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Ece2001, Sec7
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Operational Amplifiers, Comparators, and Resistive Sensors,
Experiment 3

Abstract:

For this experiment we were going over the basic properties of operational amplifiers (op amps) and configuring a bipolar power supply (+/- 5V). Work in the lab also consisted of building circuits with resistive sensors and their use in comparator circuits, using a potentiometer, and simulating op amp's in PSpice. Part one consisted of building an op amp with a +5V & -5V connection. With V_{in} we had 3 voltage sources plugged into this circuit, operating under open-loop conditions. Then we explored the idea of using it as an comparator in part two. Building a circuit which compares two input voltages and gives a discrete output depending on which voltage is the greater of the two supplied. We did this using a potentiometer and setting it to a random value (by turning it to a random position). Our comparator had two resistors (potentiometer, connected to 2 voltage sources, +/- 5v) connected to an op amp which was also connected to 3 voltage sources (V_{in} with +/- 5v). Part three consisted of choosing wether or not to use a photoresistor or a thermo resistor, my group went with the Photo-Resistor. We found V_x which fed into our op amp, to later find V_{out}. Part four was to build an inverting amplifier while measuring $V_{in}\ and\ V_{out}$. Tabulating plots between point of voltage (+/- 5V). Finally we used PSPice to determine $V_{out}\ vs\ V_{in}$ for part fours circuit using a DC sweep. The experiment consisted of reusing certain circuits for other parts and certain wirings. We used a digital multimeter to get out voltage points.

Introduction:

Finding several voltage points and measurements for our circuits, we were able to see applications of op amps in the lab. There was no theoretical data in this experiment as our data mostly consisted of gathering certain data pertaining to points of interest (our voltage points). We also used DC sweep with PSpice for more data concerning our final circuit. We were able to build a concise understanding of how a op amp works and how to wire them for usage in a circuit.

Theory:

Op-Amp: Operational amplifier that takes two different inputs (V_{in} , more specifically +/- 5V in this experiment) and produces a V_{out} depending on the input voltages.

Inverting Op-Amp: same as an Op-Amp but with inverted output.

Comparator: Circuit where two voltages are compared and discrete output is produced based on which provided voltage is greater.

Potentiometer: Consisting of 3 terminals and a kmob, changes resistance relationship within the component (2 resistors) by moving the knob.

Photo-resisitor: A resistor that gives a resistance depending on its interaction with light (if light is present or not).

Experimental:

Materials:

Digital Multimeter, protoboard, varying resistors (including the photoresistor and potentiometer), triple channel DC power supply and wires for our circuits.

Part 1:

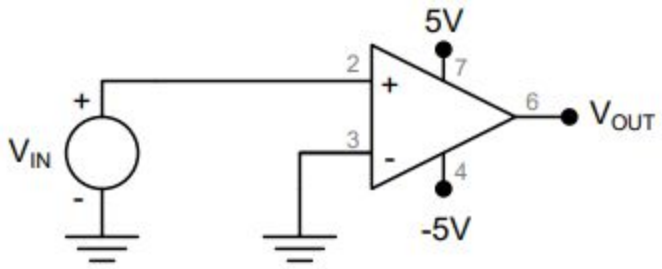


Figure 1

We constructed the circuit featured in Figure 1 above. We tabulated 10 different points of voltage between -5v and 5 volts as the input. Measuring V-out each time we got the same results until a jump into negative values took place.

Part 2:

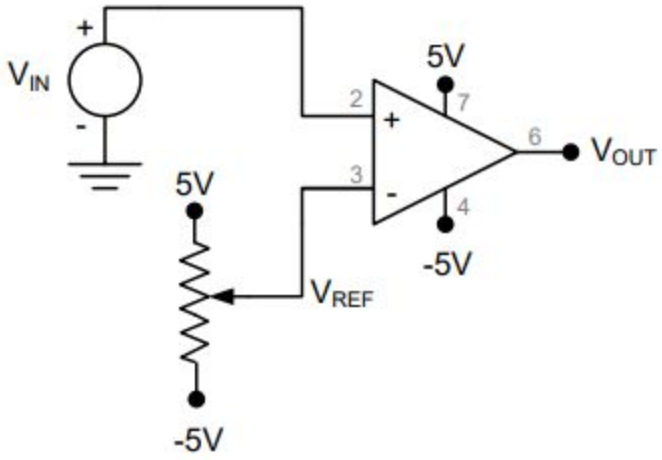


Figure 2.0 - Circuit Diagram

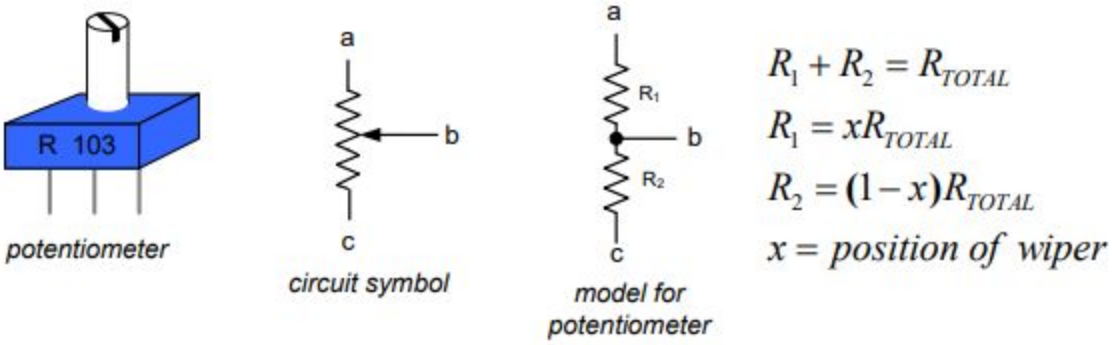


Figure 2.1 - Potentiometer Diagram

We constructed the featured circuit in figure 2 above. This was essentially the same circuit as the last part but this time out point labeled ‘3’ for the op-amp is now wired to a potentiometer. Figure 2.0 shows the circuit set up and figure 2.1 shows the potentiometer resistance set up (essentially it’s equivalent on a circuit diagram). We tabulated our data in the same fashion as part 1.

Part 3:

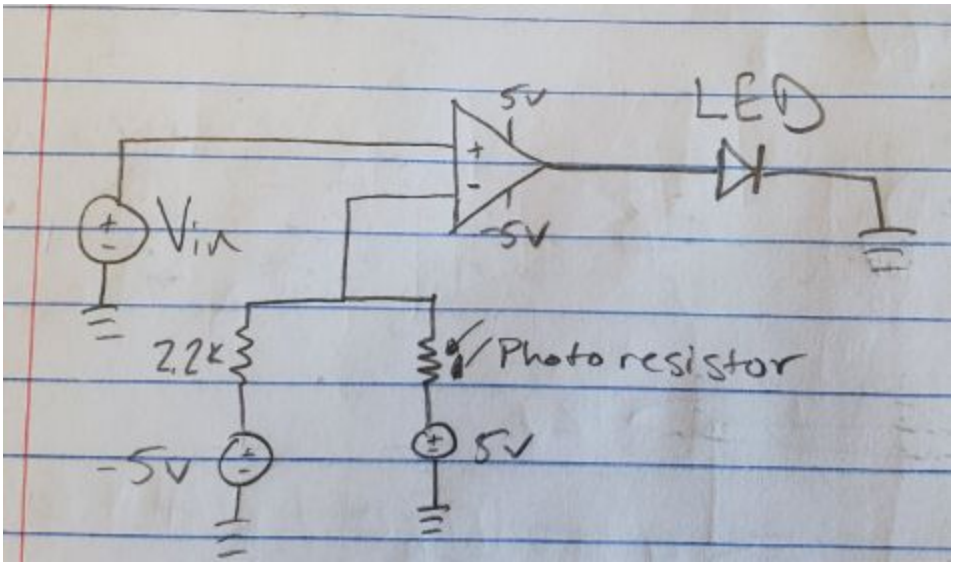


Figure 3.0 - Circuit Diagram

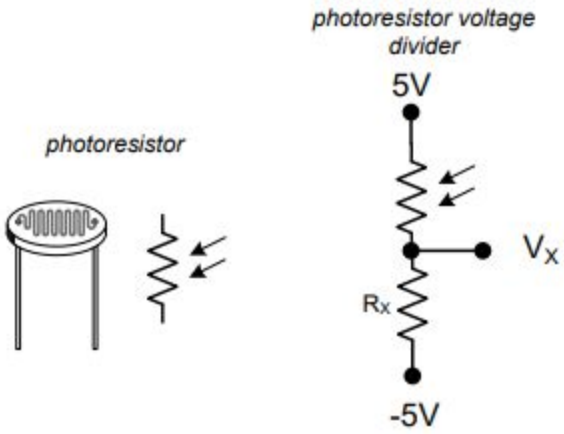


Figure 3.1 - Photo Resistor

For this part we constructed a circuit based off of a resistor of our choosing (we went with the photoresistor instead of the thermo resistor). We measured the resistance for the photoresistor when it was exposed to light and when it was deprived from it. Our

goal was to make the a LED light up when the light was deprived from the circuit. Picture of our circuit is above in figure 3.

