SANTA CLARA UNIVERSITY	ELEN 115 Spring 2023	Dr. S. Krishnan

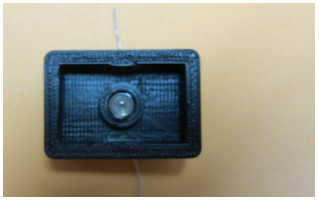
Project 3: Turbidity sensor

I. OBJECTIVES

- To build a turbidity sensor using electronic components
- To obtain an electrical voltage or current from sensing the physical quantity.
- To provide an indication on a threshold level.
- To study the operation of a switch to control a motor.

Part 1: The components of the sensor

1. You will be using a 5V power supply for the sensor portion of the circuit.
2. LEDs are tiny two-leaded light sources that fit easily into an electrical circuit. In this project you will be powering the LED to shine light on our water sample.



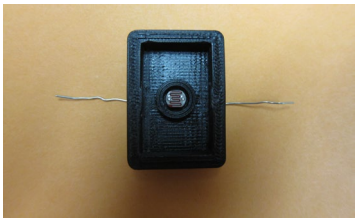
The LED you will be using is the RL50-PR543.

Datasheet is at
http://www.jameco.com/Jameco/Products/ProdDS/2095171.pdf

Note down some important specs or information you read in the data sheet.

Design a simple circuit to ensure you can power the LED to shine light through the water sample. Record your final circuit schematic and any measurements you take.

3. We now will have to sense the light passing through the sample.
   The light sensor you will use today is a **photoresistor** whose resistance varies with the amount of light intensity that it sees.



The photoresistor you will be using is CDS001-8006.
Information about the part is at the below links.
https://octopart.com/cds001-8006-jameco+valuepro-6989278

http://www.jameco.com/webapp/wcs/stores/servlet/ProductDisplay?langId=-1&storeId=10001&catalogId=10001&pa=202411&productId=202411&CID=octopart

Datasheet is at

http://datasheet.octopart.com/CDS001-8006-Jameco-Valuepro-datasheet-7084541.pdf

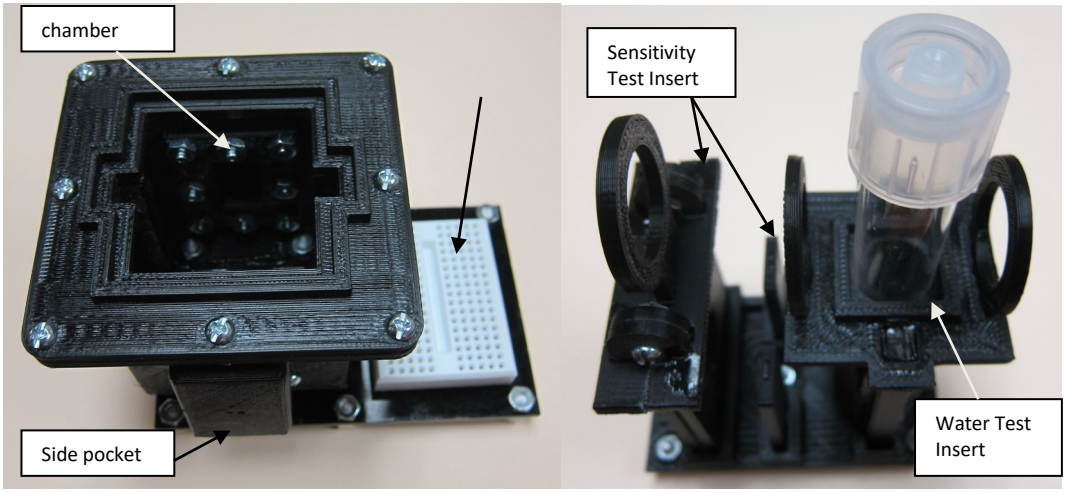
Note down some important specs or information you read in the data sheet.

Measure the change in resistance as different amounts of light fall on the photo resistor.

Design a simple circuit to ensure you can convert this "light" measurement to an electrical signal. Record your final circuit schematic and any measurements you take.

4. Sensor chamber

You have a kit of parts to sense the turbidity of the water. You have been given a chamber which houses the sensor and allows you to place water samples. This chamber has side pockets. It also has two types of inserts: one to test its sensitivity and the other in which you will place the water sample.



5. Measuring the sensory output:

You will be testing the sensitivity of your sensor. Place different papers in the insert to emulate various turbidity levels. Measure the output voltage as you vary the paper inserts from no paper, clear paper, and translucent paper to thick opaque paper.

