Building circuits

Record all measurements made as part of the lab under the relevant section. Graphs of current or resistance versus voltage when relevant are encouraged.

Basic circuit:

1. Turn on the Raspberry pi (Rpi)
2. Connect one of the 5V pins on the Rpi to the + column on the breadboard
3. Connect one of the ground pins on the Rpi to the - column on the breadboard
4. Run a connector from the + column to one row on the main part of the breadboard
5. Run a connector from the - column to a different (but close) row on the main part of the breadboard
6. If we connected a 1Ω resistor between these two rows - so that it is in a closed loop with the 5V supply from the Rpi, how much current would this circuit attempt to draw across the resistor?
    1. The Rpi adaptor provides 5V and up to 2 Amps, is this current sufficient?
        1. No, it would technically not be sufficient since it would produce too high of a current (5 amps)
    2. What do you think might happen? Please don't actually do this.
        1. Via Ohm's law, the current would be 5 amps, which is too much current for this adapter, meaning that the circuit would short circuit and potentially damage the rpi.
7. Connect a resistor of more than at least 100Ω (Why might this be enough resistance?)
        1. This might be enough resistance because it limits the amps to 1/20 amps. Which is well within the optimal range(0.5amps).
    2. If you have a multi-meter able to measure current evaluate the current across the resistor, is it what you expected?
        1. When we tried to measure the current value with a 470 ohm resistor, it would not properly measure the current (reading 0 amps).
        2. NOTE: to measure current, you have to put the meter in series with the rest of the circuit – it cannot measure current like it would voltage (connecting leads to +/- side of a component) – the current has to run through the meter

LED in a circuit:

1. Add an LED to your circuit
    1. Put it in series with the resistor and move the +/- connectors to the RPi 5V supply as needed
        1. How does the diode need to be oriented? Which wire on the LED goes to the +5V side and which goes to the GND connector?
            1. The longer leg is + and vise versa.
    2. What is the voltage drop across the resistor? Was this what you expected?
        1. The voltage drop is just below two volts. This is what we expected – the blue LED said 3-3.2 V on the box, meaning the drop across the resistor should be approximately 5 - 3 ish = 2 ish.
    3. What is the voltage drop across the LED?
            1. The voltage drop is the around 2.7 amps.
2. Try removing the resistor from the circuit, keeping the circuit closed - the LED is just in series with the 5V supply.
    1. What do you think will happen to the LED brightness?
        1. The LED should increase in brightness, as the resistance drops.
3. Try including resistors of different values - how does LED brightness change vs resistor strength?
        1. As the resistance increases, the brightness should decrease.
    2. Do the voltage drops across the resistors and LED change?
        1. Yes, they still sum to five, but with greater resistance, the drop across the resistor with the smaller resistance was larger.
4. Using the configuration with the highest LED brightness now move the 5V connection on the RPi to one of the 3.3V pins.
    1. What do you expect to happen to the LED brightness?
        1. The led brightness should decrease since there's less voltage meaning less current for a given resistance.
5. Add a step-up circuit components to increase your RPi voltage from 5V to 10V but do not close your circuit yet
    1. Using the dimmest configuration for the LED explored previously (meaning select the appropriate resistor from those you tried previously) now
    2. How will the LED brightness change?
        1. The led brightness will increase with the step up in the circuit.
6. How would you quantify the LED brightness changes?
    1. The led should double in brightness due to the doubled voltage with comparable resistance.
7. Do any of these results change with different color LEDs? Specifically do any voltage drop values change, is the relative brightness similar for different color LEDs, etc.
    1. Yes, the voltage drops change and so do the relative brightnesses. For instance, the yellow and red leds have smaller voltage drops and were less bright.

Photo-diode:

1. Replace the LED with a photo-diode (remove the step-up component as well if you had one included previously)
    1. NOTE: photo-diodes operate in reverse bias mode so you will need to orient the diode accordingly
2. What is the voltage across the resistor when you simply connect the 5V supply to close this circuit?
    1. We measured approximately 0.005 volts across our 330 ohm resistor.
3. What happens if you cover the photo-diode? What happens if you change the +connector to go to the 3.3V pin on the Rpi?
        i. When we cover the photo-diode, the voltage drop across the resistor increases to approximately 0.1 volts. When we used the 3.3 V pin, the voltage drop across the resistor dropped to approximately 0.003 V
    2. What is the dark current for this photo-diode? (Use the voltage across the resistor to determine diode current)
        i. The dark current is 1.5×10^{-5} amps
    3. Is 5V enough supply voltage to see a signal from this diode? Is 3.3V?
        i. 5 V is enough to see a signal but 3.3 V is not.
    4. What happens if you attach the step-up circuit component to increase the supply up to 10V?
        i. The voltage of the diode increases as the voltage increase, while the resister stays the same as before.
4. What are the dark current and saturation current for the photo-diode?
    1. See 3.2.i for dark current, the saturation current is approximately 3.6×10^{-4}