ECE 321 - Homework #1

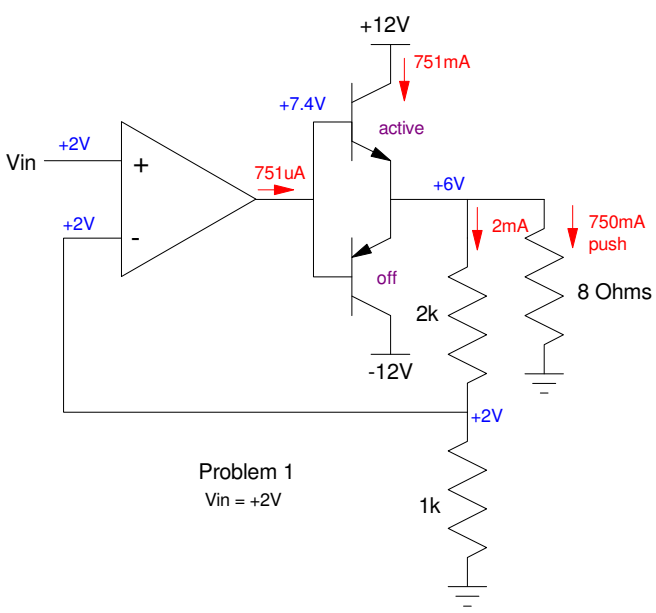
Push-Pull Amplifiers, Instrumentation Amplifiers, Active Filters. Due Wednesday, April 4th, 2018

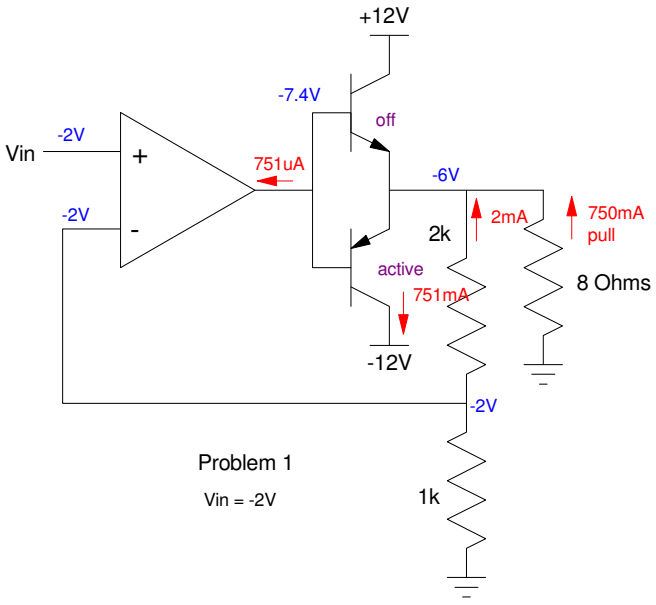
For all circuits, assume TIP112 (NPN) and TIP117 (PNP) transistors

