Welcome to MEAM5100

Before we can get started with the hands-on development this semester, we need to know that each of you has reviewed all of the necessary equipment. *The objective of lab 0 is to review standard tools used in Mechatronics.* Throughout the semester there will be additional equipment training as more tools are required.

There are tasks for each piece of equipment and to receive full credit for the assignment a short writeup is required.

Towne 195 is staffed at hours listed on the course calendar on the MEAM 5100 Canvas Page. If you run into issues or have questions please do not hesitate to ask a member of the teaching team or post on EdDiscussion.

Note: Historically, this course was mainly conducted in GM Lab. This semester **we will be mainly in Towne 195**, but some equipment (cables for oscilloscopes) may still be located in GM lab. Please use Towne 195 as your main workspace, but do look in GM lab for certain equipment. In all spaces, it is very important to put equipment back where it belongs.

What is Due: A typed report answering the questions outlined below.

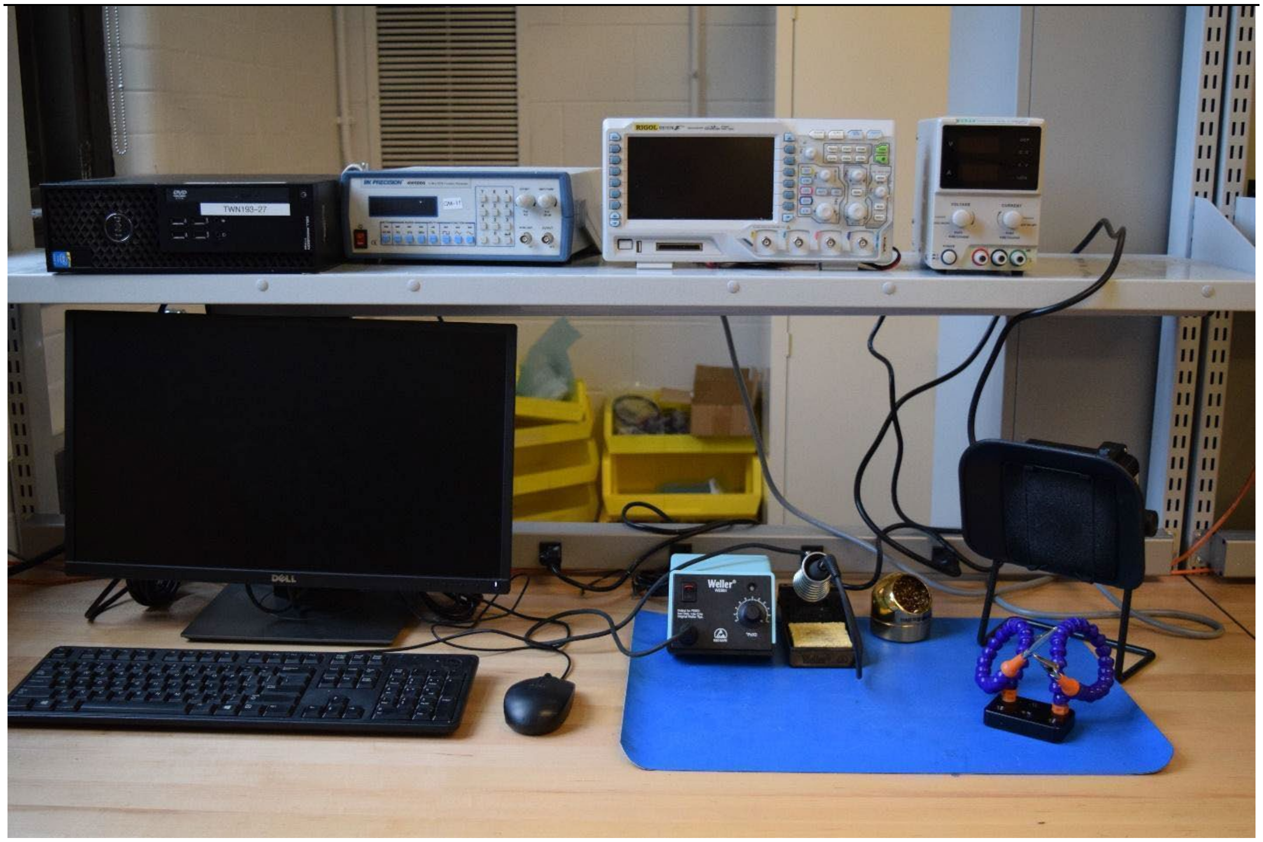
Due Date: 01/21/2025

Submission is on GradeScope.

