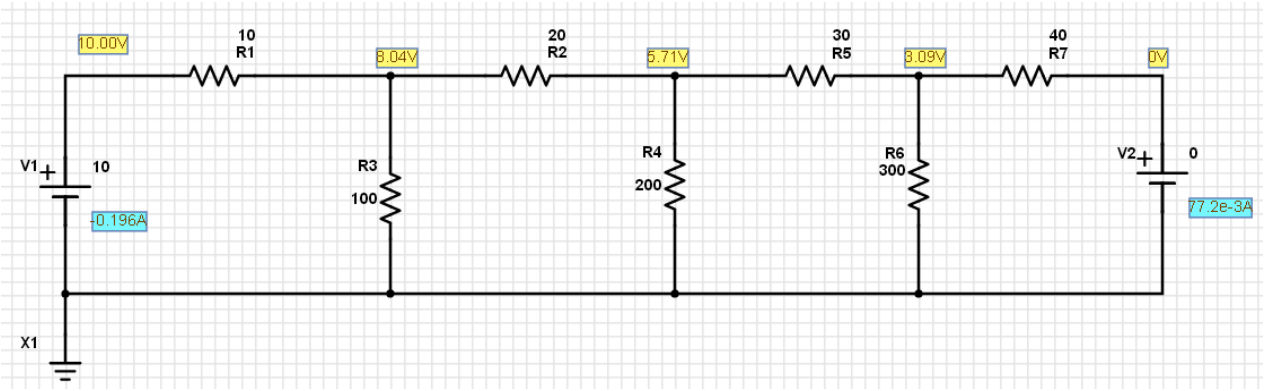
EE 206: Homework #6

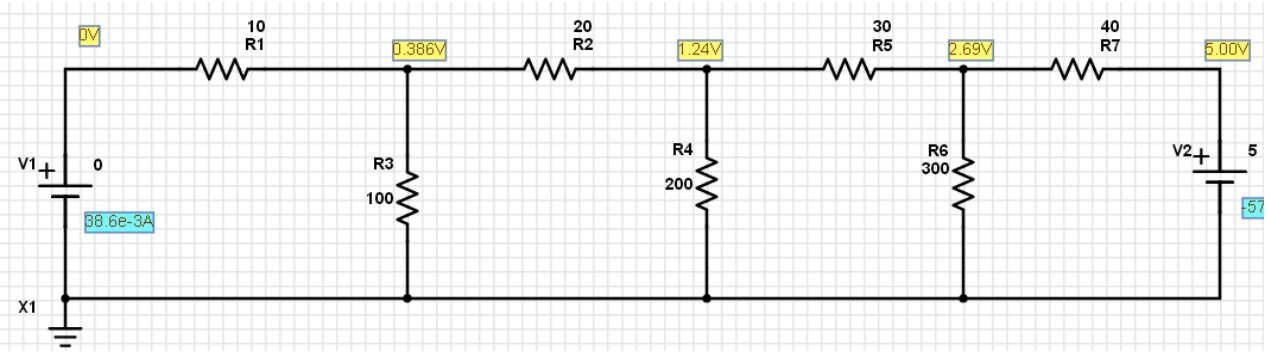
Superposition and Op Amps. Due Monday March 2nd

