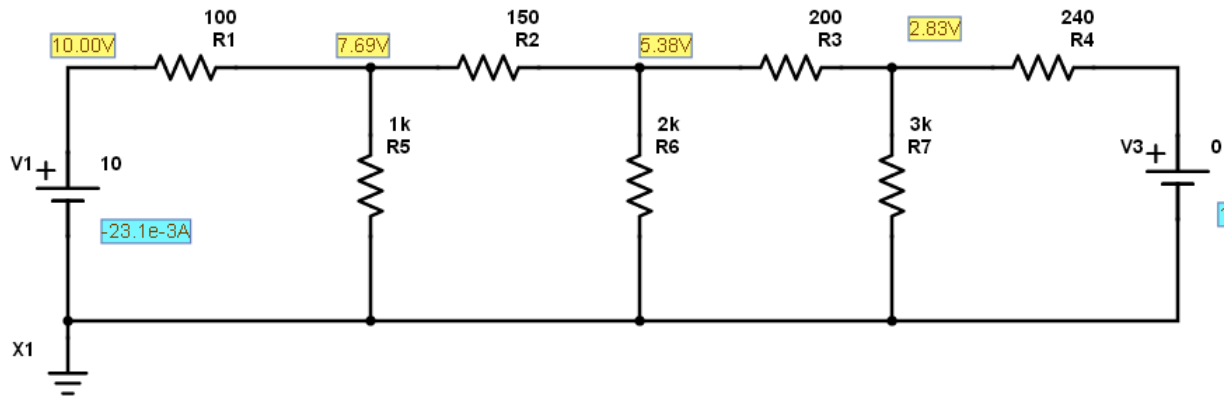


# EE 206: Solution #6

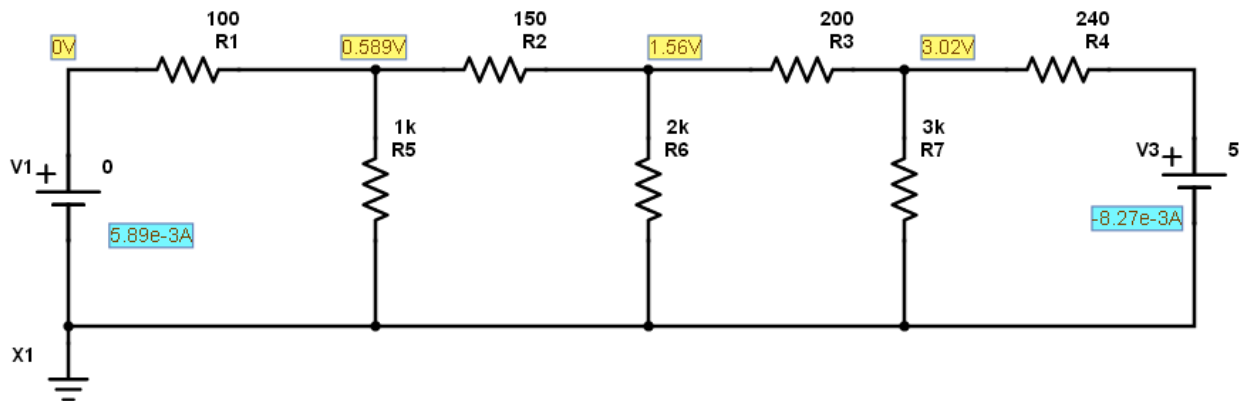
Superposition and Op Amps. Due Wed, Feb 20th