- $|V_{be}| = 1.4V$
- $|V_{ce(sat)}| = 0.9V$
- $\beta = 1000$

Push-Pull Amplifiers

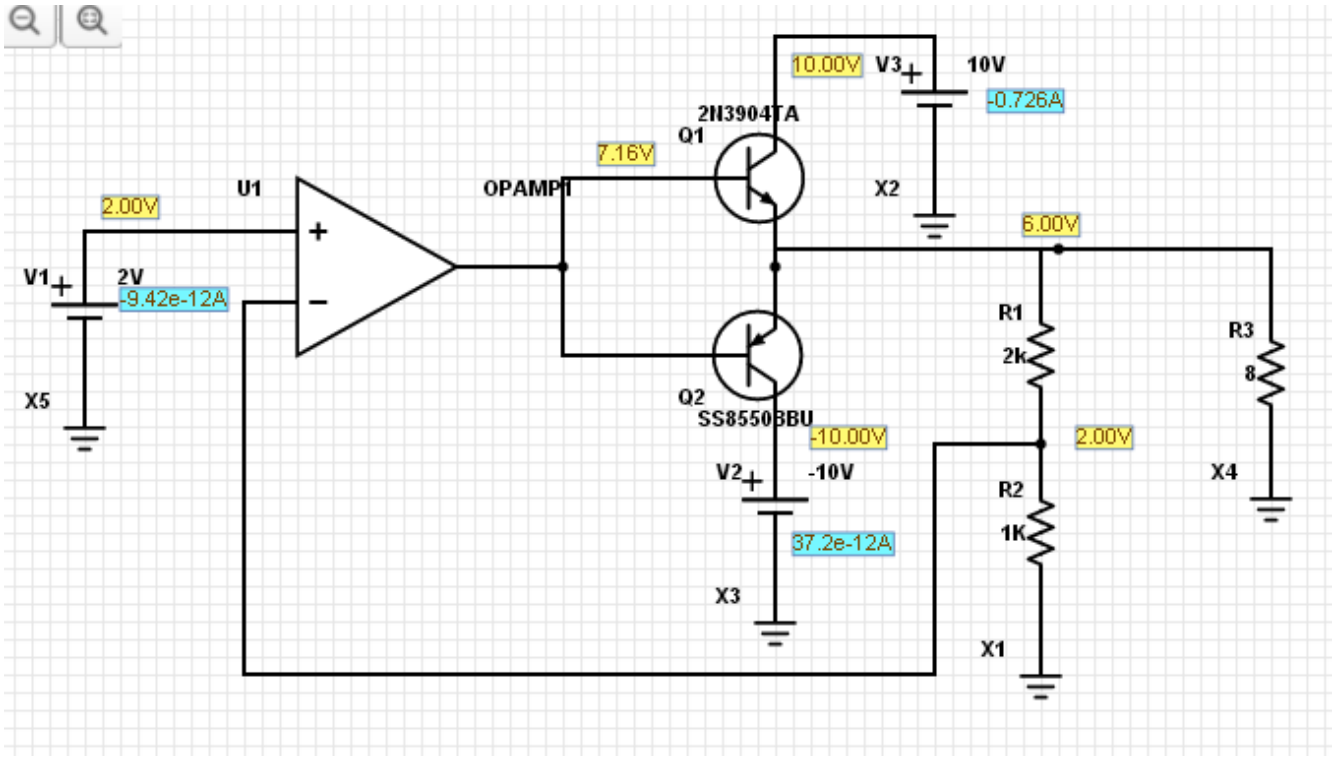
1) Determine the voltages and current for the following push-pull amplfiier with Vin = 2V