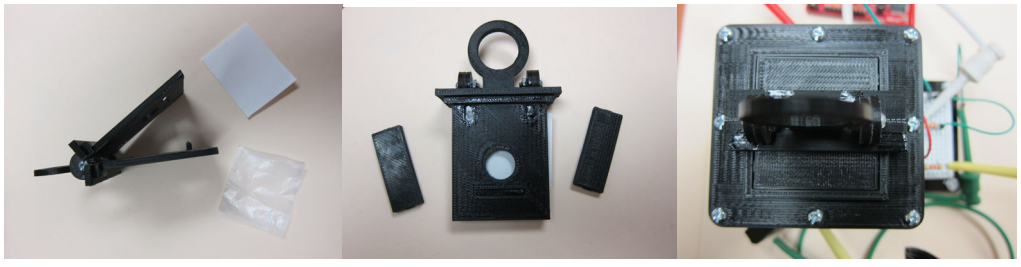


Table 1: Testing the sensitivity

Paper type	Photoresistor Resistance value	Multimeter Reading
none		
clear		
translucent		
opaque		

6. Testing your water sample

Put the test-tube with your water sample into the holder and then into the chamber.

Testing the water sample

Measure the output voltage on the multimeter.
Are you able to distinguish clearly if your water sample is turbid or not?
Do you need to make any adjustments to your design so far. Explain your answers.

Part 2: Providing an indication on Turbidity

In this project you need to indicate that the water is clear or not.

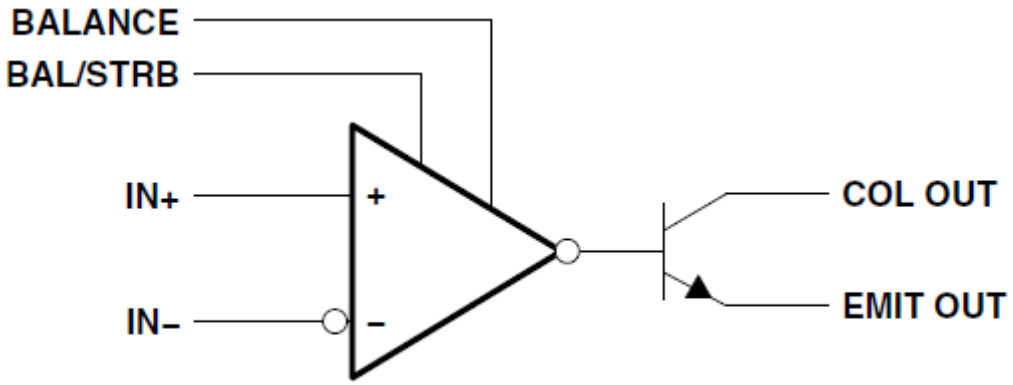
- If the turbiidty of the water is low you will light an LED.
- If the turbidity is high you will be running a motor to mimic agitating the water.

To be able to set a threshold and get the indication you will be using a comparator. Assume turbid water is between levels that you obtained for translucent and opaque paper. What threshold voltage will you set to indicate turbidity.
Record your final circuit schematic and any measurements you take.

The chip provided to you is a differential comparator LM311. http://www.ti.com/product/LM311

The chip has a BJT at its output as shown below. Make sure to provide a pull-up or pulldown for the collector and emitter of the device so it can be made functional.

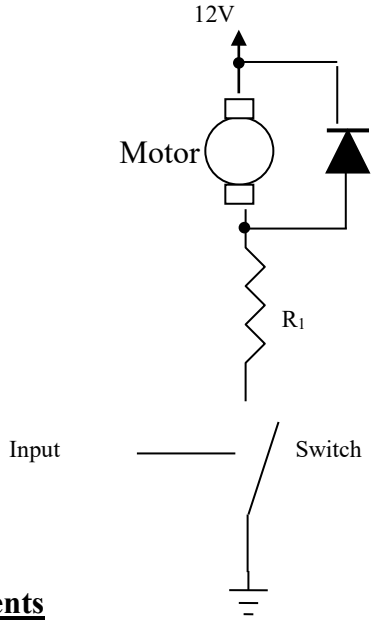
Design a simple circuit to ensure you can convert this threshold measurement to a high/low indication at the output of the comparator.



Note down some important specs or information you read in the data sheet.
Record your final circuit schematic and any measurements you take. Did you need to change any of the circuits in previous blocks you have designed? Explain why or why not.

Part 3: Motor Drive Circuit

The figure shows a sample motor driver circuit. The circuit sketched below will use a MOSFET to control the motor by using it as a switch (modes of operation: linear and cutoff).



<u>Understanding your components</u>
The motor you will be using is a Brushed DC Motor: 130-Size, 6V, 11.5kRPM, 800mA Stall.
Datasheet is at https://www.pololu.com/product/1117/specs
Note down some important specs or information you read in the data sheet.

The switch you will use is the power MOSFET IRFZ20.

15A, 40W, Power MOSFET, TO-220 package.

Datasheet is at https://www.vishay.com/docs/91340/sihfz20.pdf

Note down some important specs or information you read in the data sheet.

Designing the motor driver circuit

Determine the value of R1 in the drain to ensure that the motor does not exceed its current and voltage limits. Check the voltage drop across the FET when on. The motor is close to a short circuit when it is running.

Calculate the power consumed by R1. Is this within the power rating of the real resistor?

Detail carefully your design process and how you calculate the resistor values.

You will need to also connect a kickback diode to protect the circuit for when the switch turns off. You will use the 1N4001.

What key specs of this diode are important for its use in this application?

Part 4. Demonstration and REPORT

Demonstrate the working design to your instructor. Prepare a detailed report on your design and measurements and include all results.