Lab 4: Operational Amplifier Application
Electronic Security System Part 1 of 2

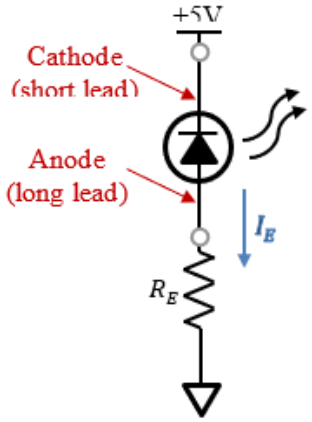
Team: Joshua Ortiz, James Robinson
ECEN 214-502
TA: Yichi Zhang

Date Performed: 02/26/19
Date Report Due: 03/19/19

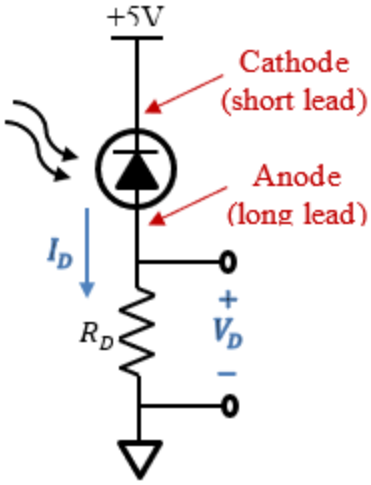
Procedure

Task 1:

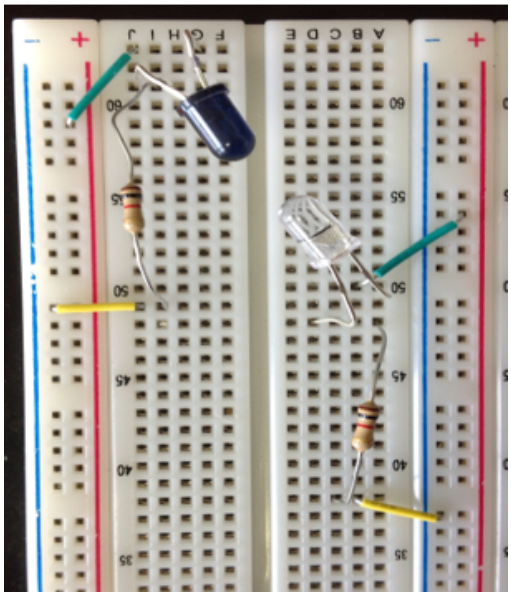
1. Set up the circuit shown in the picture below with the emitter. Resistor Re must be greater than 50 ohms.



2. Measure the voltage through the resistor and the emitter.
3. Solve and record the current across the emitter and also record the resistance of the resistor.
4. Repeat steps 2-3 for various resistor values.
5. Set up the circuit shown in the pictures below with the detector . Resistor Re must be greater than 50 ohms.



Detector

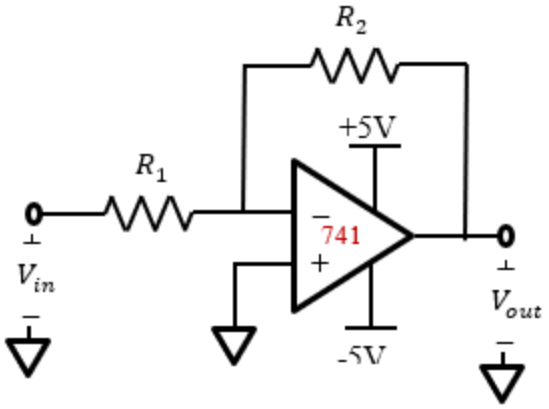


6. Measure the voltage across of the Rd and solve for the current (Id) .
7. Record values of the current and resistance.

8. Repeat steps 6-7 for various resistor values.

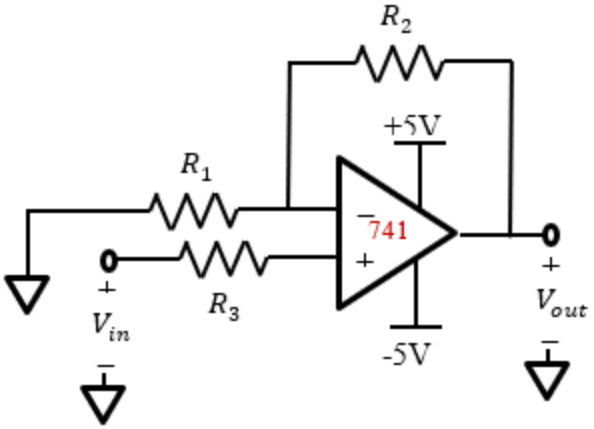
Task 2:

1. Build the inverting amplifier circuit shown below.



(a) Inverting Amplifier

2. Choose your resistor values so that the circuit provides as much amplification.
3. Measure the output voltage of your amplifier for a range of input voltages.
4. Record these values.
5. Repeat steps 2- 4 for the non-inverting amplifier configuration shown below.



