EECE 2150 - Circuits and Signals: Biomedical Applications
Lab 1
Getting started with protoboards

IMPORTANT: PRE-LAB PREPARATION

1. **Buy a bound laboratory notebook if you have not already done so!! This is important.** You will use this for all labs and part of your grade will be based on the work documented in your lab book. Each student should have their own notebook. Leave the first few pages for the table of content. Record the date at the beginning of each session and take a lot of notes on your experiments in your notebook. You will rely on these notes through the term. The pages in the lab notebook are where you record information in the lab, and where you work on circuit designs. It is not meant to be a finished piece of work like a lab report or a paper, or even homework. The notebook in this course is meant to function the same way a working engineer's notebook functions, as a complete record of the design and invention process, complete with dead ends, mistakes, corrections, and insights. In the working world it is this richness that provides a record of invention that can even be used to defend a patent in court! You should not record information in the lab on other paper and then transfer it later to your notebook, except for any printouts of code or figures from MATLAB exercises or pictures you take, for example, of a finished ProtoBoard circuit or significant oscilloscope trace. The notebook should contain partial circuit designs, calculations, speculations, redesigns, revisions and corrections. This does not reflect poorly on your work; it is what is expected. It should be a complete, if rough, record of your work in the laboratory. It should contain corrections to designs based on experiments as well as results and comments on what was necessary to get the circuits to work.
2. Equipment and supplies needed (if you do not know what the terms below refer to you need to ask the instructor or one of the TAs!):
3. From the equipment shelves in the back of 9 HA: Protoboard and reusable plastic container with your group number on them that will be kept on the equipment shelves for you for the whole semester. You can put your name and your lab partner's name on the Protoboard and plastic part box with masking tape so that you can leave a Protoboard with partially built circuit and no one else should disturb it.
4. In the plastic toolboxes stored in lab rooms: spools of wire, wire cutters, chip puller, small screwdriver, BNC "T" connector, alligator clips, and the following coaxial cables: BNC-BNC and two BNC-banana connectors. You will also find a collection of banana cables with a holder. **From the component drawers in the lab:** resistors, potentiometers, diodes, LED's, IC chips, and other components.

Part 1. From Circuit Diagrams to Protoboards

A breadboard (protoboard) is thin plastic board used to hold electronic components

(resistors, capacitors, transistors, chips, etc.) that are wired together. It is used to develop prototypes of electronic circuits,
The breadboard has spring clip contacts arranged in matrices with certain blocks of clips already wired together. Figure 1 shows the contacts which are already wired together. The boards typically include metal strips along the side that are used for common power rails and signal buses, marked with red and blue lines in Figure 1.
The components and jump wires (assorted wire lengths with pins at both ends) are plugged into the clips to create the circuit patterns.

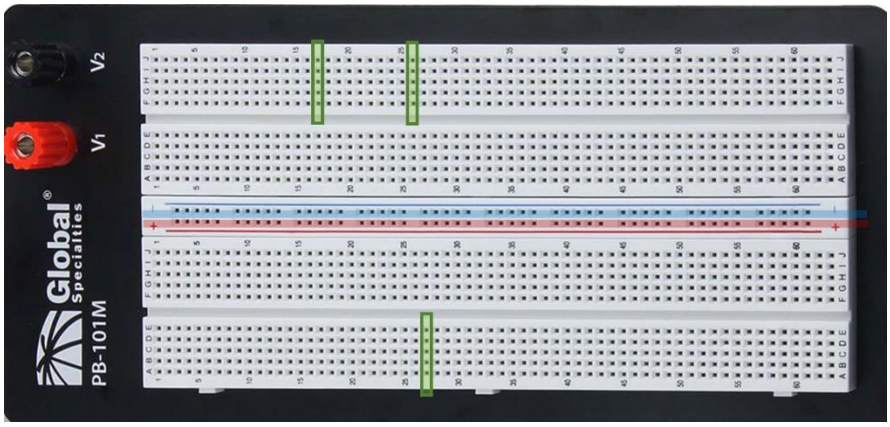


Figure 1: A picture of a breadboard showing contacts that are already wired together. Contacts along the blue strip are all wired together, contacts along the red strip are all wired and contacts along any set of 5 adjacent points highlighted in green are wired together

