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POUGHKEEPSIE, NEW YORK

LAB REPORT WRITING MANUAL

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FOR
TECHNICAL/ENGINEERING STUDENTS

ABSTRACT

This document specifies the format to be used when submitting a formal lab report. This format can be used for any technical report in a variety of disciplines. Also, this manual can be used to compose less formal reports that consist of a subset of the items presented here.

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INTRODUCTION

The purpose of a lab report is to completely and clearly describe what was done in the lab, why it was done, the results obtained and the implications of those results. The lab report serves as a means of communicating your work to others and possibly to refresh your own memory at some later date. A well-written report allows the reader to quickly understand exactly what has been accomplished in the lab and the report provides sufficient detail to allow the reader to duplicate the experiment.

The clear presentation of lab results is at least as important as the results themselves; therefore, writing a lab report is an exercise in the effective communication of technical information. Lab results, such as numerical values, designed circuits, or graphs, by themselves are not very useful; to be meaningful to others, these results must be supported by a written explanation that describes how the results were obtained and what significance they hold, or how a designed circuit actually functions. The person reading the report may have a technical background but is not as familiar with what happened in the lab as you, who performed the work. You must therefore supply details that may appear obvious or unnecessary. With practice you will learn what details to include.

The key to a well-written report is organization. A report that is divided into several sections, occurring in a logical sequence, makes it easy for the reader to quickly obtain an overview of the contents as well as locate specific information.

THE FORMAL LABORATORY REPORT

The formal laboratory report, like a technical report, contains a complete, concise, and well-organized description of the work performed and the results obtained in the lab. Any given report may contain all of the sections described herein or a subset, depending upon the report requirements. These requirements are decided by the author and are based on the expected use of the report.

All reports have certain aspects in common regardless of the expected usage. These will be presented first, then a presentation of all the possible sections to be included in a report is given.

UNIVERSAL ASPECTS OF ALL REPORTS

- The report should be written in an active voice using the third person in most instances. Avoid using personal pronouns. Personal pronouns tend to personalize the technical information that is generally objective rather than subjective in nature. Use

correct grammar, punctuation, and spelling. *All of these items help produce a professional sounding report.*

- All diagrams must be neatly presented and should be computer generated. Use a computer software package such as Multisim, EWB, and AutoCAD to draw circuit diagrams. Leave at least a one-inch margin on all sides of a full page diagram and always include a title. *Always insert a full-page diagram or graph so it can be read from the bottom or from the right.*
- For all paper reports, all pages of the report must be 8 1/2 “ X 11” in size. Any larger pages must be folded so as to fit these dimensions.

REPORT FORMAT

The pages of the report are to be assembled in the following order. This is the recommended order, however, certain reports may lend themselves to either reordering sections and/or excluding sections.

TITLE PAGE

The format for this page may vary, however, the following information is always included: report title, who the report was prepared for, who the report was prepared by, and the date of submission.

ABSTRACT

An abstract is a concise description of the report including its purpose and most important results. An abstract must not be longer than half a page and must not contain figures or make reference to them. The results may be summarized in the abstract but qualitatively, not quantitatively. This is not a numbered page of the report.

TABLE OF CONTENTS

Include all the report sections, subsections, and appendices. This is not a numbered page of the report.

INTRODUCTION

Give a brief description of the problem and how it is to be attacked. This section should give the reader an overview of the whole report. This can usually be accomplished with ease if you have carefully read the lab’s stated objectives. After introducing the problem, indicate how those objectives are met. Next, summarize how the report proceeds. Explain briefly what the reader will find in each section of the report in sequence, ending with a qualitative statement of the results. The introduction should be one to one and a half pages long. It is very important that the introduction welcome the reader to read on by telling the reader why the work was performed, how the work was performed, and then direct the reader to the interesting results.

BACKGROUND THEORY

Include, if necessary, a discussion of relevant background theory. For example, if the phase shift of an RC circuit is to be measured, give the derivation of the theoretical phase shift. Include any preparation specified in the lab manual. In deciding what should or not should be included as background theory, consider presenting any material specific to the lab that you had to learn prior to performing the lab. This section may be divided into subsections if appropriate. Keep the discussion brief and refer the reader to references where appropriate.

