Lab Report Format

General Remarks

Writing a lab report is the primary way your TA will know what you have done during the lab, how well you understood the experiment, and whether or not you know how to process the results. This is designed to serve as your first introduction to the world of scientific writing.

The formatting of your report should follow the "**IEEE Transactions on Magnetics**" format (http://ieeeauthorcenter.ieee.org/wp-content/uploads/Trans_Magnetics_instructions.pdf), with some simplifications that will be detailed below.

Your lab report should include, but not necessarily be limited to, the following features:

- Concision. There is no need to include huge excerpts from a textbook, dozens of irrelevant plots, or a lengthy derivation (unless the lab manual specifically asks for it). You should consider 2-6 typed pages, including plots, to be the typical requirement for a lab report. There is a hard limit of 6 pages for each lab report.
- Graphical representation of data: for example, a histogram or an xy plot. Plots must include error bars on the data points, be clearly labeled, and be large and easy to read. Captions should follow figures as a description of the plot.
- Proper presentation of results. When you present your data, all measurements should contain an estimate of the uncertainty and the units of measurement.
- A description of the statistical and systematic errors that affected your measurement. Again, this description should be concise but well-developed.
- A discussion containing all relevant information and reasoning, allowing the reader to validate your conclusion.
- Past, Present, Future Tense. You should use past tense to describe results you have done, results from published papers should be described in present tense and only experiments you plan to do in the future should be described in future tense.

Using a Logical Format

To provide a disclaimer, if you actually go on further in research and read other scientific papers, you will notice that there is no "one" correct way to write a paper, and the style often depends on journal requirements, field of research, author styles, etc. As you progress on after the course, you will develop your own flavor for scientific writing, but as this is still an introductory course, the expectations will be a little firmer to build a stronger foundation for you that you can build on in your future careers.

You may want to structure your report using the following framework:

1. **Abstract (Optional)**: The abstract is usually the last section one writes, and acts as a short paragraph summary of the contents of the entire report. A reader should be able to glean the essentials of what the rest of the report is going to cover, from reading the abstract.

2. **Introduction**: The introduction should provide the background for a reader unfamiliar with the field of the experiment, to jump into it. It should describe the scientific question you are looking to probe in the experiment, and motivate why you (and the reader) should be interested in it. Depending on the scenario, it can also be a good idea to very briefly mention the conclusion of the report as well.

   Any theoretical equations or derivations should be developed in the Introduction and Method section. Anything that relies on a description of the particular setup should be presented in the method section, while more general concepts may be described prior in the introduction.

3. **Method**: The method section should contain a summary of the experiment *in your own words*. You are NOT to copy large chunks of the lab manual. A simple sketch of your apparatus accompanied by a one or two-sentence description is often a good place to start.

   A good method section will also contain a description of the important parameters measured in the experiment and expectations for their relationships to one another (ie. what relationship, formula or model describes the system you are studying). Finally, you can mention some of the details of your analysis in this section; e.g., "We perform a fit to the data of the form $y = mx + b$..."

4. **Results**: You should present the results of your measurements and analysis (i.e., error propagation) here. You don't need to include lengthy tables; it is often preferable to include plots and final values, with uncertainties. The plots, which must be clearly labeled, should speak for themselves. However, you should always contextualize your figures and fit analysis. This section should continue the narrative of the rest of the report.

   Moreover, never forget that, whenever you are reporting an error associated with a certain quantity, it must be clearly explained. If the uncertainty is associated with a raw data point, you should justify why you assigned this uncertainty, often based on your specific measuring procedure. On the other hand, if the uncertainty is associated with a derived quantity (e.g. from the slope of a linear fit), then you should explain how you propagate it or derive it from a collection of measurements.

5. **Discussion**: In this section, you should demonstrate your grasp of the experiment by discussing the statistical significance of your measurements. Comment on whether or not your observations differ significantly from your expectations. If so, you should consider whether or not this could

be a reasonable physical effect, or if in fact your experiment was affected by a systematic bias. When discussing possible sources of bias, you should be as specific and quantitative as possible. Simply writing that your observations were affected by vague factors such as "human error" or "bad equipment" is not sufficient.

In many physics experiments, there are many sources of error, but a dominant error (the source that contributes the most to the uncertainty) is often identified, and measures to address this particular error source will often be suggested.

You should also discuss the *precision* of your observations — i.e., the size of the statistical fluctuations in your answer — and think about how to improve it. (Do this even if your answer does not differ significantly from expectations.)

6. **Conclusion**: In the conclusion, you quickly summarize for the reader your results, the precision and accuracy of these results relative to expectations, and the possibility of improving your measurements.

This framework can help you organize your work, but remember, it is up to you to make the report readable and transparent. In writing your report, you should still aim to present your information in an effective manner, and you are welcome to explore tweaking this structure to do