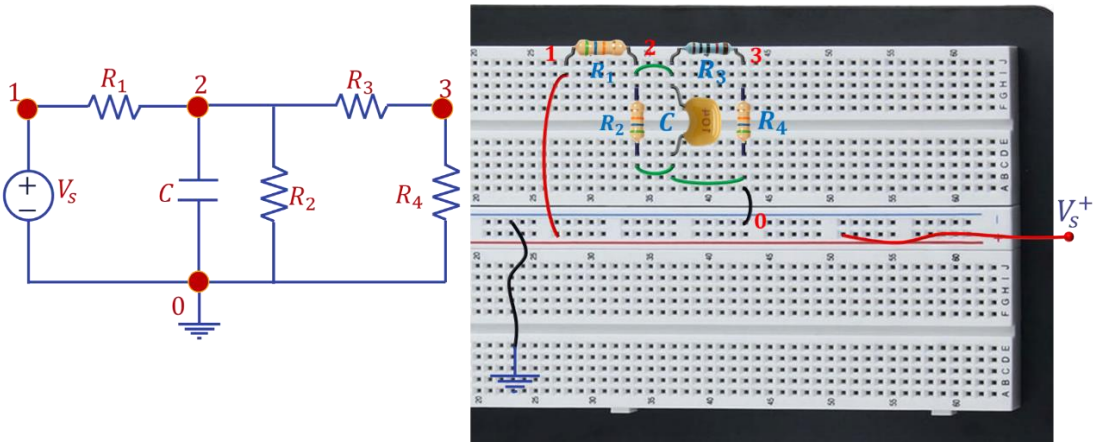


Figure 2: Example showing wiring of a circuit on a bread board. The schematic of the circuit is shown to the left and the breadboard to the right shows the wired components and the corresponding nodes

Following the example above and the discussion in class, translate the following two circuits shown in Figures 3,4 to the protoboard worksheets on the next two pages.

Note:

1. *You can build the circuit on the protoboard and take a picture for the report, or you can use the protoboard work sheet below to sketch the connections on the*

breadboard! For now, we are just practicing taking a circuit and thinking about how to build it on a protoboard.

2. We have not learned how to analyze these circuits yet. This is fine!

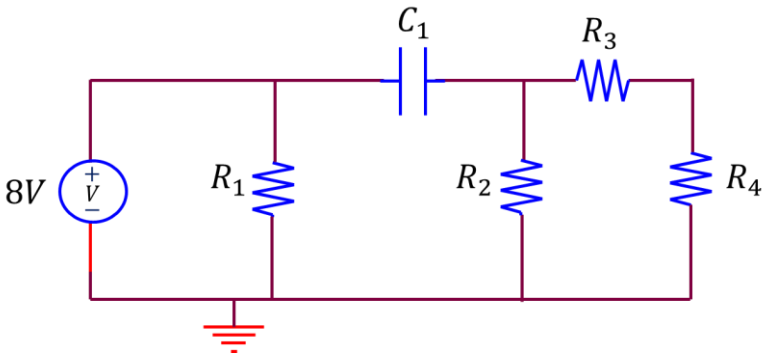


Figure 3. Example Circuit #1.

