EXPERIMENTAL LAB #2 – NODE VOLTAGES AND RESISTIVE SENSORS

This set of laboratory experiments is to be completed during the two-hour lab/recitation session. Please keep this handout, and make sure to write down (and keep) all calculations and measurements made. A brief, written lab report will be due at the beginning of the next lab session. Details of the lab report format are available on the course website.

PROCEDURE

1. Voltage Ladder

1.1. A string of series resistors can be combined to form a multi-output voltage divider, called a voltage ladder. An example of this is shown in Figure 1. For this circuit, calculate the expected voltage at each of the nodes, relative to node E. Also calculate the expected current $I$. Include these calculations in your lab report.

1.2. Construct the circuit shown in Figure 1 on a breadboard. Measure and record the voltage at each node, relative to node E. Also measure the current through the ladder. (Remember to break the circuit loop and insert the ammeter to measure current – as we saw in the previous lab, unlike a voltmeter, an ammeter only measures current passing through it.) Are the voltage and current values close to what was calculated in 1.1?

![Figure 1. Circuit diagram of a voltage ladder.](image-url)
2. Ambient Light Sensor

2.1. For some semiconductor materials, the resistivity of the material changes with exposure to light. Such materials (in this case cadmium sulfide) can be used to build light-sensitive variable resistors, which are called photocells. Get a photocell device from the TA, and measure its resistance using a DMM.

- What is the resistance of this device when exposed to ambient light?
- What is the resistance when blocking the light with a finger?

2.2. Consider the circuit shown in Figure 2, which uses a photocell to construct a voltage divider.

- Use a voltage divider equation to calculate the expected maximum and minimum $V_{out}$ under light and dark conditions. Also calculate the circuit current expected for each condition.
- As light shining on the photocell increases, will the output voltage $V_{out}$ increase or decrease?

![Circuit Diagram](image)

Figure 2. Circuit diagram for a photocell-based variable voltage divider.

2.3. Build the circuit shown in Figure 2 on a breadboard, and measure the voltage $V_{out}$ under light and dark conditions. Also measure the current in the loop for light and dark conditions.

- How do these values compare to the calculated values from 2.2?
- How much power does the circuit use in light and in dark?
2.4. Consider the circuit shown in Figure 3, which adds an LED at the output of the light-sensitive voltage divider.

- When the photocell is covered (i.e., is dark), will the LED get brighter or dimmer? Why?

![Circuit Diagram](image)

**Figure 3.** Circuit diagram for a photocell-based variable voltage divider.

2.5. Build the circuit shown in Figure 3, and test this hypothesis. An LED is a directional device, so make sure to connect this in the correct direction – it should light up if installed correctly.

2.6. Use a voltmeter to measure the voltage across the LED, and record LED voltage values for light and dark photocell conditions. Make sure to only measure across the LED. Record these values.

2.7. Now use an ammeter to measure current through only the LED for light and dark conditions; record these values. (Remember to break the circuit loop to measure current through the LED.)

- Describe the brightness vs. voltage and brightness vs. current relationships for the LED.
- Describe in words how this circuit operates to produce brighter and dimmer outputs.

2.8. Swap the positions of the fixed 2.2kΩ resistor and photocell in the circuit, and draw the resulting circuit diagram. Test the circuit in light and dark conditions. How does this affect the behavior of the circuit? Why is this?

3. Clean up the lab station, return all parts to the TA, and make sure to take your lab tools home.