Elen 115
Lab #3: Project 1
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2:15 Wednesday
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Objectives:

Exploring two variable resistance sensors which include a photoresistor and a flex sensor, this project aims to explore the effects of variable resistance sensors in circuits. Using data sheets, appropriate circuits with fitting resistors, we will note the effects of variable sensors on the circuits. Upon having constructed and observed the behavior of the circuits, various use cases will be thought of and tested to explore the use cases of the respective sensors.

Part I: Sensor 1 - photoresistor

First, in order to test the resistance range of the photoresistor, the resistor was first connected to the DMM and then various lighting conditions were presented to the photoresistor to observe the change in resistance values under different lighting conditions.

i. Room light: 2.56KΩ
ii. No Light: 21.11KΩ
iii. Flash light: 2.46KΩ

Next, in order to test the effects that the variable resistor had on an output voltage, the photoresistor was connected to a 10KΩ resistor, 5V, and ground in a voltage divider circuit. The respective circuit as well as resistance values for each case in the voltage divider circuit are noted below.

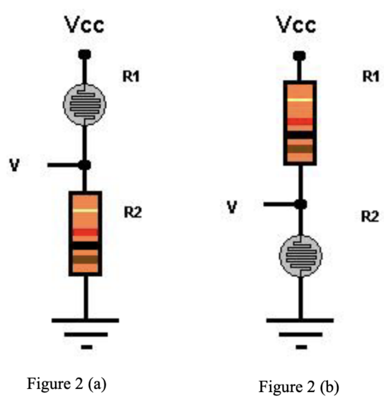


Figure 1: Two possible Photoresistor configuration

Resistance Values:

iv. R_2 = 9.9979KΩ
v. $R_{photoresistor}$ =
   1. Room light: 2.20KΩ
   2. No Light: 8.75KΩ
   3. Flash light: 1.99KΩ

Voltage Values:

vi. Room light: 1.187 V
vii. No Light: 3.92 V
viii. Flash light: 0.87 V

Next, in order to further explore the effects of light on the photoresistor, the output of the photoresistor was connected to the oscilloscope. Since only a DC input was provided, the observed voltage was linear with slight changes if the lightning conditions were changed. The respective change was observed on a voltage in versus time graph on the oscilloscope.

Following the oscilloscope experiment, we held a flashlight arms length away from the photoresistor and found the voltage across the photoresistor to be 0.87V. We then calculated the Rs value from the previous circuit to get an output of 2.5V

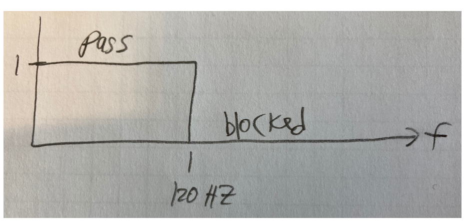
Behaves like a voltage divider. Therefore ⇒

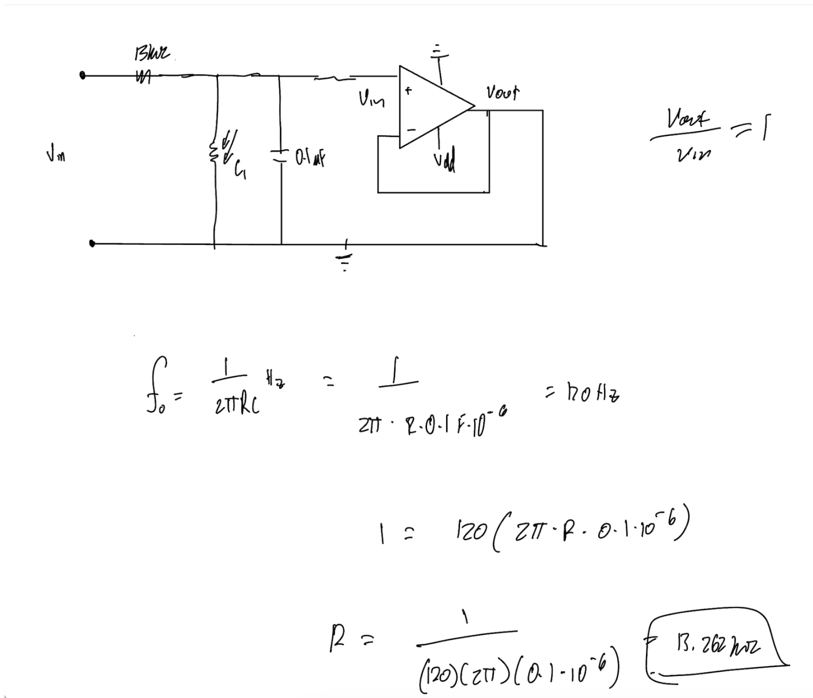
1. $V_{in}*(R_2)/(R_2+R_1) = V_{out}$
2. $5V*(R_2)/(R_2+10K\Omega) = 0.87V$
3. $5*R_2 = 0.87R_2 + 8700$
4. $4.31R_2 = 8700$
5. $R_2 = 2018\Omega$

Lab Question: If we were to connect a photoresistor as R2 and a resistor as R1, nothing would change because the photoresistor is configured as a voltage divider. It does not matter where the photoresistor is, it is still taking the same amount of proportional voltage from the input.