## Superposition

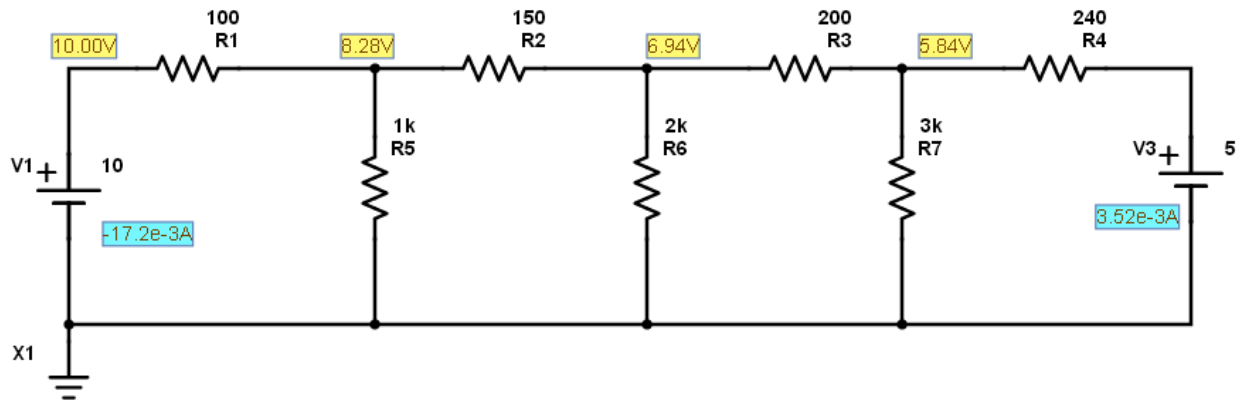
1) Use PartSim to determine the voltage at Y assuming  $V_a = 10V$ ,  $V_b = 0V$ .



2) Use PartSim to determine the voltage at Y assuming  $V_a = 0V$ ,  $V_b = 5V$ .



3) Use PartSim to determine the voltage at Y assuming  $V_1 = 10V$ ,  $V_b = 5V$



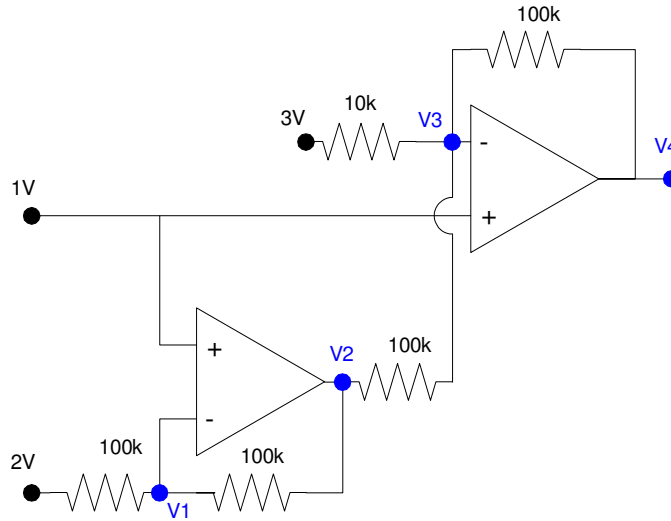
Does problem 1 + problem 2 = problem 3?

yes - the voltages match. Superposition works.

	$V_a = 10$ $V_b = 0$	$V_a = 0$ $V_b = 5$	column 1 + columns 2	$V_a = 10$ $V_b = 5$
V0	10	0	10	10
V1	7.69	0.59	8.28	8.28
V2	5.38	1.56	6.94	6.94
V3	2.83	3.02	5.85	5.84
V4	0	5	5	4

## Op Amps

4) Write the voltage node equations for the following op-amp circuit. Assume ideal op-amps.



Problem 4

There are 4 unknowns voltages. We need 4 equations to solve for 4 unknowns.

