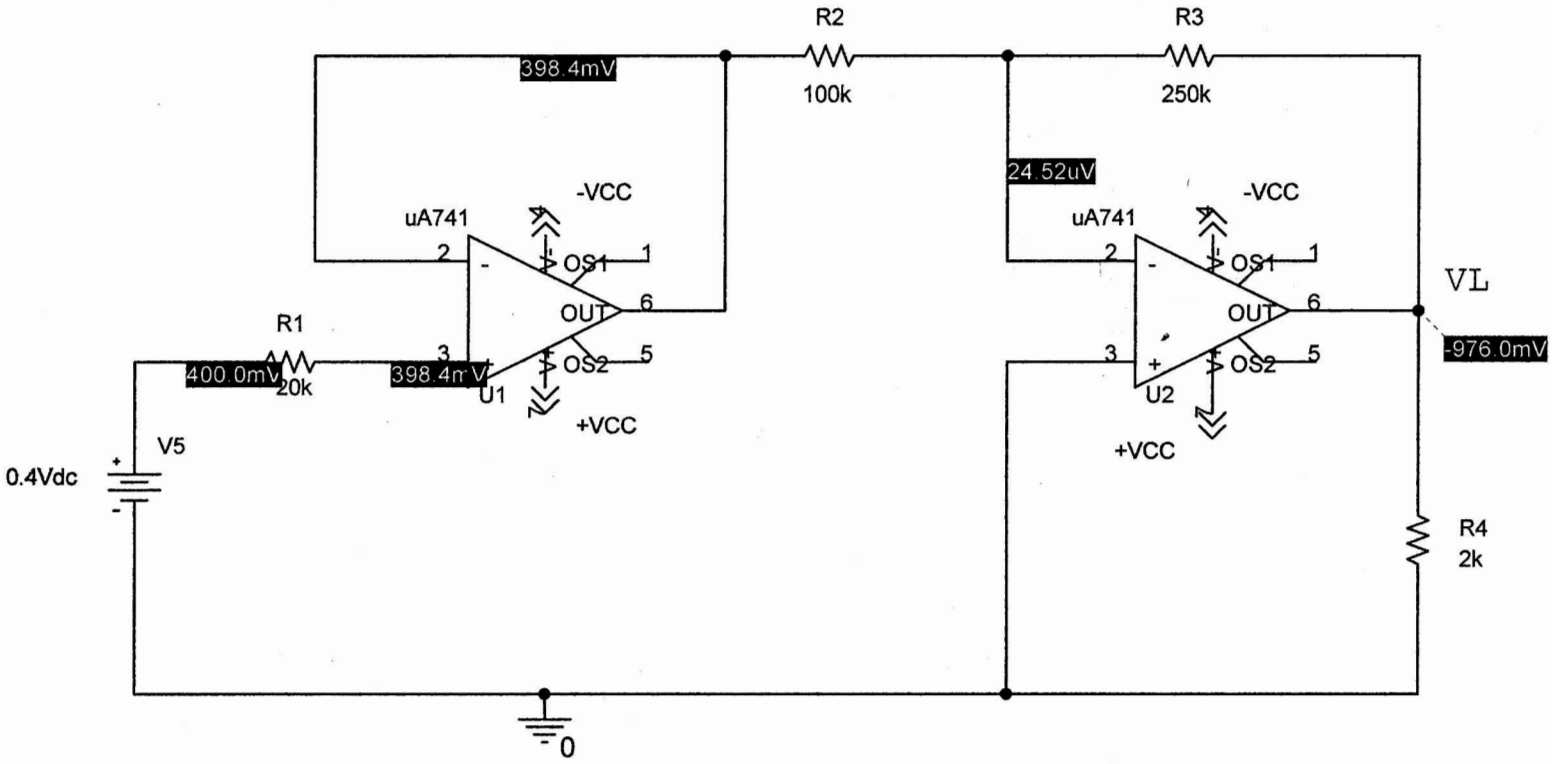


5.72 Find the load voltage V_L in the following op amp circuits. Also, simulate using P-Spice and verify your answer.

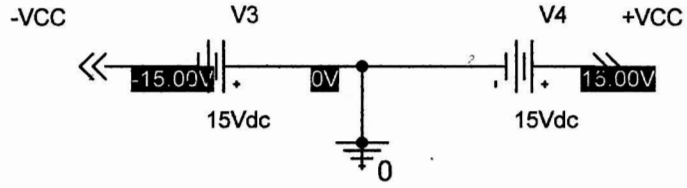


$$V_L = -0.4 \times \frac{250k}{100k}$$

$$V_L = -1\ V$$

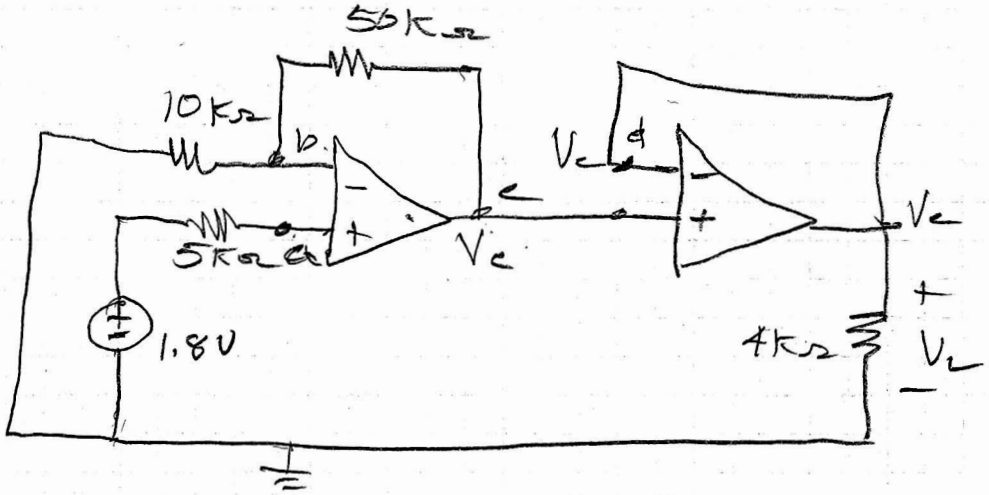


Problem 5_72: Alexander: Spring Semester 2008



5.73

Determine the voltage V_L in the following circuit.



The voltage at point a = 1.8 V.

Therefore the voltage at b = 1.8 V

At b;

$$50K\left(\frac{1.8}{10k} + \frac{1.8 - V_c}{50k} = 0\right)$$

$$9.0 + 1.8 - V_c = 0$$

$$V_c = 10.8\ V$$

The voltage at d = V_c = V_L

$$V_L = 10.8\ V$$