Potentially useful youtube videos:

Everything you need to know when buying/using an Oscilloscope! EB#49

An intuitive approach for understanding electricity



The workstation:

- It should look something like this when you get into the lab. For that to happen it must also look like this when you leave lab. This lab is a shared space, if you leave the lab everything left behind at the workstation will be considered disposable.
- On the top shelf from left to right you will see a computer, function generator, oscilloscope, and variable power supply. These have cables that can be found on a rack in the lab (organized by type) and should not be stored/left at the workstation. Part of the current lab will be on understanding the use of these.
- On the table surface from left to right you will see the computer monitor and peripherals. In the corner of the lab there are soldering irons with brass sponges, and a filter fan with helping hands in front of them. We will discuss the use of these in a later lab.
- **We have far more people than workstations so you need to share, this means you cannot lay claim to a specific workstation**.
- The Lab will become crowded and it is worth considering coming to lab when it is less crowded, for example coming in early morning instead of staying up late. Conveniently, Towne 195 is available to you 24 hours a day 7 days a week during the semester.

Multimeters

This is a **DMM (Digital Multimeter)**. It digitally measures multiple things. It has probes (seen on the right side of the picture) that attach to the holes in the bottom of the DMM. If you notice there are more holes on the bottom than there are probes. The one labeled COM means common and is the reference connector for the other two holes, this will be connected to *ground* a lot of times and is sometimes referred to as ground because of that. You don't have to connect the black cable to COM, but using the black as the COM or ground is a convention and will avoid a lot of wasted time if you are trying to get help from a TA or others.

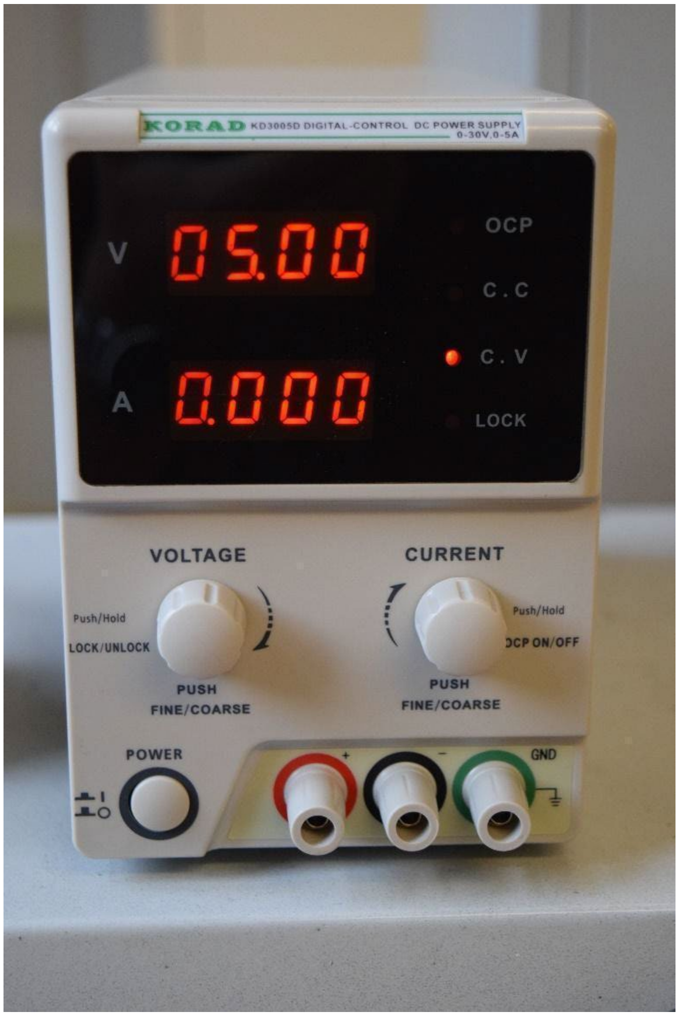
0.1.1 What do you measure with Probe in 10A (or equivalent A slot) and COM? What do you measure with Probe in V/mOhm etc. and COM? If you incorrectly measure something that does not correspond to the correct probe what are things that can happen and why?