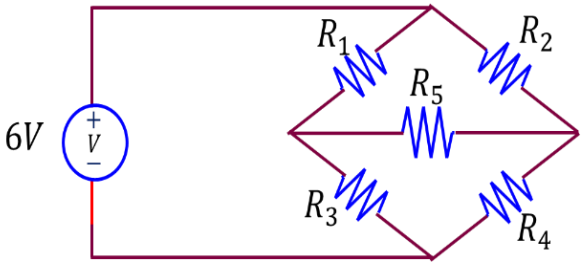
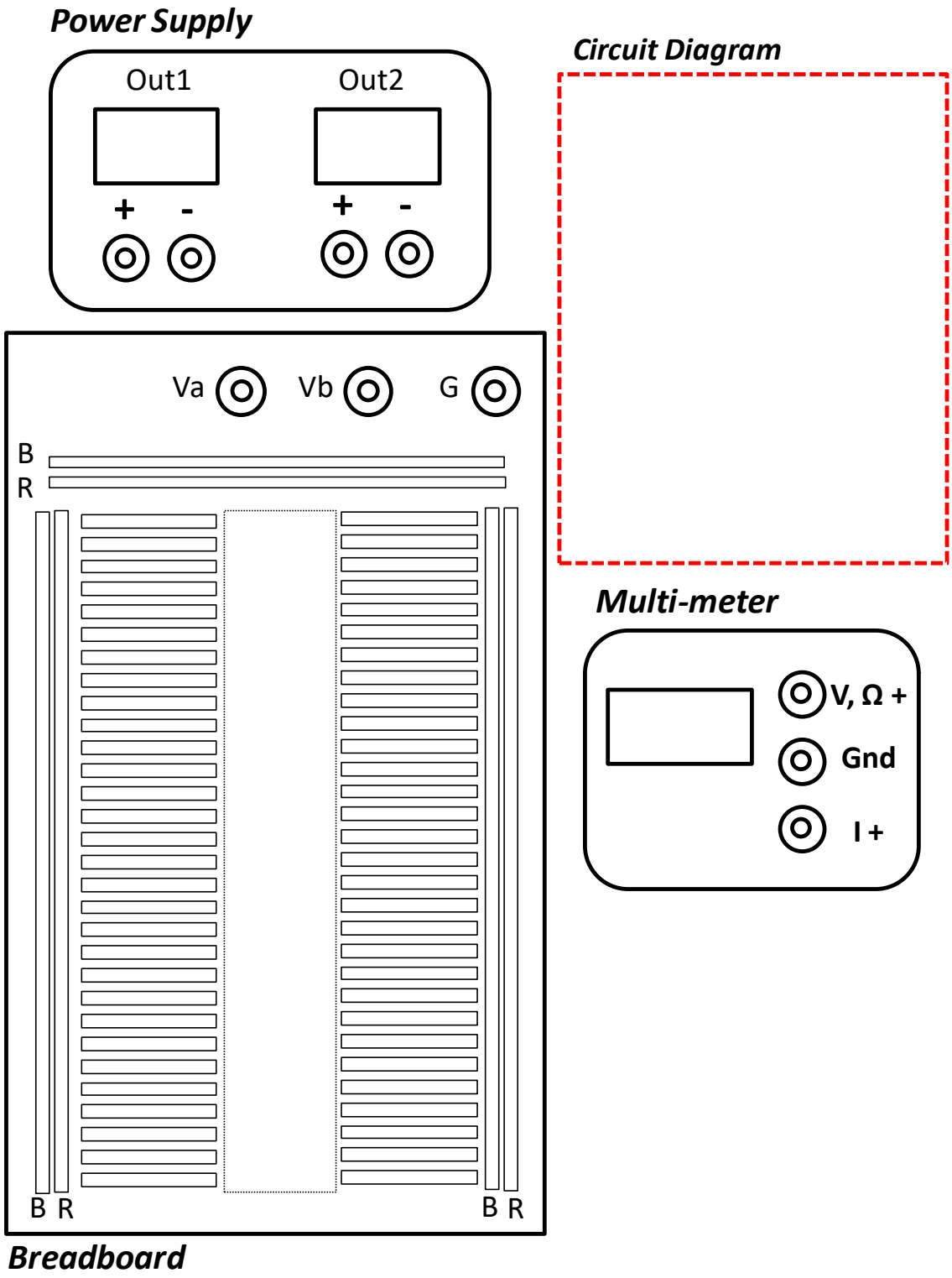