(b) Non-Inverting Amplifier

Task 3:

1. Build the circuit shown below.

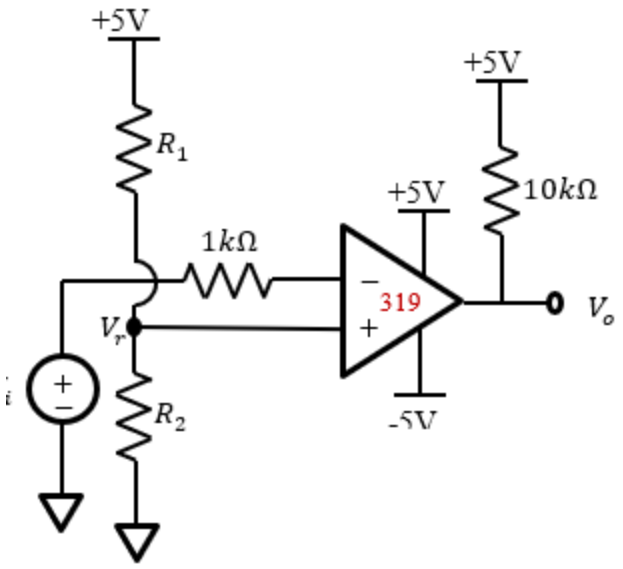


Figure 4.13 – Voltage comparator.

2. Choose proper resistors for R1 and R2 that would be a good level to set your reference voltage.
3. Measure the output voltage of the comparator for several different input levels.
4. Record the measurements.

Data Tables

Task 1:

Resistance Ohm	Voltage Across Resistor V	Voltage Across Emitter V	Current Across Resistor
100	2.478	1.325	0.0268
200	3.69	1.184	0.0198
300	4.258	1.182	0.01387
1000	3.75	1.1486	0.00392

(100 (Ohms) on Emitter)		
Resistance Ohm	**Voltage Across Vd**	**Op Amp Voltage Across Vd**
100	2.42	-0.99
1000	4.856	-2.65
2000	4.782	-6.37
3300	4.911	-8.37
5100	4.86	-12.9

Task 2:
Inverting

Resistor 2	Resistor 1	Multiplier	Vin	Vout
5100	2200	2.318	1.75	-3.694
5100	2200	2.318	0.16	-0.387
5100	2200	2.318	1	-2.0731
5100	2200	2.318	1.5	-3.1674
5100	2200	2.318	0.5	-1.41

Non- Inverting

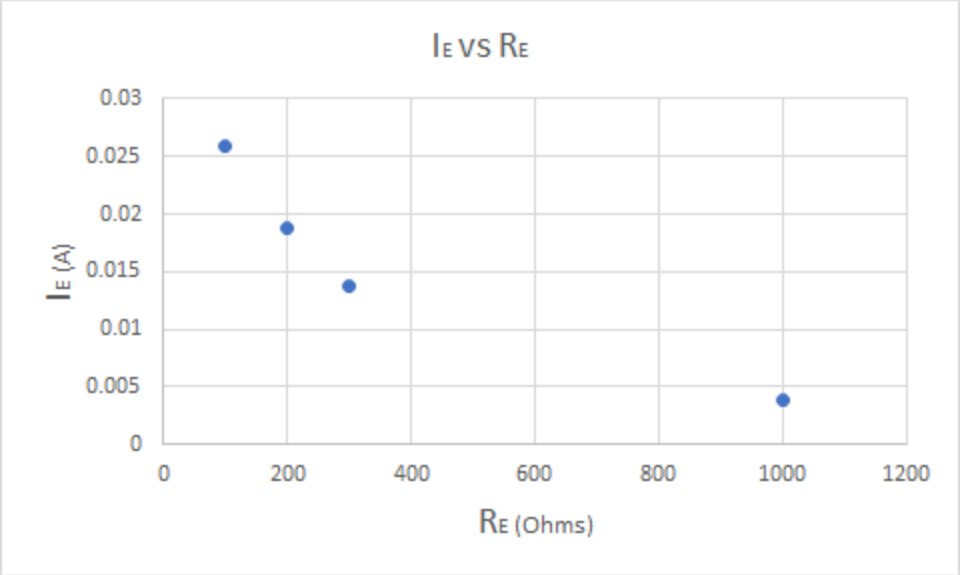
Resistor 3	Resistor 2	Resistor 1 (1000 || 2000)	Multiplier	Vin	Vout
5100	1000	666	2.502	1.75	4.2
5100	1000	666	2.502	0.16	0.4246
5100	1000	666	2.502	1	2.242
5100	1000	666	2.502	1.5	3.71
	1000	666	2.502	0.5	1.11