0.1.2. What things can your multimeter measure? Not all DMMs are the same so it is important to know what the one you have can do, and how to connect it to correctly measure what you want.

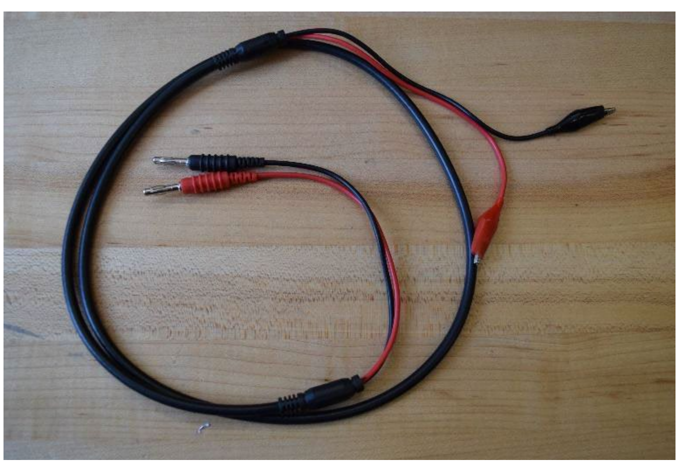
0.1.3. Find a battery and measure the voltage across the battery. Is this what you would expect? Does it match the voltage stated on the battery? If not, why?

0.1.4. A connectivity test is used to determine if two points are connected with very little resistance (shorted). Sometimes these things are supposed to be connected, sometimes they are not, and a connectivity test can help determine if things are connected properly. This is a **very useful** function of the DMM. Change the setting on the multimeter to do a connectivity test to determine what parts of your workstation are shorted together. *Write down 2 things that are connected*. **Note:** The DMM will beep if things are shorted together, however, if the batteries are low in the DMM it may not beep. You should still see a reading on the device if there is low or high resistance.

Variable Power Supply



This is a **variable power supply,** it is able to supply a voltage which can be changed depending on what you need. It also can limit the current that can be drawn by whatever is connected to it. This can prevent damage to parts that are sensitive to high currents if something is improperly connected. When in use, it displays the voltage supplied and the amount of current drawn. When the CV (constant voltage) light is illuminated, the power supply will maintain the output voltage set by the dial, thereby supplying as much current as required to maintain that voltage. (On some power supplies, this requires that you push the knob in multiple times to select the digit to change.) Conversely, if the CC (constant current) light is illuminated, the power supply has reached the current limit set by the current dial, and the voltage will decrease as needed to maintain the desired current.



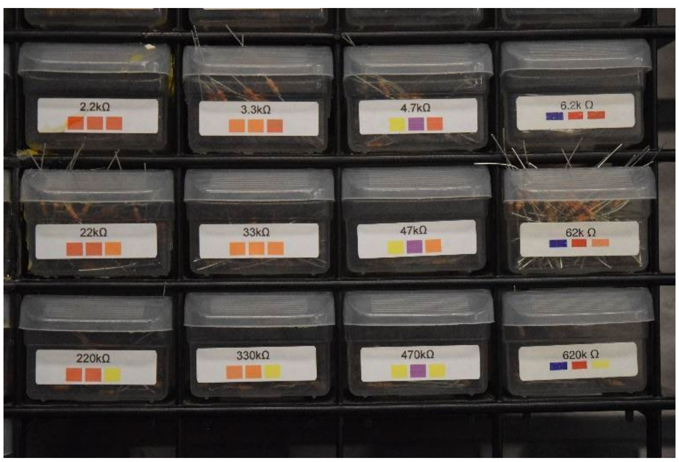
In the picture below, you can see cables available in the GM lab that can be used with the power supply. These are banana plug to alligator clip cables. The end that looks like a peg is the banana end as if it was yellow and you were in need of glasses it would kind of look like a banana. The alligator end has articulated jaws which you can pretend are alligators. You can plug the banana end into the positive and negative receptacles on the variable power supply. The voltage between these two is what is displayed on the readout. You can connect the ground to one of these if you need them referenced to a ground (the convention is to use the black cable into the black (-) plug).