Part II: Noise interference on photoresistor

We chose to develop an active LPF in order to amplify the output filter and to block any high frequencies. To construct a low pass filter, we placed a capacitor in parallel with the photoresistor in order to block any high frequencies and implement a non-inverting amplifier to amplify the signal. Adding a capacitor in parallel with an active element in the form of a non-inverting amplifier will eliminate the noise and deliver a clean DC signal. Furthermore, with the implementation of an amplifier, any desired level of gain can be produced.





In order to acheive a cut of frequency of 120Hz we have concluded from the calculations above that a resistor of 13.262KΩ along with a capacitor of 0.1μF is ideal. This will ensure that any light passed through at a frequency of 120Hz will be omitted and not affect the output.

It should be noted that due to time constraints we were unable to complete the circuit build and therefore do not have the appropriate results to prove the function of our circuit, however, based on the calculations and theoretical function of the op-amp, the input frequency of light should not be passed and affect the output.

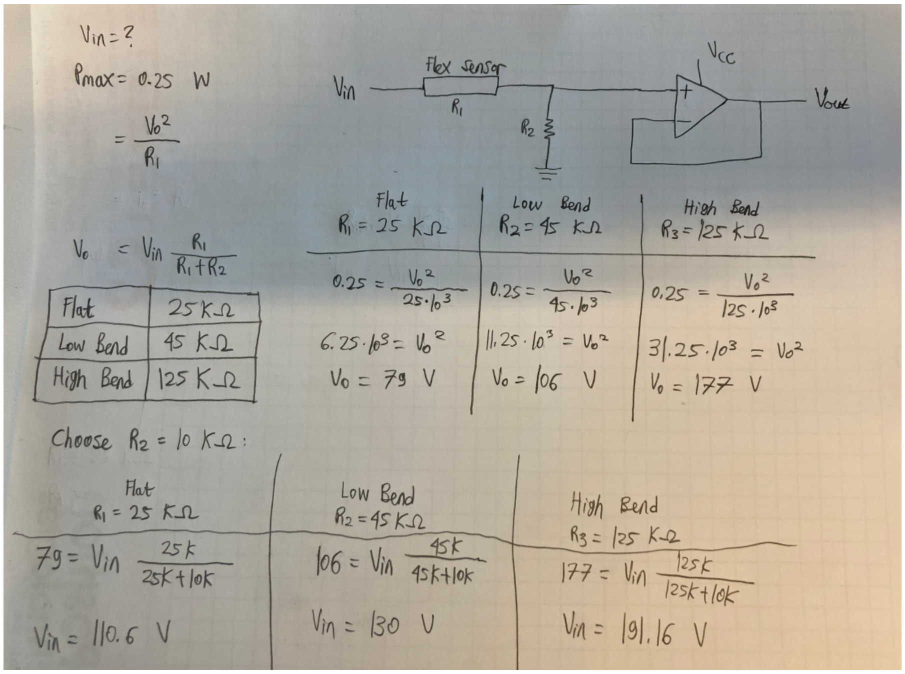
Part 3: Sensor 2 – Flex Sensor

Data sheet:

Electrical Specifications

- -Flat Resistance: 25K Ohms
- -Resistance Tolerance: ±30%
- -Bend Resistance Range: 45K to 125K Ohms (depending on bend radius)
- -Power Rating : 0.50 Watts continuous. 1 Watt Peak

Knowing that the max power that the resistor can withstand and the power rating of the 741 op-amp is 0.5 watts, it is critical that we first determine the max power that can be placed through the op-amp and then ensure that the max is not exceeded. Below those calculations are listed out.



From the results above, in order to stay well within the range of the resistors and flex sensors max power, we chose an input voltage of 2.5V and a resistance value of 10KΩ.

Due to build issues with our proposed circuit and issues with the proposed input voltage and resistance value, the flex sensor only displayed an outputting voltage of ±0.005V. Nonetheless, the varying voltage when the flex sensor was bent did indicate a change in voltage and therefore a functioning circuit and a variety resistance. Furthermore, due to time constraints and material limitations we were unable to test the proposed application of the sensor.

Application:

One possible application of flex sensors is in wearable technology, such as fitness trackers, to monitor and track the movement of various parts of the body.

For example, a fitness tracker has the capability to monitor the bending of the user's arm due to the existence of flex sensors. A flex sensor is typically attached to the arm to obtain the degree of bending. It should be connected to a microcontroller in order to process the sensor data. The microcontroller allows the values to be displayed to the user.

To design this application, we can follow these steps:

1. Determine the range of motion: We need to determine the range of motion of the arm and the degree of bending that we want to monitor. This will help us choose a flex sensor with the appropriate range of sensitivity.

2. Choose the flex sensor: Based on the range of motion and degree of bending, we can select a flex sensor with the appropriate sensitivity and resistance range.

3. Interface the flex sensor: We can interface the flex sensor with a microcontroller or a wearable device using analog or digital signals.

4. Calibration: We need to calibrate the sensor to accurately measure the degree of bending. This can be done by measuring the sensor output at different bending angles and mapping them to the corresponding sensor values.

5. Display the results: Once the sensor data is processed and calibrated, the results should be demonstrated to the users for the ultimate purpose of a fitness tracker to be accomplished.

Conclusion:
From the project, we learned how to apply sensor data sheets and design circuits around them to produce circuits that function within the range of the sensors. Furthermore, we gained an understanding of how to apply active low pass filters using op amps and how to build basic voltage divider circuits with variable resistors. Then, having gained an understanding of the function of our circuits, we were then able to produce possible applications of the sensor. In our case, we thought of a fitness tracker that could determine the movement of various limbs.