Hints for Keeping Lab Notebooks

(note: an example writeup of the first last is available at http://www.physics.ohio-state.edu/~durkin/phys516/index.html)

In the near future you will receive a degree in Physics, Engineering Physics or other sciences. Probably your future career will be in industry or a graduate school. In either case it will be assumed that you know basic physics and have some proficiency in electronics and that you have acquired discipline in data taking, recording and writing a clear and short report on an experiment. Data books in industry and National Laboratories are often a property of the institution and has legal importance and implications. For example a lab book may be need to claim a patent or a discovery. I am sure that in your career in experimental science you will be judged on your ability to perform independent experiments which in turn will lead you to an advancement in any organization. Writing lab reports is an important part of the lab technique. Reports help to collect your thoughts, stimulate ideas and provide the communication link with other scientists and the world outside of the laboratory. This note gives you some ideas on what is meant by a *good* report in science.

The experiments in Physics 517/617, unlike those you've done in previous labs, only give you an objective; they don't tell you how to accomplish it. (e.g. design and build a two-stage amplifier with a gain of 1000) In most cases there are many ways to reach the same objective, and no two students will do it exactly the same way. This similarity to the real world makes it imperative that you keep a detailed lab notebook which describes your *solution* to the problems.

What information should go into a lab notebook ? Your report should be sufficiently *detailed* that another reader, knowing only your objective, could find out how you did the experiment, and sufficiently *clear* that this reader can easily learn you results and conclusions. A useful test is to write so that you yourself could turn to it a year or more later and quickly reconstruct the exact same experiment. It is surprising how often, in a real research laboratory, one needs to consult old measurements which didn't even seen important at the time they were made. If they weren't carefully recorded anyway, then precious time may be lost in having to repeat them.

Several over-riding points when keeping a lab notebook:

1) Make the permanent record *as you go*. Don't fall into the habit of recording data temporarily and then neatly re-recording it into the lab book later.

2) Be neat ! Others have to read your report. Draw figures carefully, leave adequate room for tables of numbers and for future data analysis, label everything, and don't scribble calculations in the margins (if they're important do them neatly; if not do them elsewhere).

3) Be organized, and present information in a logical fashion. This requires thinking and preparing <u>before</u> you start. But while even the best of plans can go astray, you can still keep your

report organized by clearly stating the intent and result of each set of measurements. Where needed, cross-reference related sets of measurements (e.g. a note saying " see also current measurements on page 13")

Here are some more specifics about the actual information to be included.

1) State what you intend to do (your objective), draw the complete circuit diagram, *label* all currents, voltages, etc. which will be used or referred to.

2) For each measurement, note any special circumstances or conditions (e.g. record frequencies or voltages which are being held constant, sketch the waveforms which you see on the scope, etc.). Record the data in a table with clearly labeled columns. Leave space at the end for later use in analyzing the data. Record any comments about the measurement before proceeding - don't expect to remember them later. Perform any preliminary data analysis if the results are need for subsequent measurements.

3) Return later to finish analyzing the data and to consider possible errors in the data. It is always appropriate to graph data to get a better feeling for it. Consider not only regular graphs, but also semilog and log-log. Graphs should be drawn carefully on graph paper (buy some!) or use a computer. They should be taped, stapled, glued, etc. into your notebook. A graph should have a *title*, should have axes labeled and values shown, and should clearly indicate the set of measurements which it is taken from. Do not connect the points on a graph of experimental data. If appropriate include error bars to indicate the possible size of the errors. If appropriate, graph the theoretical result that you expect to find.

4) After finishing data analysis and theoretical computation, THINK! Do your results make sense ? If not in agreement with calculations, can you think of reasons why ? What refinements to the experiment and/or theoretical model can you suggest ? What have you learned ? Write a summary bases on these and other appropriate questions which you should ask yourself.