Sometimes you will see dual power supplies. These have two sets of variable outputs. While there are ways to link the two supplies, for this class you should only use one at a time. Do not connect two power supplies in parallel.

0.2.1. Turn the voltage knob. Does the current display change as you do this? Why or why not? Does anything happen to the CV and CC lights? Turn the current knob all the way counter-clockwise (to 0). Does the voltage display change as you do this? Does anything happen to the CV and CC lights? Connect the '-' and '+' pins together and turn the knobs. What happens now? (Be careful not to turn the current knob too high or for too long when connected, as the wires will get very hot, possibly melt).

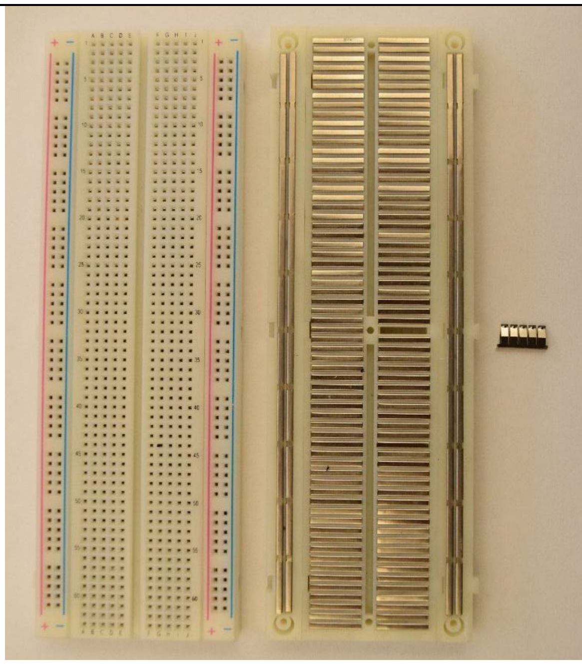
0.2.2. Using the DMM, measure the voltage difference between the (-) and (+) outputs as you adjust the voltage knob. Do the multimeter and the power supply agree? Does the current display show any current? Now measure the voltage between the ground and positive terminals. See if you can explain the difference between the ground and negative (black and green) terminals.

Resistors



When working in a lab with other people there are best practices that can be followed to make work quick and easy, such as putting tools in the correct spot and only taking the number of components you need to avoid waste or components being placed in the wrong spot. Even if you follow these practices others may not, which means when you take your components you may need to check that they are what you intend to take. We have several tools that can help with this, resistors have color codes on them which tells you their value. These color codes are listed on the drawer making it easy to check what you have pulled from a drawer is what is supposed to be in that drawer. But sometimes you are already at your bench and are too lazy to pull up a color chart to figure out the resistance. The DMM can be a quick and easy way to check.

0.3.1. Use the DMM to measure a variety of resistors from 1KΩ to 10MΩ. Write out a table of results. Combine resistors to vary resistances. Are the readings within tolerances? Were you touching



the resistor or probes with your fingers? If you were, how does the resistor change if you make the connection to the resistor without touching it? If the readings are different, why?