Superposition

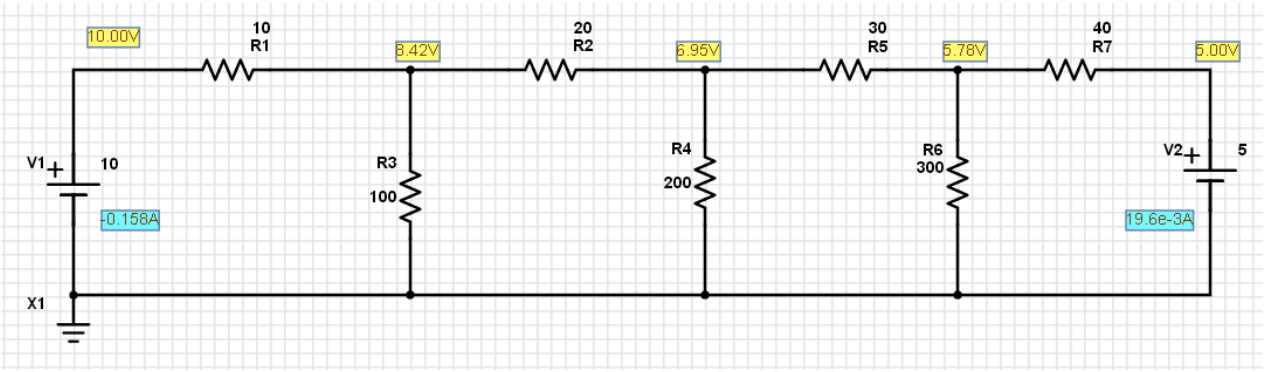
1) Use PartSim to determine the votlage at Y assuming Va = 10V, Vb = 0V.



2) Use PartSim to determine the voltage at Y assuming Va = 0V, Vb = 5V.



3) Use PartSim to determine the votlage at Y assuming V1 = 10V, Vb = 5V



Does problem 1 + problem 2 = problem 3?

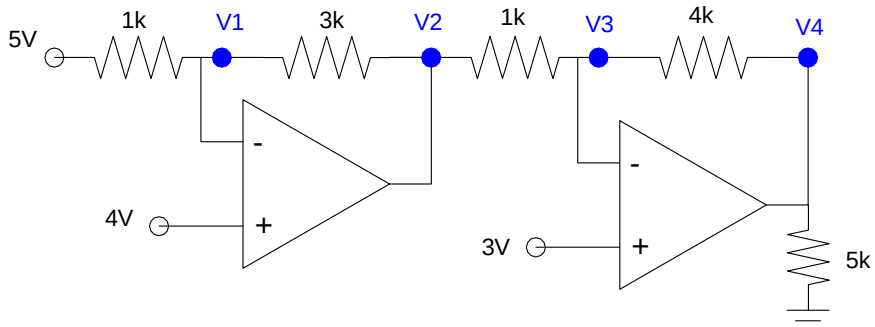
	Va	V1	V2	V3	Vb
Va = 10V Vb = 0V	10.00V	8.04 V	5.71 V	3.09 V	0.00 V
Va = 0V Vb = 5V	0.00 V	0.386 V	1.24 V	2.69 V	5.00 V
Va = 10V Vb = 5V	10.00 V	8.42 V	6.95 V	5.78 V	5.00 V

Yes, problem 1 + problem 2 = problem 3

Op Amps

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

- Solve for V1, V2, V3, and V4



Start with V+ = V-

$$V_1 = 4V$$

$$V_3 = 3V$$

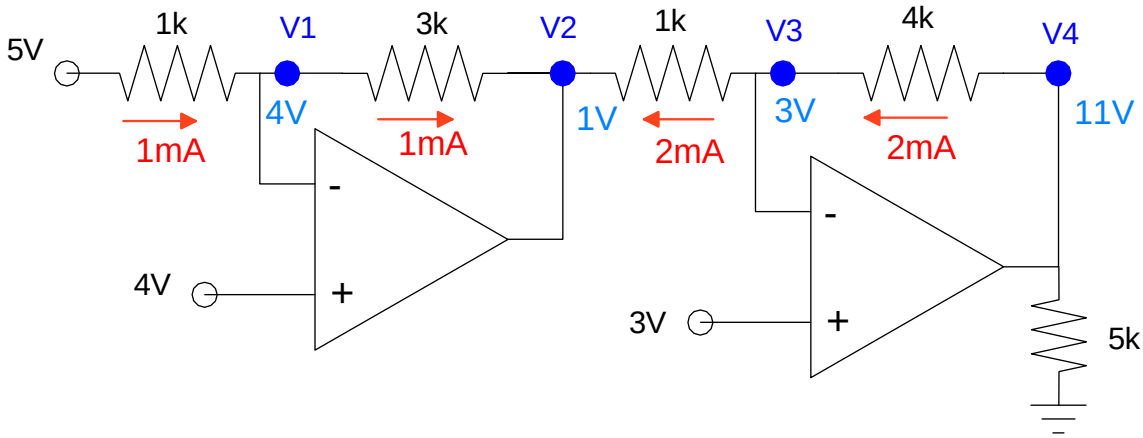
Write the voltage node equation at V1 and V3