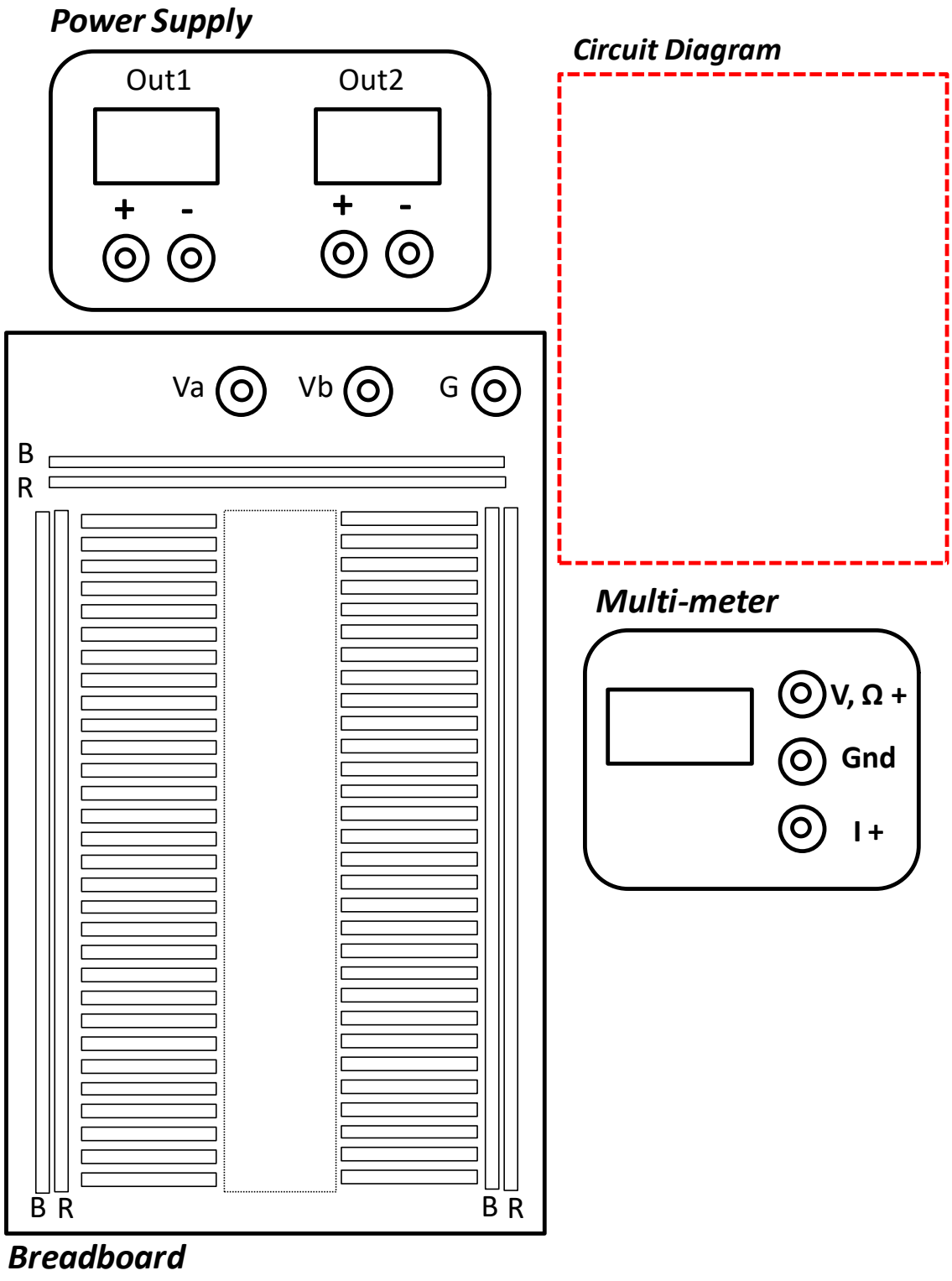