For an op-amp with negative feedback,  $V_p = V_m$

$$(1) \quad V_1 = 1$$

$$(2) \quad V_3 = 1$$

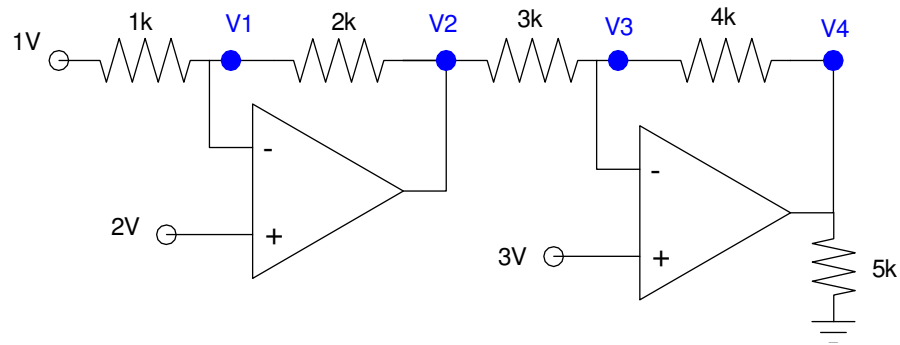
Sum the currents to zero at node V1

$$(3) \quad \left( \frac{V_1 - 2}{100k} \right) + \left( \frac{V_1 - V_2}{100k} \right) = 0$$

Sum the currents to zero at node V3

$$(4) \quad \left( \frac{V_3 - 3}{10k} \right) + \left( \frac{V_3 - V_2}{100k} \right) + \left( \frac{V_3 - V_4}{100k} \right) = 0$$

5) Write the voltage node equations for the following op-amp circuit. Assume ideal op-amps.



Problem 5:

There are 4 unknown voltages. We need 4 equations to solve for 4 unknowns.

Start with  $V_p = V_m$

(1)  $V_1 = 2$

(2)  $V_3 = 3$

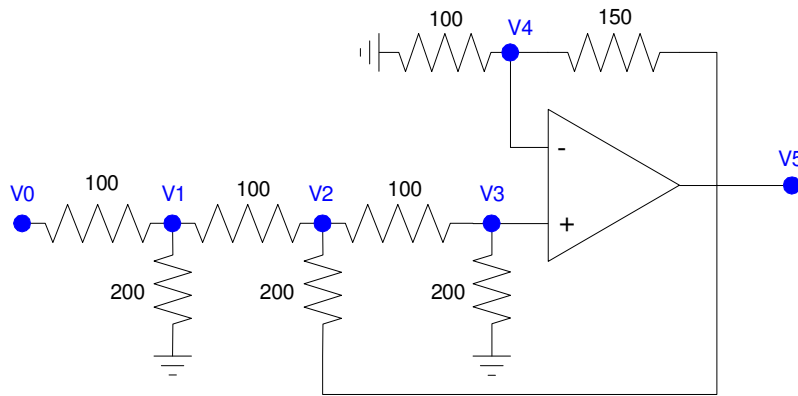
Sum the currents to zero at node V1

(3)  $\left(\frac{V_1-1}{1k}\right) + \left(\frac{V_1-V_2}{2k}\right) = 0$

Sum the currents to zero at node V3

(4)  $\left(\frac{V_3-V_2}{3k}\right) + \left(\frac{V_3-V_4}{4k}\right) = 0$

6) Write the voltage node equations for the following op-amp circuit. Assume ideal op-amps.



Problem 6

There are 5 unknown voltages. We need 5 equations to solve for 5 unknowns.

Start with  $V_p = V_m$

$$(1) \quad V_3 = V_4$$

Sum the currents to zero at node V1

$$(2) \quad \left( \frac{V_1 - V_0}{100} \right) + \left( \frac{V_1}{200} \right) + \left( \frac{V_1 - V_2}{100} \right) = 0$$

Sum the currents to zero at node V2

$$(3) \quad \left( \frac{V_2 - V_1}{100} \right) + \left( \frac{V_2 - V_5}{200} \right) + \left( \frac{V_2 - V_3}{100} \right) = 0$$

Sum the currents to zero at node V3

$$(4) \quad \left( \frac{V_3 - V_2}{100} \right) + \left( \frac{V_3}{200} \right) = 0$$

Sum the currents to zero at node V4

$$(5) \quad \left( \frac{V_4}{100} \right) + \left( \frac{V_4 - V_5}{150} \right) = 0$$