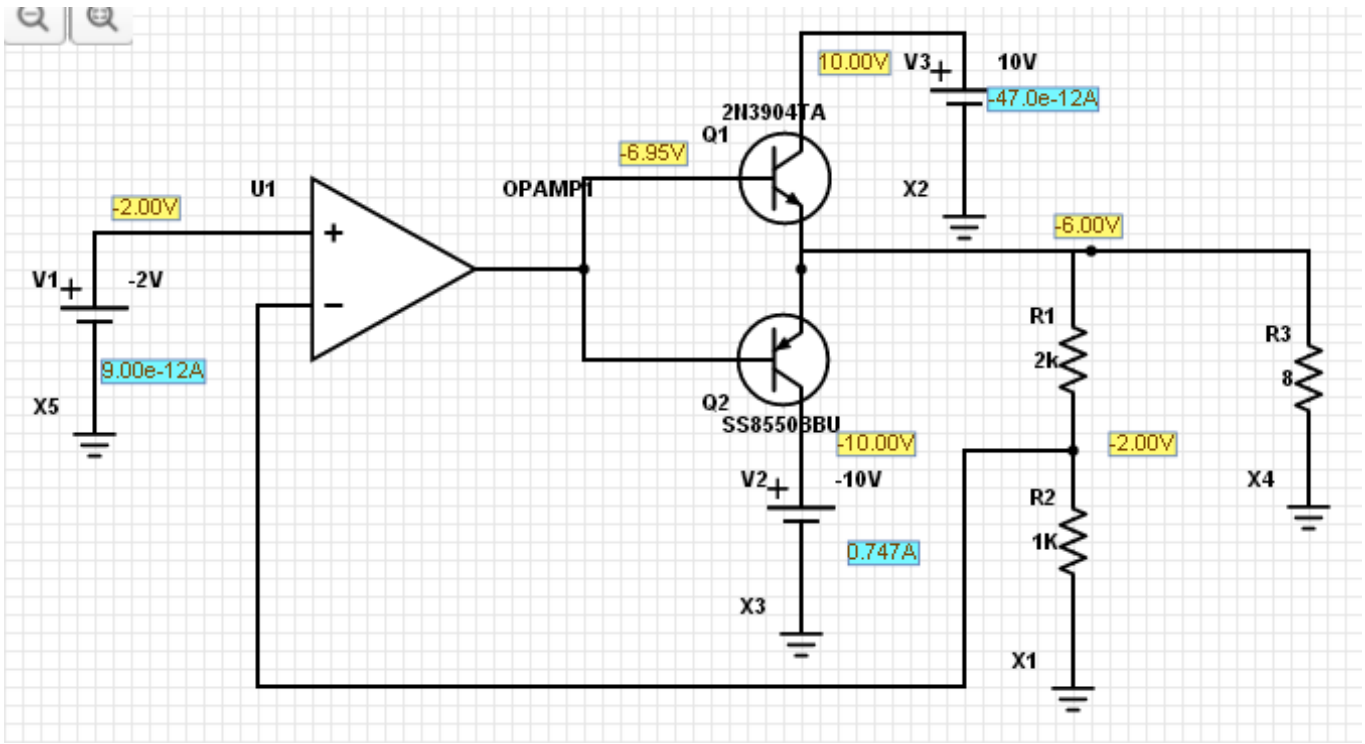


2) Verify your design in PartSim

Push: At +2V, the NPN does almost all of the work (provides 726mA)

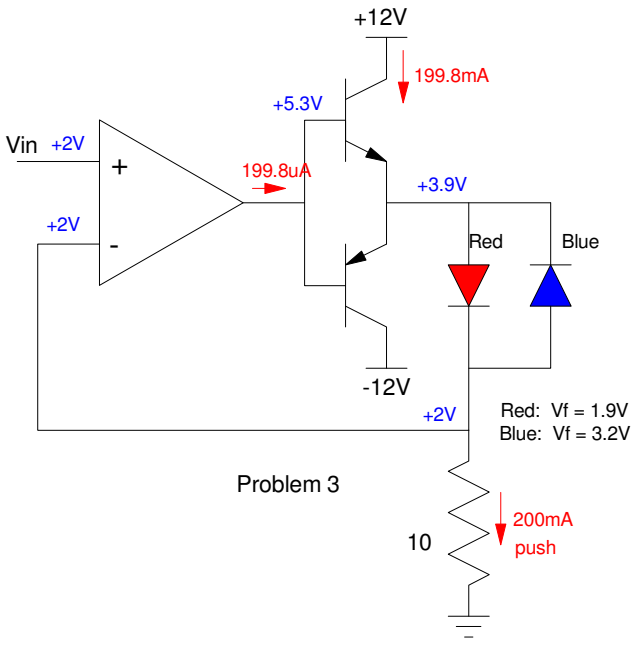


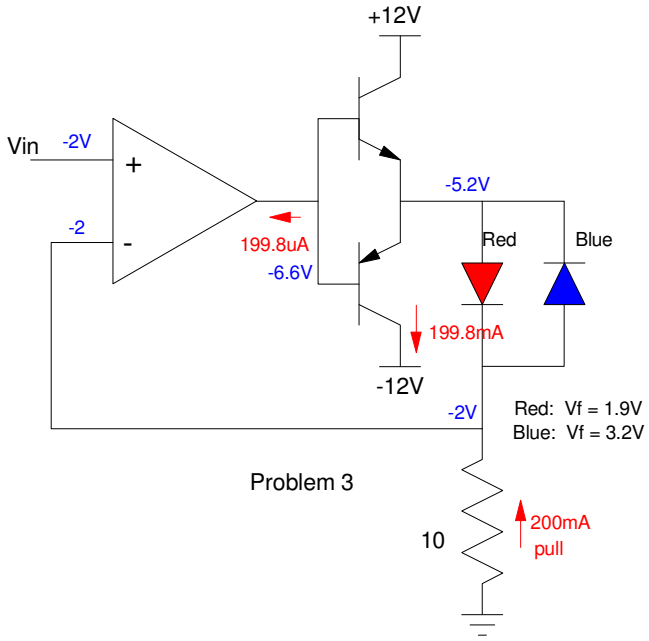
Pull: At -2V, the PNP does almost all of the work (747mA)