Task 3:

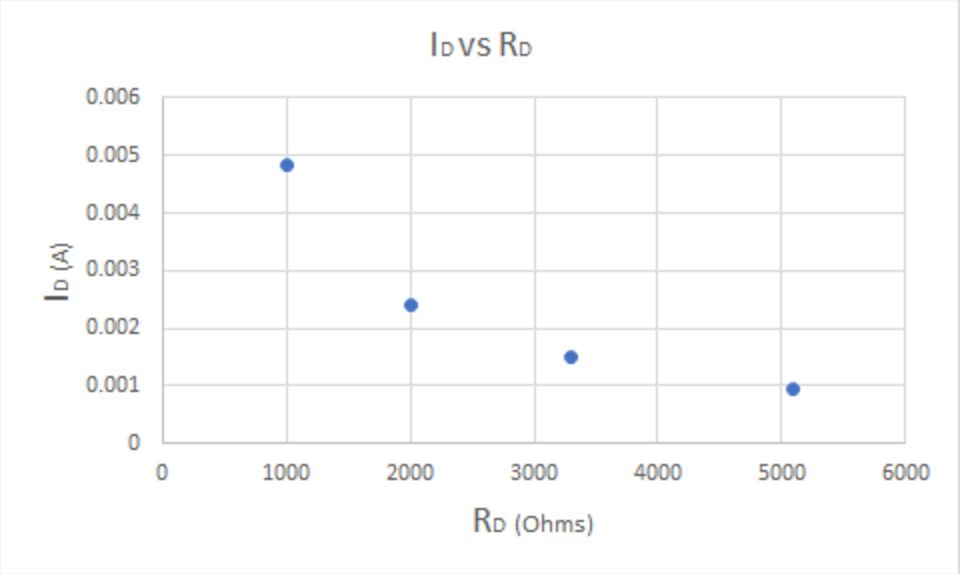
		Comparator	(From Amplifier)	
Resistor 2	Resistor 1 (1000 || 2000)	Multiplier	Vin	Vout
1000	666	2.502	1	4.96
1000	666	2.502	2	4.94
1000	666	2.502	3	0.176
1000	666	2.502	4	0.1453
1000	666	2.502	0.5	4.95
1000	666	2.502	0.3	4.95
1000	666	2.502	2.48	4.95
1000	666	2.502	2.35	4.95
1000	666	2.502	2.65	4.95
1000	666	2.502	2.9	4.94
1000	666	2.502	2.99	0.455

