General Lab and Lab Report Information

This lab course will require you do several different things: simulate circuits, construct them, characterize them (measure voltages and currents), and compare those measured results against the results from the simulations as well as expectations from theory developed in lectures and from your readings. Your lab reports should show that you did all these things and in the process demonstrate that you understood the concepts behind the circuits and the data.

- **You should have a good idea what results you should expect before you start.**
    - Setting up experimental circuits requires that you pay close attention to detail. A single wrong connection will still give you results. But they will virtually always be different from the ones you should have observed. If you don't know what to expect, you won't know that it is wrong.
    - Electronic components fail.
        - A burned out fuse on a voltage supply line is only easy to find if you look for it. But if you don't know that your results are wrong, you will not look for it.
        - A burned out diode or transistor is not going to tell you that it is broken. If you don't know what to expect, you will not know that they were blown.
    - If you just follow the instructions, take data, and then try to make sense of all this later when you go to write up your lab report, you will be surprised at how little sense your data makes.
    - How will you know what to expect?
        - Review and seek to understand the circuits in the lab manual before you come to class.
        - Helpful in that will be to read the relevant book sections and the lecture notes, and,
        - use the simulation software to "build" the circuit and simulate its behavior.
    - During the experiments:
        - Besides measuring voltages at the outputs you may find it useful to measure voltages at other locations in the circuit and consider if these make sense.
        - It is often useful to modify the circuit a bit, to check if the result changes as expected. For example: A transistor is often used to amplify a current. But this can only work if its collector terminal is powered. If you disconnect the power to its collector and nothing changes, your transistor is likely faulty. Don't rush to conclude this, further tests will be necessary, but you need to be willing to explore.

The Parts of a Lab Report

Organize your information:

- **The Title** identifies the major topic of your report:
    - For example: Lab 1: AC components and filters
- **You are the Author**
- **The Abstract** gives a very brief (150-200 word) description of what is covered in the report.
- **Subheading, indicate each section.** Generally, each lab consists of a series of small experiments. For example, in Lab. 2 you build a simple AC voltage divider, observe the RC decay of an RC circuit on different timescales, investigate a CR high pass, RC low-pass, and LR filters, investigate an LRC resonant circuit and finally build a tank circuit Fourier analyzer. **Cover each of these experiments completely as described in the following sub-bullets before describing the next experiment.**
    - **Provide a sentence or two about the motivation for this experiment (section):** What is the goal? As motivation for the circuits built you can take the approach that you are seeking to confirm the physics embodied in the expressions used or to confirm the circuit behaviors expected from the textbook readings (with appropriate citation to those).
    - **Circuit diagram:** This can be a copy of the circuit built in the simulator.
        - **This should include the values of all components and clearly identify the output nodes in your circuit.**
        - **Add a list of components used in the form of a table. When relevant use the measured values of the components rather than the nominal values.**
        - **Measured voltages from DC power supplies should be listed as well.**
    - **Experimental Procedure**: In your own words describe the measurement process referring to the circuit diagram(s). If the order in which things were done is relevant to the procedure/result then give the temporal order but otherwise avoid using irrelevant temporal phrases. Do not include your measurement of the resistors, capacitors, and supply voltages discussed above (it is assumed that you did this correctly). Do not copy text from the lab manual to the report. Describe what you actually did (not what the manual says you were supposed to do). If your procedure deviated from the instructions given in the manual state that. If you've written this up properly another reasonably intelligent researcher should be able to follow your description to do what you did and get your results.

- **Results**: This should include results from the simulations, relevant screenshots of your scope image, and data from your measurements in neat tables and plots.

    - Graphics need to be clear, easily read, and well labeled (e.g., "Figure 3: RC filter circuit", "Figure 4: Measured voltage amplitude as a function of frequency for the RC circuit of Figure 3"). Every figure and table that appears in the report must be called out in the text of the report. For example: "To investigate the behavior of a CR filter the circuit shown in Figure 3 was assembled. The frequency response of its voltage amplitude was both simulated and measured from 10 Hz to 100 kHz. The measured result is shown in Figure 4, the simulation in Figure 5." One very common mistake is that the axes of 'screenshots' from the oscilloscope are often not labeled. It is a novice mistake to believe that only the shape of the curve matters. The voltage values (vertical axis scale) versus the time (horizontal axis scale) are critical.
    - Compare your results with your expectations. Plots should include the data as data points and a curve based on the applicable theory should be fitted to the data if possible.
    - Include a brief discussion of how the circuit works. Show that you understood the experiment. We will not be concerned with experimental error in this course. That will be dealt with (in spades) in PHY4803L.

- Next experiment...

- **Summary/General discussion**:
    - At the end give a general summary of what can be said about the larger set of experiments, but keep it short. There are no bonus points for long reports. Labs should be 6-8 pages.

- **Lab Report Guidelines**
    - Use proper English: write in complete, grammatically correct sentences. Use a spell checker.
    - Label all figures and tables with a descriptive sentence.
        - e.g., "Figure 1: Output from a high-pass filter, using as input a 60 Hz, 2 V, square wave. R = 10k, C = 100 pF."
    - Show the complete analysis of your work. "Yes." is never accepted as an answer.

        - Example: the lab may ask if the output from a circuit is what you expect. "yes" or "no" is not appropriate. Appropriate would be: "We expected the half-wave rectifier circuit would pass only the positive swing of the input AC voltage. The input AC and output voltages were fed to channel 1 and 2 of the scope, respectively. The input AC showed both the positive and negative going voltage swings, while the rectifier output showed the positive swings when the input was positive and was flat line zero during the negative swings thus matching our expectations."
    - Show the data needed to support your statements.
        - If the lab manual asks you to show something you need to show the data, or a screenshot or a plot that demonstrates the trend. Simply saying we observed the thing that was asked for is not sufficient.
    - Try to address all questions that are asked in the lab manual. If you aren't sure if something should be answered, ask the instructor. Address these in the part of the report where they are relevant.

- Your report should only include data that you yourself took. Data sharing between students may be sought with the instructor's permission in extremely rare, extenuating circumstances, but is generally disallowed.