$$\left(\frac{V_1-5}{1k}\right)+\left(\frac{V_1-V_2}{3k}\right)=0$$

$$\left(\frac{V_3-V_2}{1k}\right)+\left(\frac{V_3-V_4}{4k}\right)=0$$

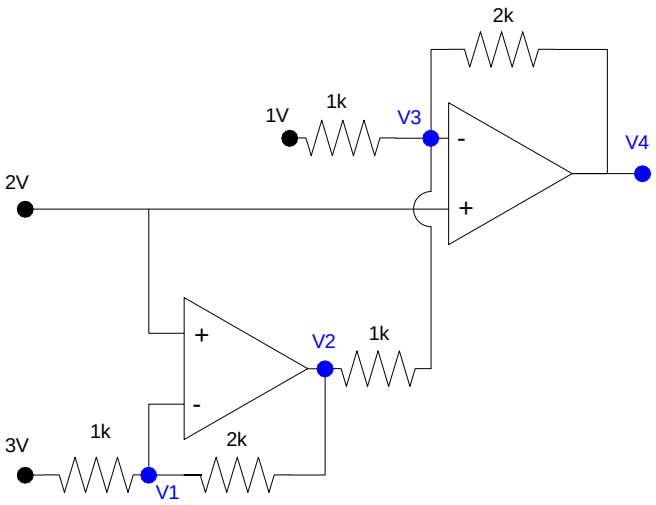
Solving:

- V1 = 4V
- V2 = -5V
- V3 = 3V
- V4 = 35V



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

- Solve for V1, V2, V3, and V4 assuming ideal op-amps



Start with V+ = V-

$$V_1 = 2V$$

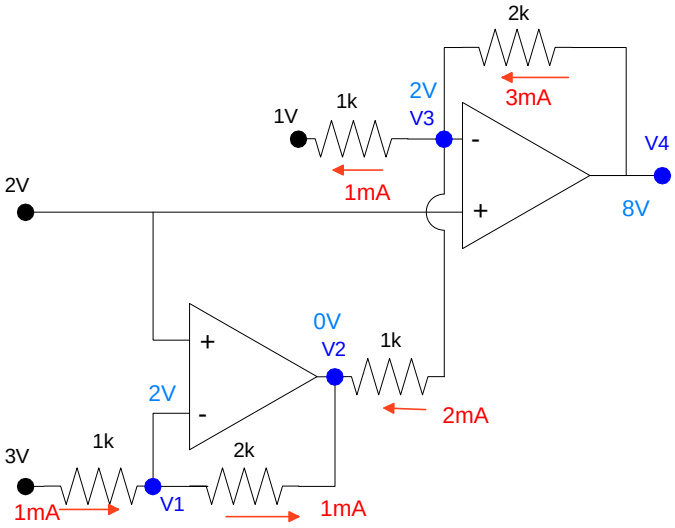
$$V_3 = 2V$$

Write the voltage node equations at V1 and V3

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

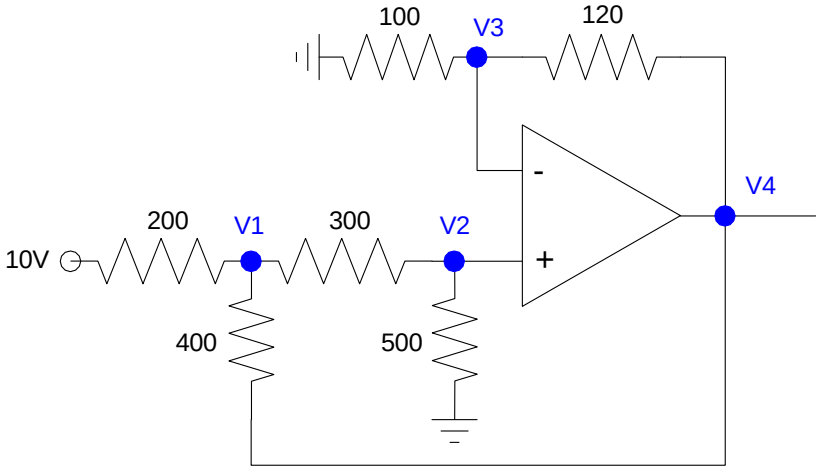
$$\left(\frac{V_3-1}{1k}\right)+\left(\frac{V_3-V_2}{1k}\right)+\left(\frac{V_3-V_4}{2k}\right)=0$$

Solving



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

- Solve for V1, V2, V3, and V4 assuming ideal op-amps



Start with V+ = V-

$$V_2 = V_3$$

Write the voltage node equations at V1, V2, and V3

$$\left(\frac{V_1-10}{200}\right)+\left(\frac{V_1-V_2}{300}\right)+\left(\frac{V_1-V_4}{400}\right)=0$$

$$\left(\frac{V_2-V_1}{300}\right)+\left(\frac{V_2}{500}\right)=0$$

$$\left(\frac{V_3}{100}\right)+\left(\frac{V_3-V_4}{120}\right)=0$$

Solve...

Group terms

$$V_2 - V_3 = 0$$

$$\left(\frac{1}{200}+\frac{1}{300}+\frac{1}{400}\right)V_1 - \left(\frac{1}{300}\right)V_2 - \left(\frac{1}{400}\right)V_4 = \left(\frac{10}{200}\right)$$

$$-\left(\frac{1}{300}\right)V_1 + \left(\frac{1}{300}+\frac{1}{500}\right)V_2 = 0$$

$$\left(\frac{1}{100}+\frac{1}{120}\right)V_3 - \left(\frac{1}{120}\right)V_4 = 0$$

Place in matrix form

$$\begin{bmatrix} 0 & 1 & -1 & 0 \\ \left(\frac{1}{200}+\frac{1}{300}+\frac{1}{400}\right) & \left(\frac{-1}{300}\right) & 0 & \left(\frac{-1}{400}\right) \\ \left(\frac{-1}{300}\right) & \left(\frac{1}{300}+\frac{1}{500}\right) & 0 & 0 \\ 0 & 0 & \left(\frac{1}{100}+\frac{1}{120}\right) & \left(\frac{-1}{120}\right) \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \\ V_4 \end{bmatrix} = \begin{bmatrix} 0 \\ \left(\frac{10}{200}\right) \\ 0 \\ 0 \end{bmatrix}$$

Solve using Matlab

```
A = [0,1,-1,0];
A = [A ; 1/200+1/300+1/400, -1/300, 0, -1/400];
A = [A ; -1/300, 1/300+1/500, 0, 0];
A = [A ; 0, 0, 1/100+1/120, -1/120]
```

```
    0.          1.         - 1.          0.
    0.0108333  - 0.0033333    0.        - 0.0025
  - 0.0033333    0.0053333    0.          0.
    0.           0.           0.0183333  - 0.0083333
```

```
B = [0;10/200;0;0]
```

```
    0.
    0.05
    0.
    0.
```

```
V = inv(A)*B
```

```
V1    9.4117647
V2    5.8823529
V3    5.8823529
V4    12.941176
```