Graphs

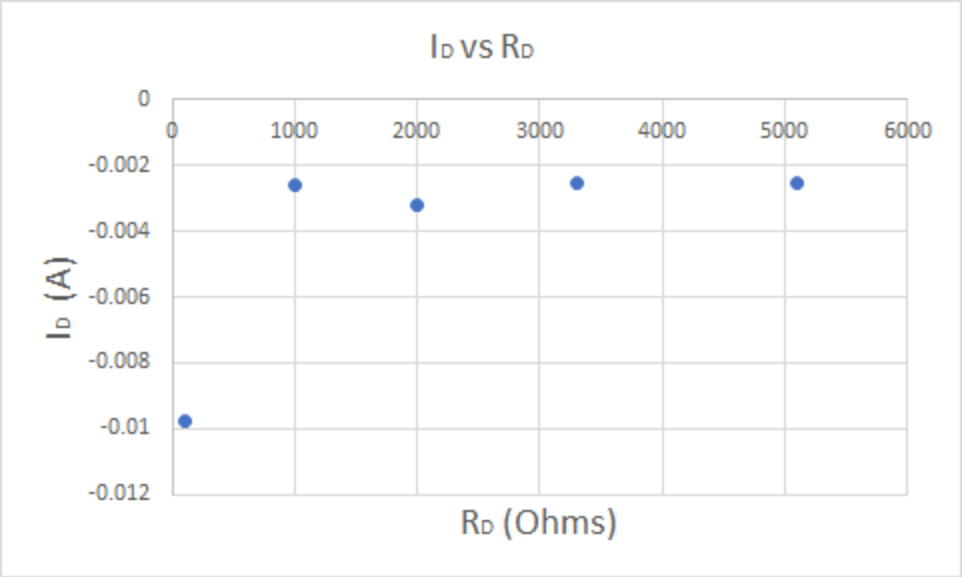
Task 1: Emitter Graph



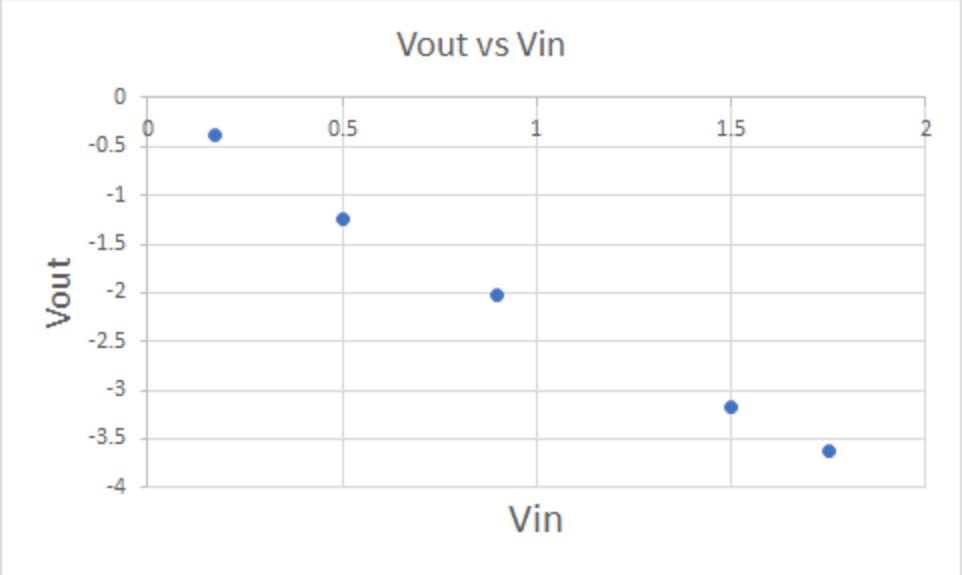
Task 1: Detector Graph



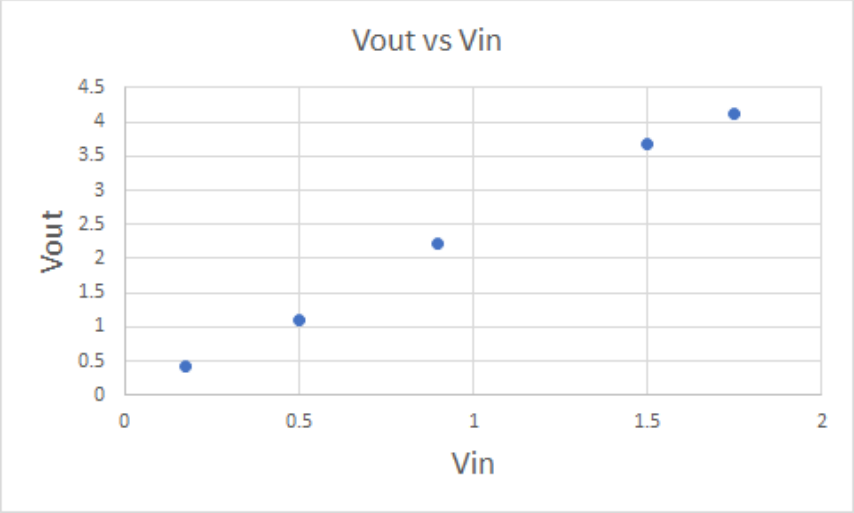
Task 1: Detector Op Amp Graph