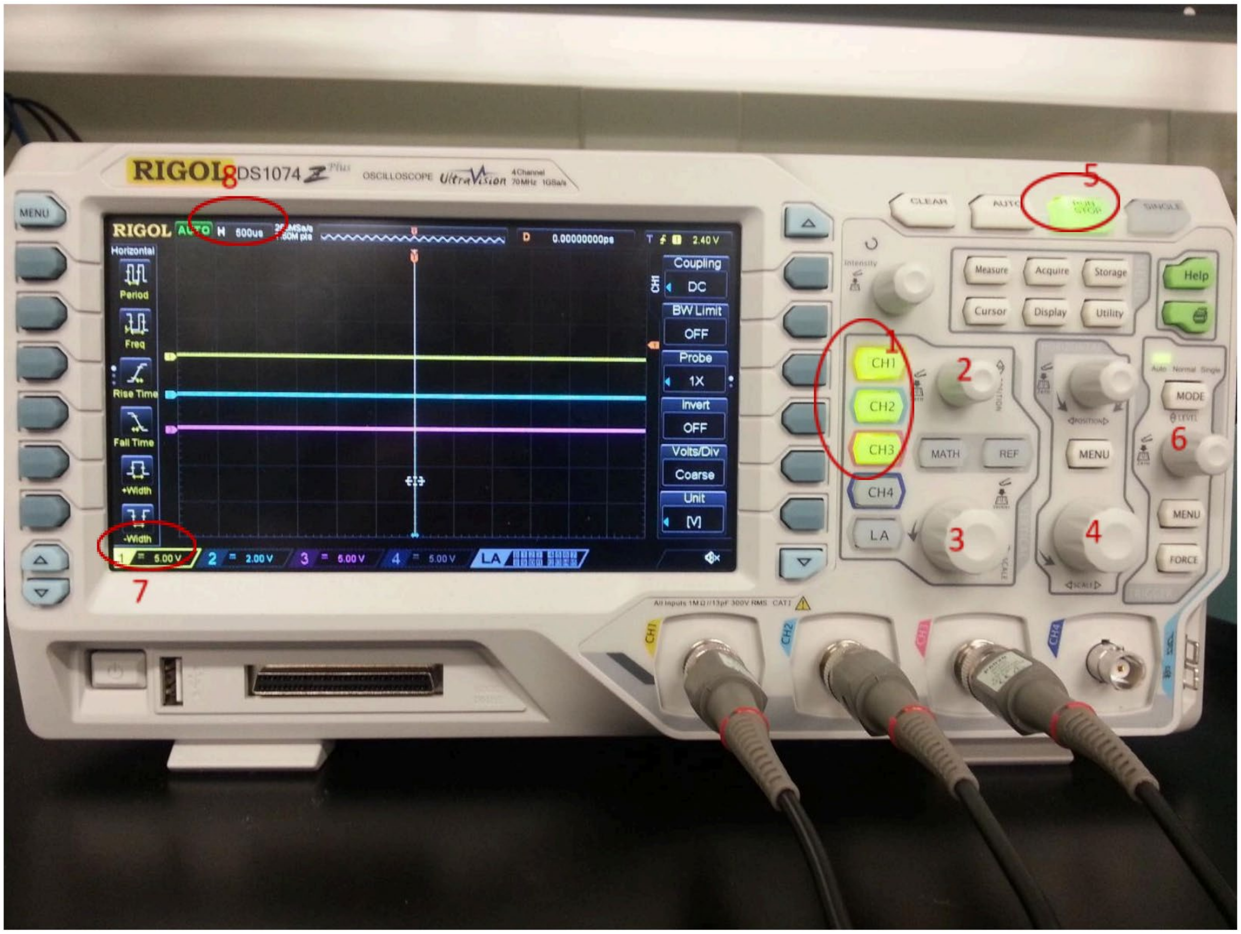
A useful tool for making circuits is a solderless breadboard (also called a protoboard), seen to the left. The "rails" on either side form a connection for anything connected in a vertical column. The central portion is divided into two sides, and each horizontal row of 5 pins is connected.

0.3.2. Connect the same range of resistors to a 5V supply. Use the power supply current reading to determine how much current is flowing through the circuit. Write a table with expected current (Ohm's Law) vs. actual current measurement and the resistance values used. Do the values match? If not, why do you think this is happening?

0.3.3. Find a 10 ohm resistor. Given the power rating of the resistor, what is the maximum current you should apply through this resistor? Apply this current rating using the power supply. Measure the voltage drop across the 10 ohm resistor using the DMM. Does this match voltage displayed on the variable power supply? Does this fit what you would expect from the V=IR relationship? If not, why do you think this is happening?

Hold on to your resistors and setup. You will repeat this process in a little bit.

Oscilloscope



This is an oscilloscope. It is used when more detail is needed for a signal than a multimeter can supply. It is a very useful tool. There are many ways to set up the scope (short for oscilloscope). Some of the most common settings are in the list below labeled with the numbers in the figure.