Part 4:

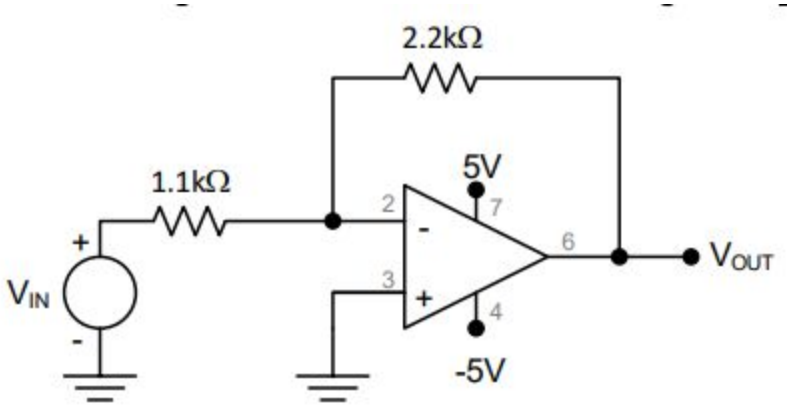


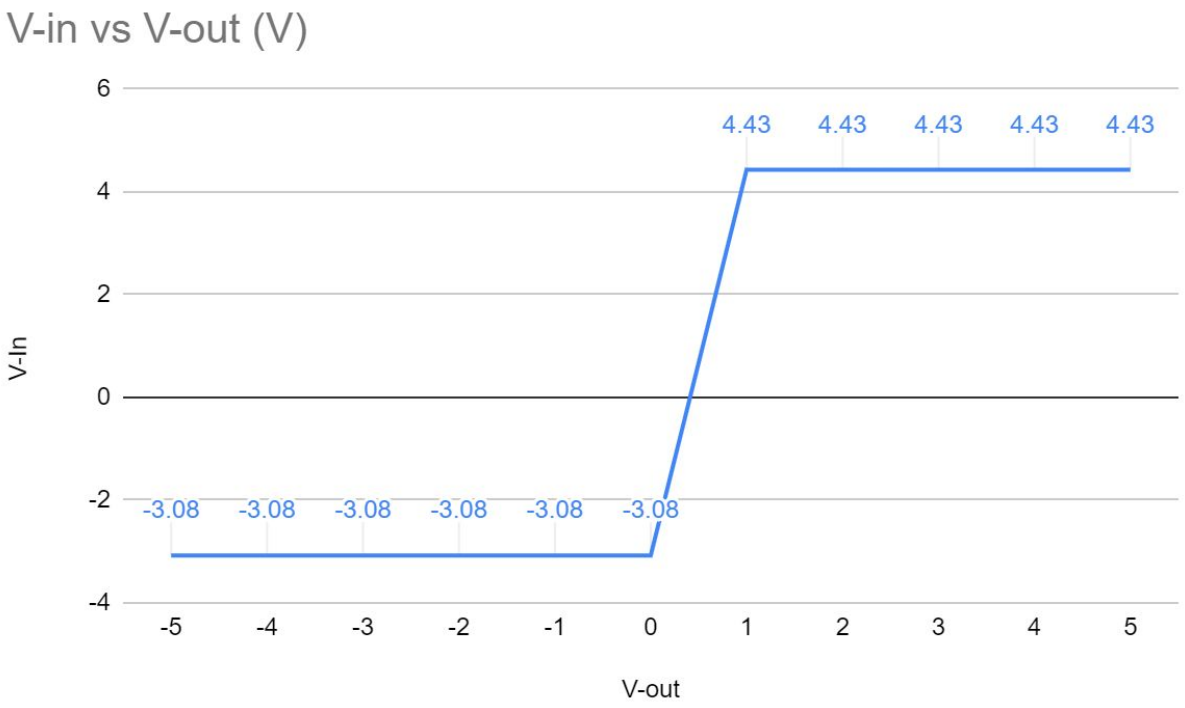
Figure 4

We constructed the circuit featured in the diagram above in figure 4. It is essentially the same circuit as part 1 but with a different set up of resistors. We had our triple voltage channel hooked up for V-in, 5v and -5v inputs respectively. Just like the previous parts, we measured our V-out for changing a changing input voltage (-5v to 5v). We then performed a DC Sweep on Pscpice after simulating the results there respectively

Results:

Part 1:

V-in (V)	-5	-4	-3	-2	-1	0	1	2	3	4/5
V-out (V)	-3.08	-3.08	-3.08	-3.08	-3.08	-3.08	4.43	4.43	4.43	4.43