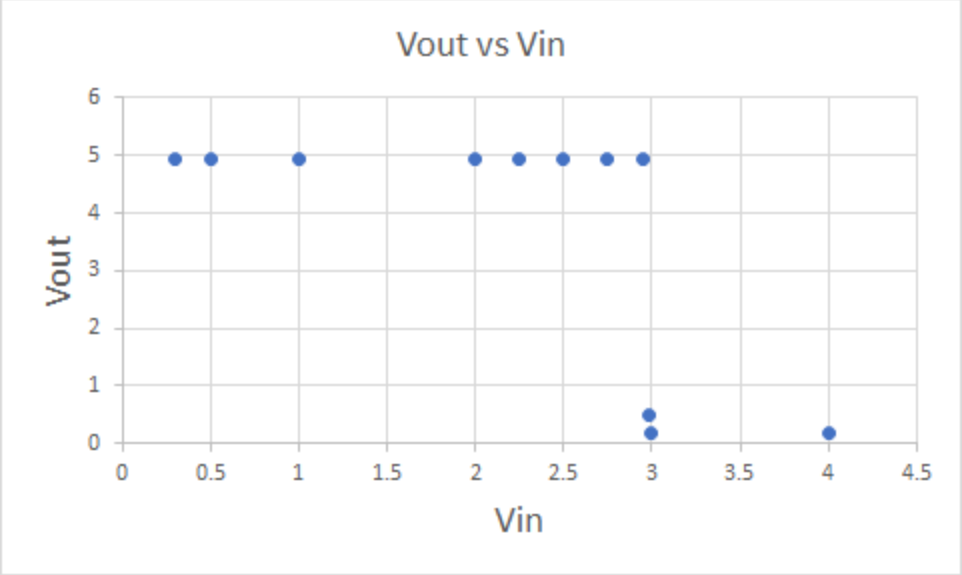
Task 2: Inverting Graph



Task 2: Non- Inverting Graph

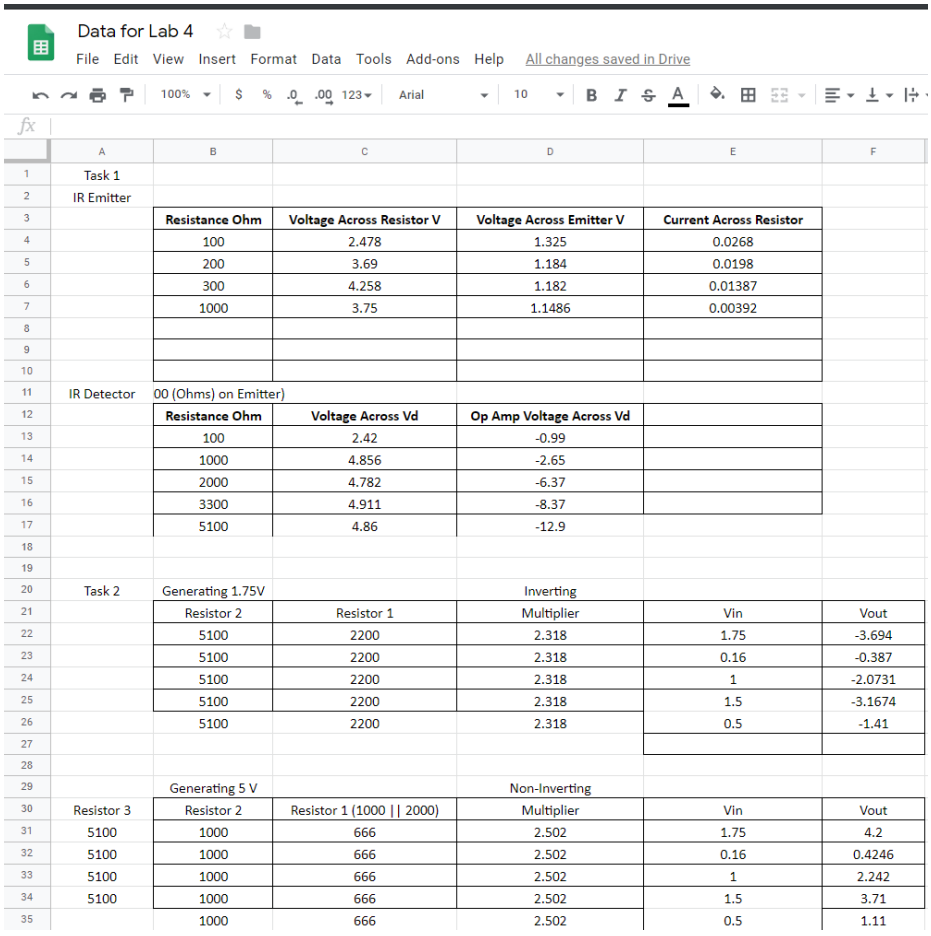


Task 3: Comparator Graph



Screenshots

(We used sheets to record our data not the notebook)