PROCEDURE

This section should *discuss* the procedure as if you were standing at the lab bench with a visitor and describing the necessary steps to test a theory or verify a circuit design. BE BRIEF – do not include all the detail of the lab handouts. The lab handouts can be referred to by including them in the appendix.

Give the details of any lab procedure that may not be obvious to a reader of your report. Remember that a well-written report allows the reader to duplicate the experimental work. Assume, however, that the reader has a technical background and, for example, knows how to measure a voltage or current in a circuit. Include specific procedures such as how an oscilloscope was externally triggered or what sequence of steps was used to write and verify memory data. Include details for procedures that were new to you.

Include all circuit diagrams in this section. Keep this section as general as the lab handout is. Do not specify resistor values that are not specified in the original lab handout. Use diagrams to show equipment interconnections. Make sure the diagrams are clearly labeled.

DESIGN / THEORETICAL ANALYSIS

Give the details of your design procedure. Be sure to introduce and describe your design work using sentences, equations alone are not sufficient. Use footnotes if you wish to refer the reader to reference material. Divide this section into subsections where appropriate. For example, a lab design may consist of designing several circuits that are subsequently interconnected; you may choose to treat each circuit design in its own subsection. Keep this section as general as possible.

If there is no design but strictly analysis, then provide the important details of all the analysis performed. Be brief. It is not necessary to show every step, sentences can be used to describe the intermediate steps. Furthermore, the reader can be directed to the appendix for complete details.

RESULTS AND DISCUSSION

Present your laboratory results using neatly organized and completely labeled tables and/or graphs whenever possible. Always include theoretical values alongside

experimental values and compute the percent error between them. Include a few sample calculations, but put lengthy calculations in an appendix.

ALWAYS accompany results with a meaningful discussion. The discussion explains what the results are showing, what they mean, and points out trends. In some cases, the results speak mostly for themselves and the discussion may be brief, i.e., “The above table shows that the designed variable modulus counter works as expected”. In other cases, the meaning of the results may not be as clear and the discussion needs to be more detailed.

There are some tips that are fitting to most all labs. For one, you should always calculate meaningful percent difference where percent difference is commonly understood to be:

$$\% \text{ difference} = \frac{(\text{measured value}) - (\text{theoretical value})}{\text{theoretical value}} \times 100\%$$

You must provide reasons whenever a significant percent error exists. Typically, a percent difference of less than 5% can be attributed to component tolerances. Percent differences between 5 and 15% occur for only one of two reasons. First, a significant (and unacceptable) error was made during experimentation. Second, the percent difference is an indication that the theory is not doing as good a job predicting the results as generally expected. In this case, there is always a reason to suspect the theory and it is important to determine the theoretical assumption at fault. Generally, a percent difference greater than 15% is unacceptable. It indicates a gross error in the lab which must be spotted WHILE in lab. Considering that lab preparation would always include performing theoretical predictions first and may also include computer simulation, the experimenter MUST be in a position to judge the data as it is being recorded. If a large percent difference is noted during lab, do not proceed until the problem is resolved. This may include seeking assistance from the instructor and obtaining permission to proceed.

Another tip for the results and discussion section is to pay close attention to all questions that were asked in the lab handout. Somehow, all answers to questions are to be addressed in this section. Think of the overall presentation and where the answers to the questions belong. Generally, lab questions indicate to you what aspects of the lab are considered important and need to be discussed along with the presentation of results.

Always refer to your graphs and tables when discussing your results. Construct graphs using the following guidelines:

1. Create the graph using a computer software package such as Microsoft Excel. If computer access is not available, use grid paper.
2. Provide one-inch margins on all sides; do not write in the margins.
3. Clearly label axes, including quantity plotted and its units.

4. Use a smoothed line to produce the best-fit curve.
5. Clearly indicate your data points using a circle, triangle, or square. Use different shapes for different curves plotted on the same axes.
6. Label different curves plotted on the same axes.
7. Title every graph. “V vs. R” is NOT an acceptable title whereas “Measurement of Voltage (V) as a Function of Varying Resistance (R)” is.
8. Date the graph.
9. Place all graphs in the report so that the bottom of the graph is either along the bottom of the paper or the right side of the paper.

CONCLUSION

In this final section of the body of the report, you need to briefly bring everything together. It is similar to the abstract except that now the results are concluded upon in a quantitative way.