Figure 4, Example Circuit #2

Proto-board Worksheet for Circuit #1



Proto-board Worksheet for Circuit #2



Part 2. Building a simple LED circuit

In this part of the experiment, we will be building a circuit, use the lab equipment to power the circuit and a few measurements.

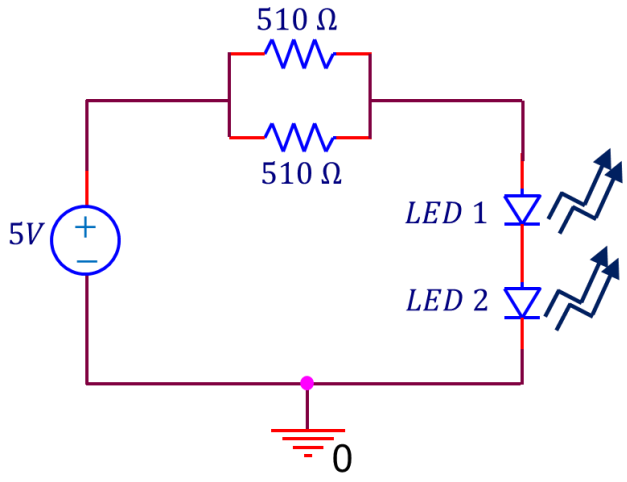


Figure 5. Simple LED circuit

2.1 Build this circuit on your protoboard. You can use either 510Ω or 470Ω resistors. You can also use any color (or color combination) that you want for the LEDs but be careful not to use the infrared LEDs if you want to see the light! Note that the ***direction of the LEDs*** is very important because ***LEDs are polarized and will pass current in one direction only***. See the spec sheet online. The longer lead corresponds to the anode (positive side). If they do not light up this is probably the issue. Try flipping the LEDs to see this effect.

Also, the point of this exercise is to get acquainted with proto-boarding. Therefore, take your time and have a look at the various cables and connectors in your toolbox.
Adjust power supply to 5V. Connect the power supply output from (terminals $\boldsymbol{V^+}$ and ground) to your circuit.

2.2 Using the digital multimeter, DMM, and a pair of hook connectors, measure the ***voltage drop across*** each circuit element. To measure a voltage, the positive and negative terminals of the DMM are connected to the terminals of the component. Be sure to have the function of the DMM set to DC Voltage. What voltage drop did you measure across $\boldsymbol{R_1}$, $\boldsymbol{R_2}$, ***LED1 and LED2***? Did you measure any negative voltages? If so, why is this?

Part 3 - For the Write-Up…

- To be submitted in one week:
- Submit a paper copy of the 2 protoboard worksheets (or a picture of the component on the protoboard if you used this option).
- Answer the question in 2.2 above.

- Follow instructions for writing lab reports
- Submit electronically on Canvas

Reports will be required for all Labs. They will need to be submitted on Canvas one week after the session in which the lab work is finished. If you are not finished with the lab work, it is your responsibility to finish the work during any of the laboratory "office hours" during the week. Please follow instructions for writing lab reports available on Canvas. When you have finished the lab work on a Lab, you should have your Lab Notebook signed off by a TA or the instructor who will ask a few questions to see if you have understood what you have measured.

IMPORTANT: BEFORE YOU LEAVE THE LAB:

a. Place all of the components that your removed from the toolbox back in that box and return it to the cabinet that houses them
b. Collect all used components and wires from your bench and place them in your group's reusable plastic container. If you are not going to use these components or wires again, please discard them in the trash bin located in your lab room.
c. Turn off all the equipment you have used on your workbench.
d. Make sure you return your protoboard, the equipment wires and your reusable container to the cabinet

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Last updated, I Salama,8/31/2023, 8/10/15, M.Niedre