Data for Lab 4

File Edit View Insert Format Data Tools Add-ons Help All changes saved in Drive

	A	B	C	D	E	F
1	Task 1					
2	IR Emitter					
3		**Resistance Ohm**	**Voltage Across Resistor V**	**Voltage Across Emitter V**	**Current Across Resistor**	
4		100	2.478	1.325	0.0268	
5		200	3.69	1.184	0.0198	
6		300	4.258	1.182	0.01387	
7		1000	3.75	1.1486	0.00392	
8						
9						
10						
11	IR Detector	00 (Ohms) on Emitter)				
12		**Resistance Ohm**	**Voltage Across Vd**	**Op Amp Voltage Across Vd**		
13		100	2.42	-0.99		
14		1000	4.856	-2.65		
15		2000	4.782	-6.37		
16		3300	4.911	-8.37		
17		5100	4.86	-12.9		
18						
19						
20	Task 2	Generating 1.75V		Inverting		
21		Resistor 2	Resistor 1	Multiplier	Vin	Vout
22		5100	2200	2.318	1.75	-3.694
23		5100	2200	2.318	0.16	-0.387
24		5100	2200	2.318	1	-2.0731
25		5100	2200	2.318	1.5	-3.1674
26		5100	2200	2.318	0.5	-1.41
27						
28						
29		Generating 5 V		Non-Inverting		
30	Resistor 3	Resistor 2	Resistor 1 (1000 || 2000)	Multiplier	Vin	Vout
31	5100	1000	666	2.502	1.75	4.2
32	5100	1000	666	2.502	0.16	0.4246
33	5100	1000	666	2.502	1	2.242
34	5100	1000	666	2.502	1.5	3.71
35		1000	666	2.502	0.5	1.11

	Generating 5 V		Non-Inverting		
Resistor 3	Resistor 2	Resistor 1 (1000 || 2000)	Multiplier	Vin	Vout
5100	1000	666	2.502	1.75	4.2
5100	1000	666	2.502	0.16	0.4246
5100	1000	666	2.502	1	2.242
5100	1000	666	2.502	1.5	3.71
	1000	666	2.502	0.5	1.11
Task 3			Comparator	(From Amplifier)	
	Resistor 2	Resistor 1 (1000 || 2000)	Multiplier	Vin	Vout
	1000	666	2.502	1	4.96
	1000	666	2.502	2	4.94
	1000	666	2.502	3	0.176
	1000	666	2.502	4	0.1453
	1000	666	2.502	0.5	4.95
	1000	666	2.502	0.3	4.95
				2.48	4.95
				2.35	4.95
				2.65	4.95
				2.9	4.94
				2.99	0.455

Simple Calculations:

$$I_E = \frac{V_E}{R_E}$$

Discussion:

Task 1: For the resistor values on the detector and emitter, we chose 100 and 300 Ohms because these values had produced the greatest difference in obstructed and unobstructed voltage. When we tried to spread the emitter and detector apart, we found that an inch was about as far as they could be separated with full functionality. At the resistor values we chose, we found that the unobstructed value at this distance was 2.94 V and the obstructed value to be 0.15 V. After redoing the experiment with the op amp implementation, we concluded that the op amp was a better setup because it provided a wider range of voltages for the data set then the first setup.

Task 2: If we used the op amp based detector with the inverting amplifier this would yield the greatest amplification because Vout would produce a positive voltage. The op amp based detector itself produces a negative voltage, so when placed with a inverting amplifier the Vout would be positive (Vout = -Vin(R2/R1)).

Task 3: We chose resistor values R1 = 666 and R2 = 1000 to keep it consistent with our non-inverting amplifier. Based of the graph and table of task 3, the input voltages needed to cause the output to produce each of the desired logic levels would range from 0-3 volts.

Conclusion:

In this lab, learned about the properties of diodes. We learned to configure op amps and saw the results of their implementation. We figured out which amplifier is better for certain situations (inverting vs non-inverting). Last, we learned about voltage comparators and their behavior.

0	1	2	3	4	5	7
			3	4	10	17