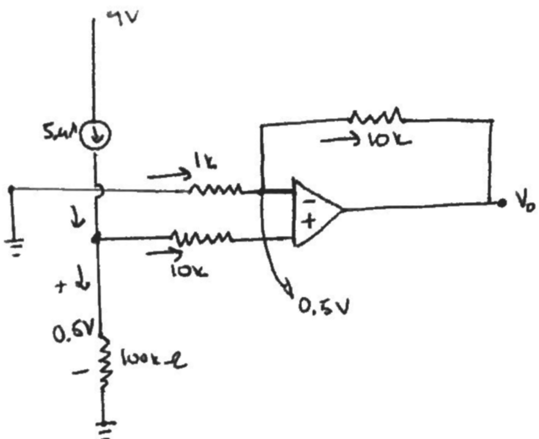
PreLab 5
October 7, 2020

1. Suppose we use the resistor based detector with our photodiode. Furthermore, suppose that our emitter and photodiode are spaced at such a distance that the photodiode produces ID = 5μA and that we have chosen a detector resistance of RD = 100$k\Omega$ so that the detector voltage will be VD = 0.5V. We will model the photodiode as a 5μA current source. If the detector circuit is followed by the non-inverting amplifier as shown in Figure 5.3, find the value of the amplifier output voltage for each of the following cases (assume an ideal op-amp):
a. $R1$ = 1$k\Omega$, $R2$ = 10$k\Omega$, $R3$ = 10$k\Omega$, Vcc = 9V
b. $R1$ = 1$k\Omega$, $R2$ = 100$k\Omega$, $R3$ = 10$k\Omega$, Vcc = 9V.
Simulate this circuit in SPICE or Multisim and comment on any difference between your simulated and theoretical values.

1)

a)



$$\frac{0 - 0.5}{1k} = \frac{0.5 - V_o}{10k}$$

$$-0.5 \times 10 = 0.5 - V_o$$

$$V_o = 0.5 + 5$$

$$\boxed{V_o = 5.5V}$$

b)

