INTRODUCTION: The goal of this laboratory experience is triple: First, students will become familiar with solar cells as photovoltaic energy converters. Secondly, students will practice measuring voltage and current in different devices and will present them in tables and graphs in order to provide information. And finally, students will become experienced at writing meaningful laboratory reports.

PROCEDURE:

1.- Consider the circuit shown in the figure below. This circuit allows measuring the voltage and the current produced by the solar cell simultaneously. The variable resistor is used to modify the amount of current that we are extracting from the solar cell at different conditions.

![Circuit diagram](image)

2.- Build the circuit shown in the figure above. Rotate the variable resistor to one of the sides so the voltage reading is maximum.
3.- Now we are ready to characterize your solar cell. We will start setting up the experiment inside the electronics lab and moving outside afterwards.

The open-circuit voltage for a solar cell is the value of its voltage when there is no load and therefore there is no current being extracted from the solar cell. This is the maximum voltage that the solar cell will generate in these conditions.

The short-circuit current for a solar cell is the value of the current generated by the solar cell when the load is shortcircuited. This is the maximum current that the solar cell is able to provide in these conditions.

To measure the open-circuit voltage, break the connection between the Ammeter and the potentiometer. Measure the voltage across the solar cell. Record it in your notebook. Put the connection back. Remember that in this case, I = 0 A.

To measure the short-circuit current, rotate the potentiometer to the point that the current reading is maximum. This should also correspond to a minimum of voltage. Record the value of current in your notebook. Move the potentiometer back to recording a minimum of current.

The two values that we have found are the two extreme values for the behavior of the solar cell. Next, we will find several intermediate values so we can plot the current-voltage behavior for your solar cell.

4.- Changing the value of the potentiometer will allow us to find several pair of points [Voltage, Current]. Complete the table below by finding several values of Voltage and Current.

Note that at some point of changing the value of the potentiometer, the voltage will change rapidly. It is useful to take additional values around the area in which voltage seems to change fast.

You may have to take additional measurements. Copy the table as much as needed.

Remember that the open-circuit voltage corresponds to I = 0 and the short-circuit current corresponds to V = 0. You found those values in the past section.

<table>
<thead>
<tr>
<th>V</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>0</td>
</tr>
</tbody>
</table>

5.- Use Excel to plot the curve current versus voltage for your solar cell. The graph you obtained should look like the one below although the values may and will be different. However, the shape of the graphs should be similar.
6.- Calculate the power delivered by the solar cell at each one of the voltage, current pairs found before. Complete the row for the power in the table that you created earlier:

<table>
<thead>
<tr>
<th>V</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Power</td>
<td>0</td>
</tr>
</tbody>
</table>

It is important to realize that the solar cell does not deliver any power when it is in open-circuit or short-circuit. In fact, the maximum power delivered corresponds to the “corner” in the graph found in the previous section.

What is the maximum power delivered in this condition? (If you cannot find a definite corner for the solar cell, take additional measurements around the voltage/current for the corner).

7.- A solar cell is nothing else than a P-N junction, also known as a diode. The voltage generated by a single junction (single cell) is around 0.6 to 0.7 Volts. Based on your open-voltage measurements, how many single cells or single junction does your cell have? How can you check that out?

8.- Connect two solar cells in series. Repeat the measurements, calculations of maximum power and plot for direct sunlight. What is the maximum power delivered in this case? What is the parameter that has changed the most with respect the measurements of a single cell?

9.- Connect two solar cells in parallel. Once again, repeat the measurements, calculations of maximum power and plot the graphs. What is the maximum power delivered in this
case? What is the parameter that has changed the most with respect the measurements of a single cell?

10.- Size matters when it comes to solar cells. For the same technology, the power delivered by a solar cell is directly dependent on its surface area. Measure the area of the solar cell you have used. What would be the size required to power a device consuming 100 W?

12.- Write a laboratory report following the guidelines found in the website for EET 105. I am especially interested in your opinions and thoughts about what you have learned in this lab as well as what you liked and didn’t like.