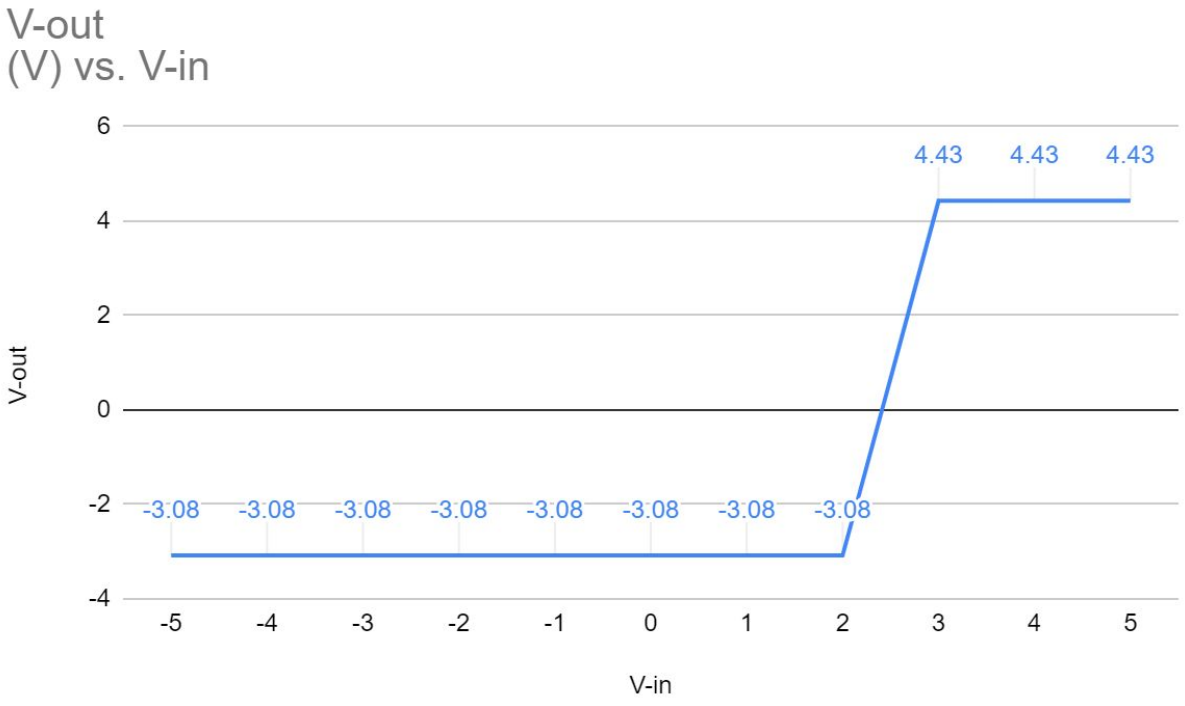


We see the extreme shift from -3.08 to 4.43 right after we change the input voltage of 5v from 0 to 1v.

Part 2:

Attempt 1 under a V-ref of -3.32v:

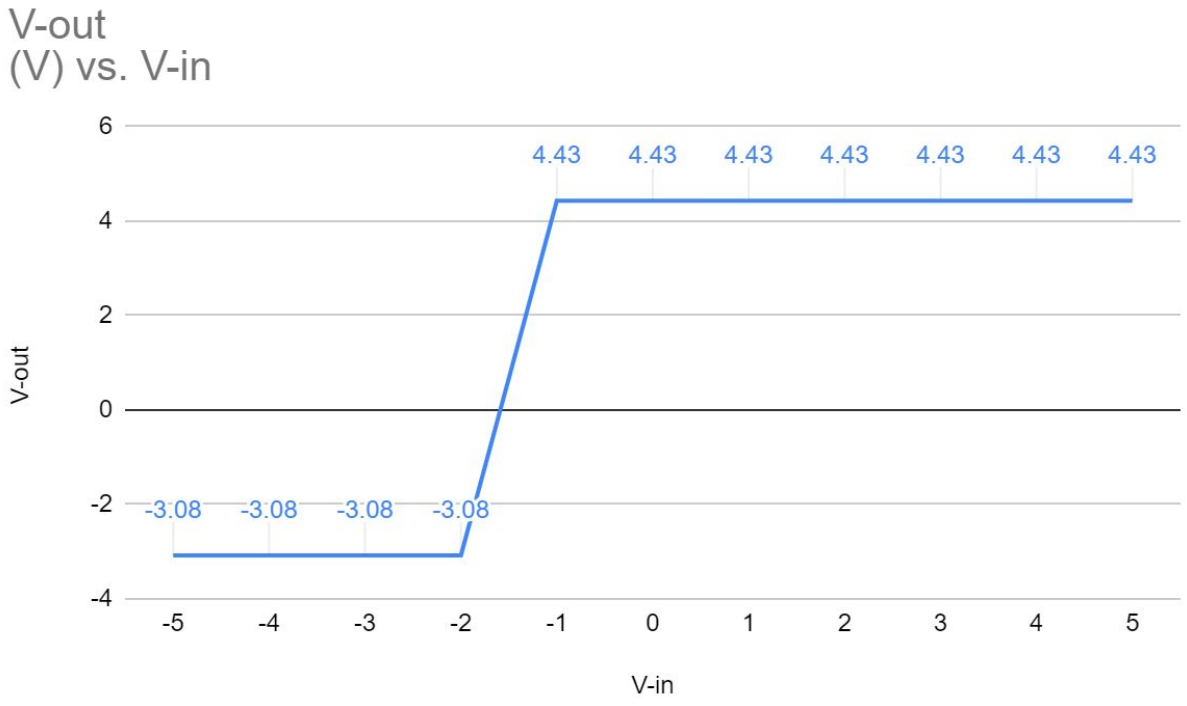
V-in (V)	-5	-4	-3	-2	-1	0	1	2	3	4	5
V-out (V)	-3.08	-3.08	-3.08	-3.08	-3.08	-3.08	-3.08	-3.08	4.43	4.43	4.43



