ECEn 487 Lab Report Guidelines

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***Abstract*—Writing is an essential skill that engineers must develop to successfully communicate ideas and procedures. The laboratory portion of 487 is an opportunity to practice encapsulating your ideas in written form. A grading rubric is given.**

I. Introduction

Communication is an essential skill for engineers. Often, at the undergraduate level, this important part of engineering work is downplayed or downright denigrated by students. However, it does not matter how bright or innovative you are if you cannot share your ideas with other people who will appreciate them. This is particularly true in a business organization, which relies heavily on written communication through e-mails and reports to document important developments and problems. In academia, the primary form of communicating ideas is through articles written in peer-reviewed journals. In academia and industry, the ability to present concepts using attractive visual representations is a valuable skill. Thus, being able to communicate your ideas through writing and visual representation effectively will be necessary in whatever path that your career takes. Indeed, your ability to communicate may determine the success that you have in your career.

Given that introduction, this short guide is intended to help you in your preparation for lab report for 487. Writing a report is not so much that the professors love reading your work, that you have a Nobel prize-winning idea, or that we just love you to have mindless busy work. It is because taking the time to write a report implies necessarily that you will absorb material, mull it in your minds, and then put your ideas on paper. Clear writing stems from clear thinking and it is the latter that we encourage through the use of lab reports.

In a lab report for 487 I do not expect a regurgitation of everything that you did in the laboratory. I don't need to know that you used a broken RCA cable, it took you ten minutes to debug that aspect, and that finally you took a better cable from the shelf and the system worked. I assume that you figured out many of the problems, put in the effort to complete the assignments, and that your system works. I want you to document for yourself and for others what has been learned in the laboratory. I have deliberately made the labs somewhat open-ended in order to give you the opportunity to figure out how to best document your work. The majority of you are seniors in electrical engineering and your next steps in graduate school or out in the field will require much more than following cookbook procedures.

II. Word Processing

While the majority of you can use Microsoft products for producing documents, this often is not a good choice for documents requiring the use of many equations. The LaTeX typesetting language is a much better alternative. Often, for many IEEE conferences, you need to typeset your documents using LaTeX at the time of submission. An example of this is found in an article that Michael Rice and I co-authored [1]. If you have never used LaTeX, a good way to get started is by using the word processing software LyX. This free software allows you to write as if you were using a normal word processor, but has much better support for graphics and equations. Consider, for example, how well it typesets the convolution integral,

$$x * y = \int_{-\infty}^{\infty} f(\tau)g(t-\tau)d\tau. \tag{1}$$

The typesetting procedures in LaTeX are much better than most other word-processing alternatives. I strongly suggest that you use LyX with the "ieeetran.cls" article class to compose your laboratory reports. That is the class file that was used to produce this document. I believe that you will find that you can produce a professional-looking technical document in a much shorter amount of time than by any other method.

The other nice feature of writing in a LaTeX environment is the handling of references by the processor BibTeX. This allows reference lists to be automatically generated from the citations in your text. While I have used other software for this task, BibTeX does a very good job and generally does not require significant modifications to the lists after they have been generated.

III. Figure Preparation

Figures are extremely important to convey information and results. However, figure preparation is really an art. When a figure is done correctly, it can easily convey ideas better than any other way. Poor figures add confusion or are not properly annotated and can make ideas or concepts even more obscure. In 487, I would like you to practice generating high-quality figures that could be used in formal presentations or reports in industry or academia. For presentations in PowerPoint, it is often better to export the figures in a bitmapped format such as Portable Network Graphics (.png). For LaTeX and most journal articles, you want to use a vector-based graphics format because it is possible to obtain much higher resolution, especially as figures are enlarged.

I have provided examples of two different figures generated from the same data. The first figure, Fig. 1, was made from a direct screen capture of the standard figure that MATLAB produces. No adjustments were made to improve the figure. I have seen many of these types of figures in laboratory reports. This one is not nearly as bad as some as I have seen, but if you zoom into this figure, you will note the pixelation that occurs as the figure is enlarged.

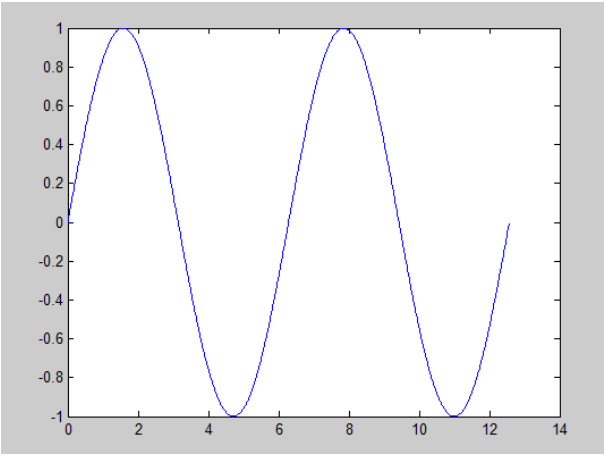

Figure 1. A figure from a screen capture from MATLAB. The screen capture in EndNote was then saved as a .png file.

