Physics 334  
Notes for Lab 0 – Intro to Electronics Lab

1. Read through the notes provided by Jason Alferness on using the breadboard and on lab organization. Paying attention to the latter is important; you may need Jason's help in a pinch someday (like when a part burns out and the instructor or TA is not around), and you want him to be nice to you!

2. Familiarize yourself with the major equipment at your station:

- **The digital multimeters (DMMs).** You should have two meters. Note that they can measure voltage and current—both AC and DC, and resistance. Figure out how to set the meters to make each type of measurement.

  Something to remember: If you find that your meter refuses to measure current, you (or someone who has used the meter before) may have blown the fuse. An easy way to check is to try to measure the “resistance” of the suspect meter when set on the “mA” scale by using the other one as an ohmmeter. If the resistance is very high (OL), then the fuse is blown. Typically, you will need to open the case and replace the fuse, usually a small 500mA one.

- **The power supplies.** Notice that there are 3 outputs: two variable ones (A and B) and a fixed one at 5 VDC. Measure each output with one of your DMMs. Adjust the variable controls on A and B up and down. Do the variable outputs go all the way to zero? What is the maximum voltage you can get? Using the DMM, set each output to exactly 10.00 VDC. How well do the panel meters track this value? Are the knobs for each channel set in exactly the same spot? Now compare what you measure with the other DMM. Do both DMMs measure exactly the same voltage? (This gives you some idea of the measurement error from DMM to DMM.)

- **The function generator.** Look at the function generator and find these controls: Amplitude knob, DC offset knob, Duty cycle knob, frequency knob. Find the frequency multiplier switches; try them out, noting that only one is pushed in at a time. Find the waveform type selector switches: sine, square and triangle. Find two outputs: “signal” and “sync”. You may see other features as well, but these are the most important.

  Turn the generator on and connect one DMM to the “signal” output. Set the waveform type to sine and the frequency to about 100 Hz. Measure the AC voltage as you adjust the amplitude knob up and down. What is the maximum amplitude? With an amplitude of a few volts, see what happens when you change the frequency. At the very high end and very low end you should notice the AC voltage measurement will drop. This gives you an idea of the frequency response of the AC part of the DMM. With the meter still on AC, adjust the DC offset (again at 100 Hz). Do you see a change? Try the same thing with the DMM set to measure DC volts. Now what happens?

- **The oscilloscope.** Turn the “scope” on and let it warm up. First, try fiddling with various knobs to see what happens. You will probably be confused at this point, but keep calm!

  Connect the function generator’s “signal” output into channel 1 of the scope using a BNC cable. Set the vertical amplifier on Channel 1 to 1 V/div and the time base to 1 mS/div. Set the trigger input to Channel 1, “auto”, and DC. Set the function generator to make a 1000 Hz sine wave, and adjust the amplitude knob about halfway up. If you are lucky, you should see the waveform on the scope screen.

  Now, read through the Lab Manual section 1-5, pp. 29–31, and follow the directions there. Pay particular attention to the warnings about “CAL” vs. “VAR” on the vertical amp.
After you have done the parts of section 1-5, you should have a good understanding of how each of the three main parts of the scope work: vertical amps, horizontal sweep control (or “timebase”) and the trigger control. The trigger control is the trickiest part; don’t be discouraged if it takes some time to get used to it. Ask for help if you need it, either from the instructors or other students.

Figure 1: DC measurement circuit.

3. **DC measurements.** Assemble the circuit shown in Figure 1. Use one multimeter as a milliammeter to measure the DC current.

   (a) Set the DC voltage from the power supply to +5 volts. Measure the DC current and write it down.

   (b) Measure the three voltage drops, $V_1$, $V_2$, and $V_3$ using the other DMM. Is it true that $V_1 + V_2 + V_3 = 5$ volts? What is the voltage across the current-measuring DMM? Does this make up the difference?

   (c) Add up the series resistance of $R_1 + R_2 + R_3$, Use this value to see if Ohm’s law, $V = IR$ holds true here. Question: which $V$ should you use in this calculation?

   (d) Set the power supply to −10 volts. (What does this statement mean in practice?) Check to see that $V_1 + V_2 + V_3 + V_{DM,M} = −10$ volts.

4. **AC measurements.** Modify the previous circuit by removing the DMM used as a milliammeter (replace it with a jumper wire) and replace the DC power supply with the signal output of the function generator. See Figure 2 for the modified schematic. Use a BNC “Tee” to connect the output of the generator to both the breadboard and channel 1 of the scope. Make sure that the center pin of the BNC is connected to point $a$ on the diagram and that the outer conductor (“ring”) is connected to point $b$. Set the oscillator frequency to 1 kHz, and set the “peak-to-peak” amplitude ($V_{pp}$) to 2 volts.

   (a) Use channel 2 of the scope to measure the voltage between points $c$ and $b$ ($V_{cb}$), $d$ and $b$ ($V_{db}$), and $e$ and $b$ ($V_{eb}$). Is it true that $V_{cd} + V_{de} + V_{eb} = V_{eb}$? (Look again at the subscripts.)

   (b) Try to measure $V_{de}$ directly using channel 2 of the scope. Do you get the same value as you did before from subtraction in the previous measurements? Why not? (Hint: where could you have inadvertently connected two points together thus altering the circuit?)
Figure 2: AC measurement circuit.

All done! Show the TA that you have made the measurements. *No report is due for this first lab.* You may find it handy to bring this sheet and related material to the next lab.