$$\frac{0 - 0.5}{1k} = \frac{0.5 - V_o}{100k}$$

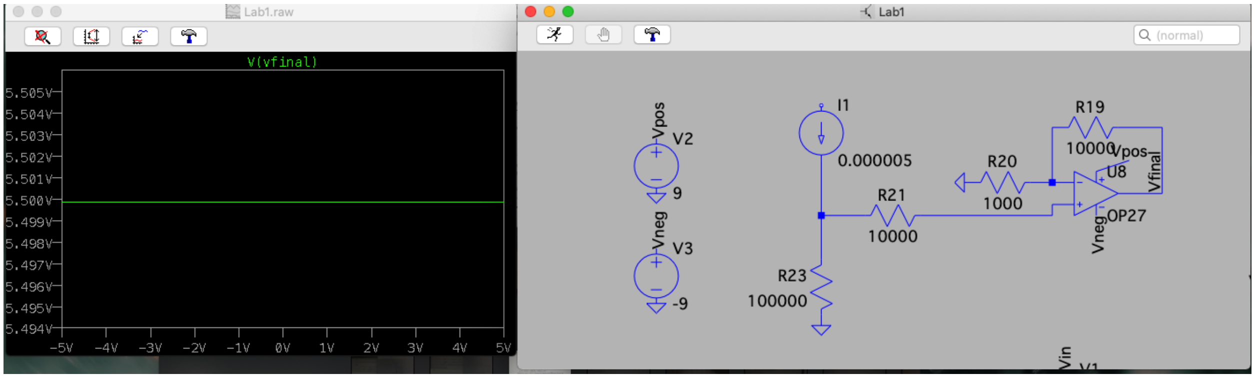
$$-0.5 \times 100 = 0.5 - V_o$$

$$V_o = 0.5 + 50$$

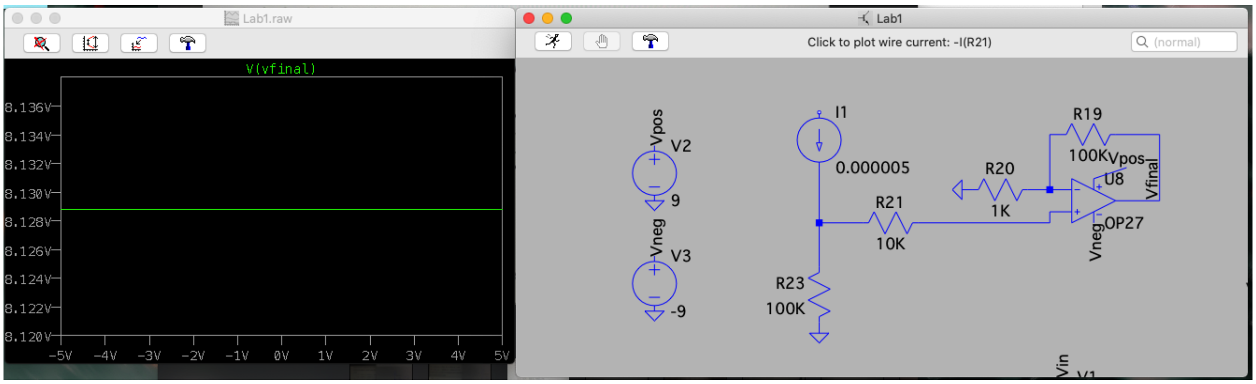
$$V_o = 50.5V$$

$+V_{cc} = +9V$ saturation voltages so = V_o

$$\boxed{V_o = 9V}$$



For part a the voltage in the simulation matches the voltage in my calculations.



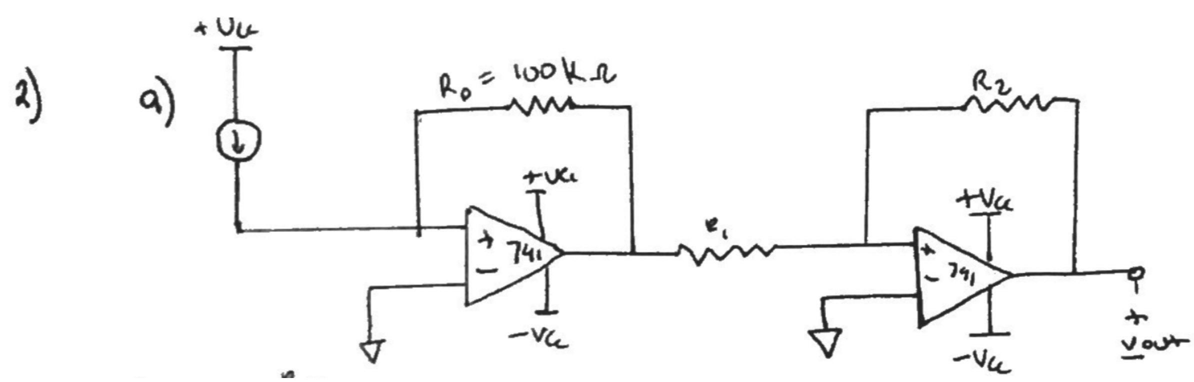
The voltage in the simulation is very close to the voltage in the calculation for part b, as the calculated voltage was 9V and the simulation showed 8.129V.

2. Now suppose we use the op-amp based detector circuit followed by an inverting amplifier as shown in Figure 5.4. Find the value of the amplifier output voltage for each of the following cases:

a. $R1$ **= 1**$k\Omega$**,** $R2$ **= 10**$k\Omega$**,** $R3$ **= 10**$k\Omega$**,** Vcc **= 9**V**.**

b. $R1$ **= 1**$k\Omega$**,** $R2$ **= 100**$k\Omega$**,** $R3$ **= 10**$k\Omega$**,** Vcc **= 9**V**.**

Simulate this circuit in SPICE or Multisim and comment on any difference between your simulated and theoretical values.