We see the extreme shift from -3.08 to 4.43 right after we change the input voltage of 5v from 2v to 3v.

Attempt 2 under a V-ref of -1.91v:

V-in (V)	-5	-4	-3	-2	-1	0	1	2	3	4	5
V-out (V)	-3.08	-3.08	-3.08	-3.08	4.43	4.43	4.43	4.43	4.43	4.43	4.43



We see the extreme shift from -3.08 to 4.43 right after we change the input voltage of 5v from -2v to -1v.

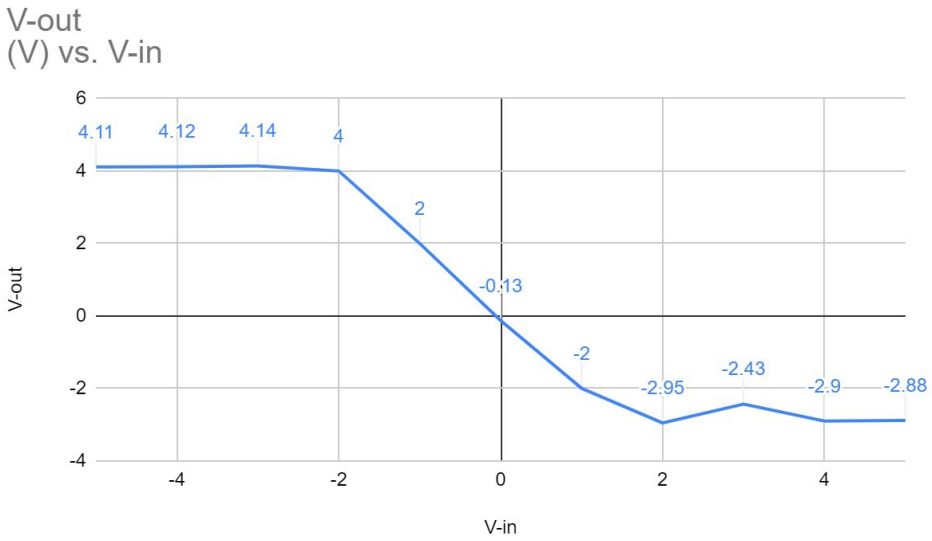
Part 3:

Photoresistor in light:	Photoresistor without light:
$V_{In} = 2$	$V_{In} = 2$
$V_{Out} = -3.1$	$V_{Out} = 2.86$
$V_{Ref} = 4$	$V_{Ref} = 1.62$
$Rpr = 2.4K\Omega$	$Rpr = 6.4K\Omega$

We can see the relationship between the measured voltage and the effect from the photoresistor.

Part 4:

V-in (V)	-5	-4	-3	-2	-1	0	1	2	3	4	5
V-out (V)	4.11	4.12	4.14	4	2	-0.13	-2	-2.95	-2.43	-2.9	-2.88



Conclusion:

We were able to get a better understanding of circuits pertaining/relating to op amps. With the introduction of new circuit components such as the photoresistor and the potentiometer we were able to design new circuits with varying application. Through tabulating the V-out under a range of voltages we were able to see the relationship and effect a component may have to a voltage in a given circuit.

References:

The figures were provided from the Ece2001 lab manual provided in the class.