REFERENCES

List all references used, include all the important bibliographical information.

APPENDIX

This section may not always be present. Use it for the lab sheets, parts list, and wiring diagrams. Where appropriate, include extensive calculations, error analyses, and lengthy computer programs. Do not put different items in one appendix rather introduce numbered appendices.

HOW A READER PERUSES A TECHNICAL REPORT

For obvious reasons, the reader will first read the title page and abstract. Therefore, it is imperative that the abstract be clear and well written. It should tease the reader into looking further into the paper.

The conclusion is often the next section to be read. All valuable readers, politically speaking, will jump directly to the conclusion making it important to provide a table of contents to ease navigation of the document. If the conclusion, relative to the title page, sounds interesting and conclusive they will read the other sections to learn more.

The introduction is read next. It should provide the reader with enough information about how the report progresses so that the reader can pick and choose which sections are most applicable to their interests. Based on this, some or all of the subsequent sections may be read.

In light of understanding how a technical report is read, there are several general guidelines to consider:

- If you use acronyms, describe them first then include the acronym in parenthesis, i.e. Digital Multimeter (DMM). Do not use acronyms in the conclusion section.
- DO NOT be judgmental in your writing; “I felt that ...”, the results were great ...”, etc. Simply write what was performed and validate experimental procedures with small and justifiable experimental error where possible.
- Give your report to someone to read. Note where they had questions or couldn’t understand your discussion. Then see if you can improve how that information is presented.
- Remember that the reader can’t understand what you are “thinking”. Write your report for a technical peer but do not assume they are comfortable with the current course material.
- Write your reports generically. Referring to a “Lab 3 Part 1” does not mean anything to a general audience. Think beyond the academic assignment and imagine composing a general report on the subject at hand.
- A professional looking and well-organized document sets the tone for the reader.

CONCLUSION

The lab report writing manual presented here should serve as a recipe for writing clear technical reports for a variety of disciplines and applications. If all of the information contained herein is studied and applied, the result will be a report worth reading. Considering that most technical jobs require accurate communication through written material, development of these skills can only improve your career status. Be aware that most jobs in a technical field require a significant amount of technical writing, from informal memos to formal proposals for presentation to customers. It is worth your time to read this material carefully and practice your writing skills.

REFERENCES

Lab Report Manual, Electrical Engineering Department, Lafayette College, Easton, PA, Sept. 1984.

“Objective Comments on Lab Reports by a Professional Engineer”, Jefferson H. Akins, P.E., Morris Associates, Poughkeepsie, NY, 1994.

**APPENDIX: INFORMATION FOR ANSWERING LAB QUESTIONS
(AIDS IN REPORT WRITING)**

- In consideration of the accessibility to word processors, this assignment should be submitted in typed form.
- First type the question, then type the answer.
- It is expected that ALL team members contribute to the discussion and writing of the answers to the lab questions.
- You must use full sentences and make sure you answer all parts of the question. If you are asked to explain, make sure you explain.
- Make sure you understand the lab's objectives as they are the indication of what you are supposed to focus on in answering questions and writing reports.
- When comparing data, make sure you clearly indicate the type of data. Data that is obtained completely from theory with no use of data collected in the lab is theoretical data. Data obtained from experimental measurements is experimental data. If theory was used to derive data, such as using current to calculate voltage using Ohm's Law, the result is still experimental in nature since it is based on experimental information. Finally, data can be computer generated or simulated data.
- Tables or graphs should allow for easy comparison between numbers, should indicate the type of data and its units, and supply a percent difference where appropriate. All types of data should be included.
- It is important to be involved in answering lab questions, even if your responsibility is to write the formal report, because you will need to incorporate the answers to ALL the questions in to the results/discussion section.
- When comparing two sets of data, supply the data AND the percent difference. There is little meaning to have one without the other.
- Make sure to read over what you have written to see if it actually answers the question at hand. You may not be getting straight to the point or you may not be backing up your answer with meaningful information. For example, saying that the voltage difference is only 0.02V is meaningless without explaining the percent difference. If the voltage was calculated to be 0.085V and you measured 0.065V then the percent difference would be -31%! Whereas if you measured 0.58V and you expected 0.6V, then the percent difference is only 3.4%. Both cases are for a 0.02V difference ... do YOU see the difference?