$$I_0 = \frac{0 - V_{o1}}{R_p} = 5\times10^{-6} = \frac{-V_{o1}}{100\times10^{3}} \quad \therefore V_o = -100\times10^{3}\times 5\times10^{-6}$$

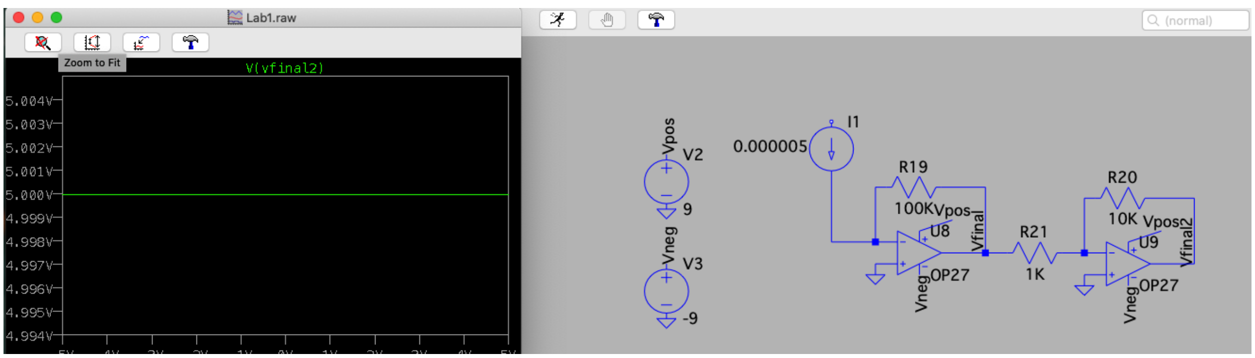
$$V_o = -0.5\,V$$

$$V_{out} = -\frac{R_2}{R_1}\times V_o$$

$$V_{out} = -\frac{10\times10^{3}}{1000}(V_o)$$

$$= -10\times(-0.5)$$

$$\boxed{V_{out} = 5\,V}$$



The simulation results match exactly with my calculations since they both are 5V.

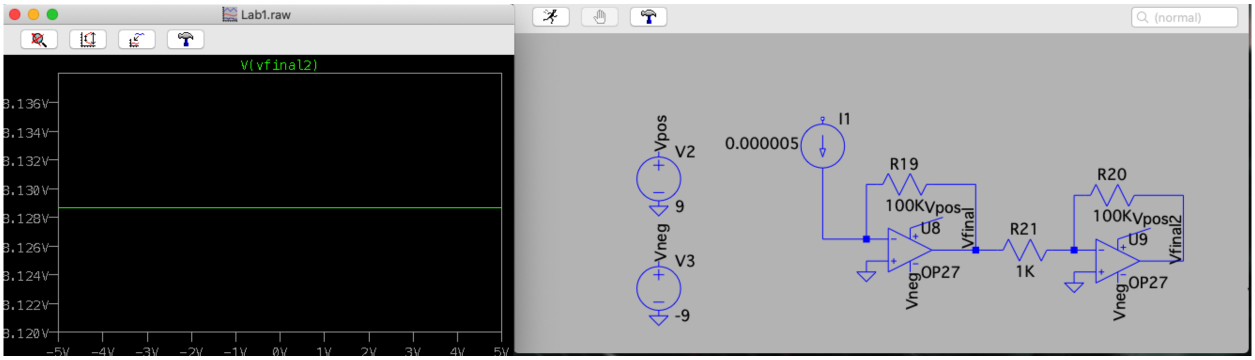
b) $V_{o1} = -0.5$

$$V_{out} = -\frac{R_2}{R_1}(V_{o1})$$

$$= -\frac{100\times10^{3}}{1000}\times(-0.5)$$

$$V_{out} = 50\,V$$ more than saturation voltage

$$\boxed{V_{out} = 9\,V}$$



The voltage in the simulation is very close to the voltage in the calculation for part b, as the calculated voltage was 9V and the simulation showed around 8.129V.