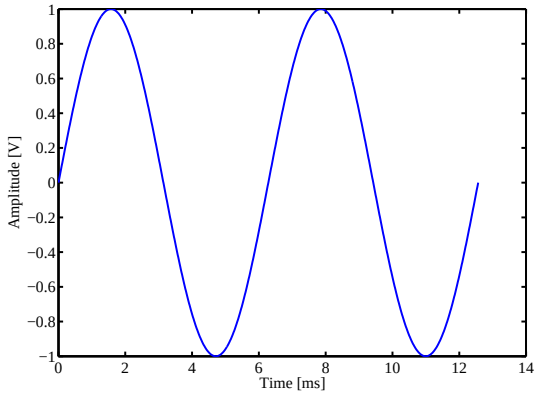

Figure 2. Figure exported as a vector-based graphics file. The export parameters from MATLAB were the following: size of 8.5 cm by 6 cm, fixed font size of 16 points, Times New Roman, and a fixed line width of 2 points. Then the figure was saved as an Encapsulated PostScript (.eps) file.

The second figure, Fig. 2, was also made from the same data in MATLAB. However, greater care was obviously used here to export the figure as a vector graphics file to make sure that the fonts and lines would scale correctly. Note how much smoother the lines appear in the vector-based plot than the bitmapped plot. Being able to produce high-quality figures from MATLAB is not so much more difficult, it just takes a few moments to adjust the export settings before exporting the figure into a suitable format.

One of the nice features of the LyX word processing environment is that it can handle both bitmapped and vector-based graphics with ease. This results in very clean graphics output for reports.

IV. Organization

Make sure that you organize your report in a format that makes sense. You want to have a clear, concise title that conveys the essential point of your report. Then you want to make sure you have an abstract that captures the main points that you will discuss in your report. In the abstract, it is often wise to include the most significant numerical result that you obtain because it will be the value that most others will want to reference.

Once you have written a title and abstract (which are often the last things that you compose), then you want to get into the body of your text. I find that it is often easier to first compose all of the figures for your report and then generate the text to accompany your figures. This approach means that you will have a good story to tell and the figures will not feel that they are haphazardly placed around the text.

For many reports, an acceptable format is to start with an Introduction, then move to a Theory section, then a Methods section, a Results section, a Discussion, and a Conclusion. This allows the reader to move through your ideas in a logical flow. While you may actually perform the work required for the report in a far different order, presenting your work in a logical fashion makes it much more easy for others to read and understand. I find that students have the most trouble with the Discussion section. This is perhaps the most important section, however, because it is where you really get into your results, why anomalies occurred, and what the implications are from your results. In the Discussion section, you are engaging the reader in a conversation about your work and, if it is written well, they can enter the dialogue and argue and extend your ideas.

V. Grading

Attached to this document is the grading rubric that we will use to evaluate your reports. This rubric was developed from the LabWrite program (http://labwrite.ncsu.edu), which was sponsored and funded by the National Science Foundation and hosted by North Carolina State University. I feel that it captures the important aspects of the laboratory report and also provides a clean way for the instructors to grade your reports.

VI. Conclusion

Writing is an essential communication skill for engineers. The process of writing should help you to clarify your thoughts about the material in 487 as well as the results that you obtain in the laboratory. Developing the skill of writing will enhance your abilities as an engineer. I look forward to receiving your laboratory reports!

References

[1] B. Mazzeo and M. Rice, "On monte carlo simulation of the bit error rate," in *Communications (ICC), 2011 IEEE International Conference on*, pp. 1–5, IEEE, 2011.

EVALUATION: Lab Report _____ Writer: _____

Section Points		Poor 0	0.25	0.5	0.75	Excellent 1	Section Scores
5	**Title**						5.00
	Describes lab content concisely, adequately, appropriately					x	
5	**Abstract**						5.00
	Conveys a sense of the full report concisely and effectively					x	
10	**Introduction**						10.00
	Successfully establishes the context (concept/lab procedure) of the lab					x	
	Effectively presents the objectives and purpose of the lab					x	
	Presents interesting questions or issues related to the lab					x	
15	**Methods**						15.00
	Gives enough details to allow for replication of procedure					x	
15	**Results**						15.00
	Opens with 1 or 2 sentence(s) describing main finding of lab					x	
	Presents visuals clearly and accurately					x	
	Presents verbal findings clearly and with sufficient support					x	
	Successfully integrates verbal and visual representations					x	
20	**Discussion**						15.00
	Opens with explanation of how findings link to the context of lab					x	
	Addresses questions & issues related to the lab & discusses the answers					x	
	Sufficiently addresses other issues pertinent to lab					x	
10	**Conclusion**						10.00
	Convincingly describes what has been learned by doing the lab					x	
10	**Presentation**						10.00
	Citations and references adhere to proper format					x	
	Format of tables and figures is correct					x	
	Report is written in scientific style: clear and to the point					x	
	Grammar and spelling are correct					x	
10	**Overall aims of the report:** *the student...*						15.00
	Has successfully learned what the lab is designed to teach					x	
	Accurately analyzes data for lab findings					x	
100						**Points Earned**	
						Total Possible Points	**100.00**
						Percentage	100
							100%