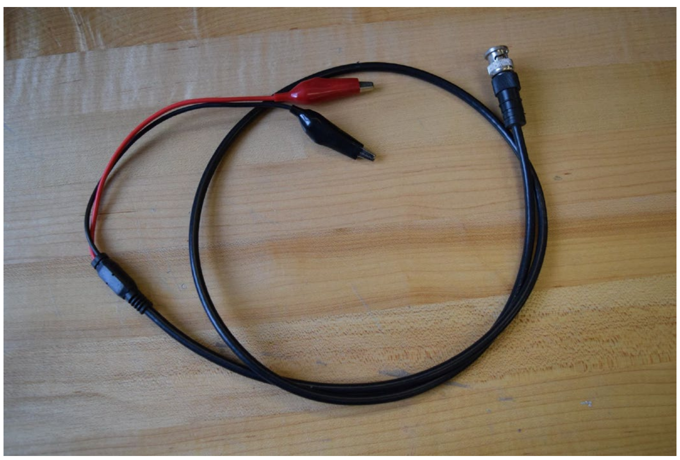
1. Channel select: selects the channel you want to change the settings for.
2. Position: changes the vertical origin of the channel as indicated by the small arrow on the left side of the graph. This is the zero position of the channel of that color.
3. Signal scale: Changes the scale of the signal, number of volts per vertical square on the graph. You can see this scale labeled 7 in the figure.
4. Time scale: This can be used to change the horizontal scale of the graph, time per horizontal square of the graph. The value of one square can be seen labeled 8.
5. Run/stop: This pauses/unpauses the graph.
6. This knob adjusts the trigger. This makes it so a rising or falling edge of a signal always appears at the same place on the screen which can make it easier to read.

If you notice something looks odd, check to make sure it is in DC coupling mode. Sometimes this can get changed and will change the behavior of the output.

This is a scope probe. One end is a BNC connector which twists to lock. The other end is a test lead. You pull back a spring loaded cover to expose a hook which can be connected to a wire. This test lead can generally be pulled off to reveal a bare metal pin which can be pressed against contacts. **IF YOU REMOVE THE TEST LEAD, PUT IT BACK WHEN YOU ARE FINISHED.** There is an alligator clip attached to the probe, this is the reference for the probe (typically ground). Many probes have a 1X – 10X switch and the scope has a 1X – 10X setting. Most scopes in the GM lab have a blue arrow button on the right side which corresponds to a Probe entry on the screen. *You should make sure these match otherwise your readings may be off by an order of magnitude.* Note that some scope probes in the GM lab are broken.

0.4.1. Repeat 0.3.3 with the scope and probe set to 1X. Then repeat it with both set to 10X. Is the result different? If so, why? Regardless of your findings, why would this feature be included?

Function Generator



This is a function generator. It supplies a voltage that varies with time on its output. It is not capable of supplying a lot of current, so it should not be used in situations where a significant current is needed. Below you can see the cable that should be used with it. It has alligator connectors on one end and a BNC connector on the other end. While this connector and scope probe are similar, don't use a scope probe with the function generator. The black wire is the reference and the red wire is the signal. You can change the signal shape, frequency, amplitude and DC offset. You should plug the BNC connector to the output port of the function generator when you are using it.

0.5.1. Connect the function generator to the scope and test the different wave functions. You will need to adjust the scope settings, and you may need to change the power range on the function generator as well. Feel free to explore different settings to get a better sense of both machines. What does the duty cycle do to each of them?

0.5.2. Adjust the offset of a square wave so that it is always positive. What happens when you now change the amplitude by a factor of 15?

0.5.3. Change the frequency of the signal by a factor of 1000 and set it to a sine wave. Adjust the scope so you can see the signal, and trigger it on a falling edge. What happens when you move the trigger up and down? How is this different from what happens with a square wave?

Congratulations!! (Two exclamation points so you know it is a big deal.) You have made it through what is hopefully the most boring lab of the semester. This one was needed to make sure you understand how to use some of the tools you will need for the rest of the class. In the rest of the labs you will start creating the tools you will need for the final project.

Did you clean up your workstation? Take a couple of minutes to put everything back to how they are supposed to be (including any DMM's batteries and cables, but don't bother putting resistors back- you can keep them, even if that is not how you found it.