3) Determine the voltages and current for the following push-pull amplfiier with

- Vin = 2V
- Vin = -2V

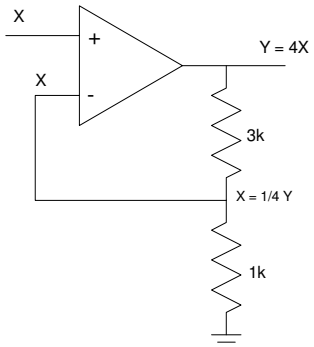




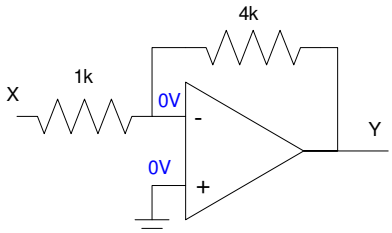
Op-Amp Circuits:

4) Design an op-amp circuit to implement the funcitons

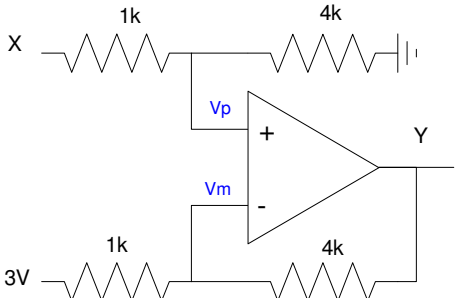
Y = 4X



Y = -4X



Y = 4X - 12 = 4 (X - 3)



A light sensor has the following light / resistance relationship:

$$R = \frac{100{,}000}{Lux}\ \Omega$$

5) Design an instrumentation amplifier whose output is

- 0V when the light level is 50 Lux
- 10V when the light level is 100 Lux

Assume a voltage divider with a +10V input and a 1k resistor:

50 Lux

- R = 2000 Ohms
- Va = 6.666V
- Vo = 0V

100 Lux

- R = 1000 Ohms
- Va = 5.00V
- Vo = +10V

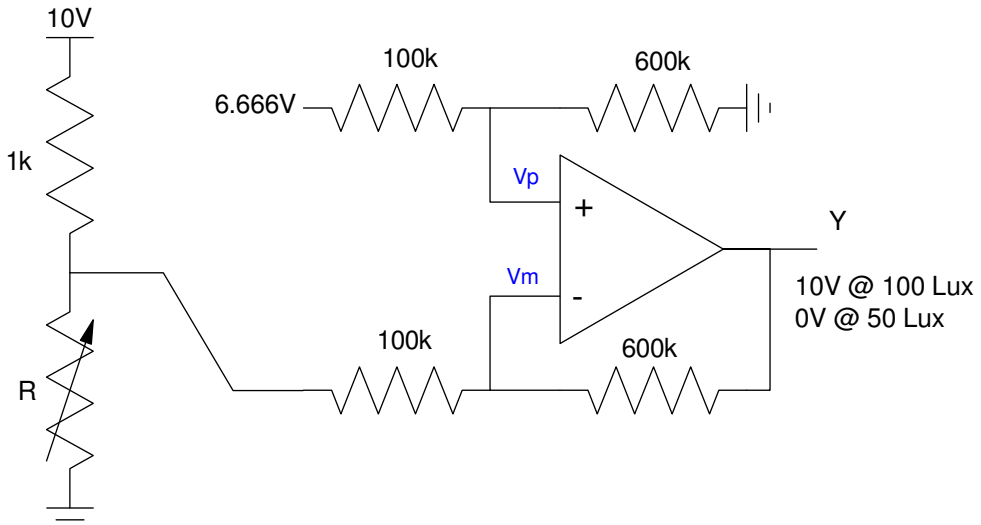
Since the output increases when the input decreases, connect to the - input

The ouput is 0V when the input is 6.666V. Set the offset to 6.666V

The gain is

$$gain = \left(\frac{\delta output}{\delta input}\right) = \left(\frac{10V - 0V}{6.666V - 5.00V}\right) = 6$$

Pick a 6:1 ratio for the resistors:



6) Design an instrumentation amplifier whose outout is

- -10V when the light level is 50 Lux
- +10V when the light level is 100 Lux

Assume a voltage divider with a +10V input and a 1k resistor:

50 Lux

- R = 2000 Ohms
- Va = 6.666V
- Vo = -10V

100 Lux

- R = 1000 Ohms
- Va = 5.00V
- Vo = +10V

Since the output increases when the input decreases, connect to the - input

The gain is

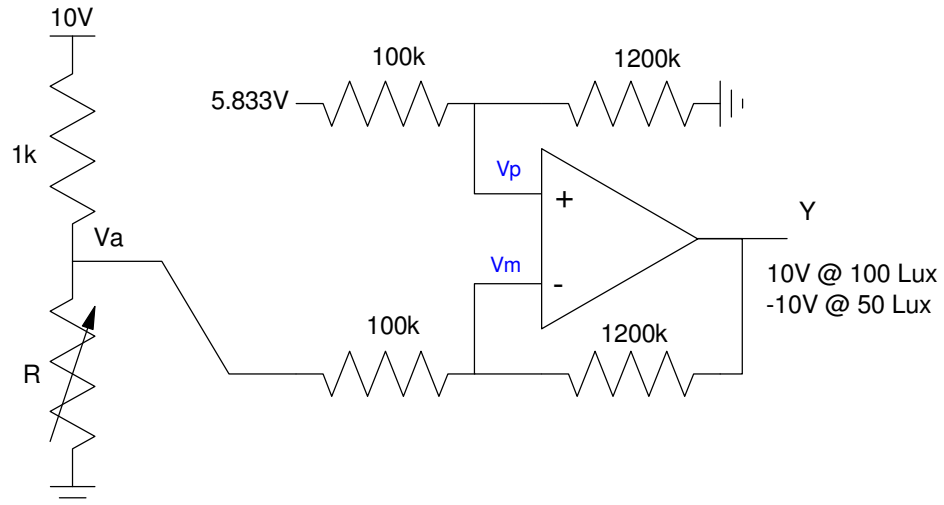
$$gain = \left(\frac{10V - 10V}{6.666V - 5.00V}\right) = 12$$

At 100 Lux

$$Y = gain(V_p - V_m)$$

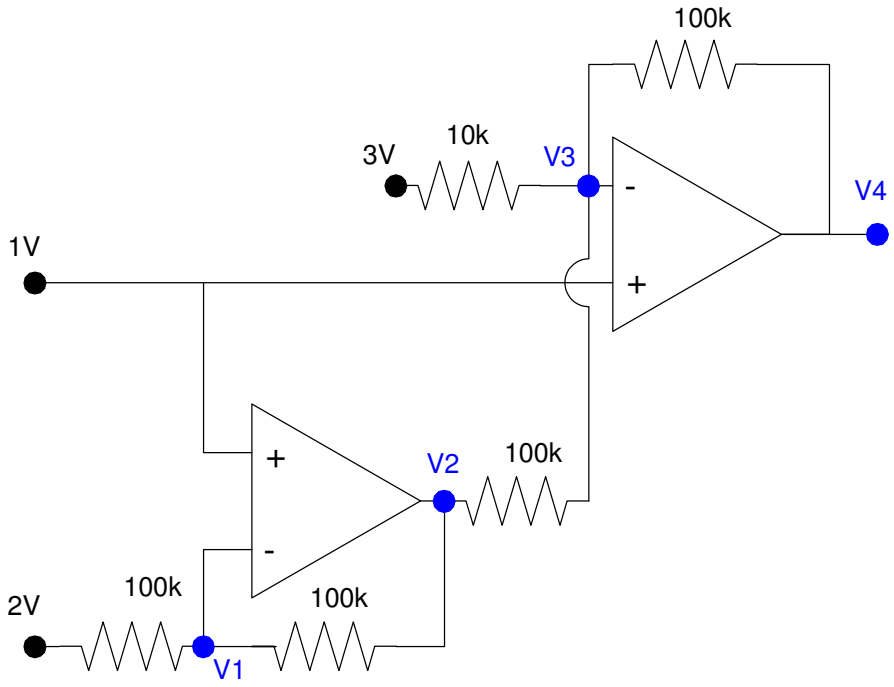
$$10 = 12(V_p - 5)$$

$$V_p = 5.8333$$



Op-Amp Circuits

7) Assume ideal op-amps



Write the voltage node equations for the following op-amp circuits

@ V2 $V_1 = 1$

@V4 $V_3 = 1$

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

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

Solve for the voltages V1 .. V4

$$V_2 = 0V$$

$$V_4 = 9V$$