

REPORT WRITING GUIDE

Introduction

The importance of good report writing and data presentation cannot be overemphasized. No matter how good an experiment, or how brilliant a discovery, it is worthless, unless the information is communicated to other people. As you complete each laboratory report, you will be gaining experience in writing technical reports and will be developing skills, which you will find invaluable throughout your career. There are great many books available on report writing. However, the purpose of this document is to provide some basic pointers in the writing of laboratory reports. In particular, a major objective of this work is to provide the format for laboratory report writing, and to provide hints and tips to improve your reports. Each of these topics is discussed at length in the appropriate sections that follow.

General Guidelines for Report Writing

All of the reports you submit during your career at Southern University should follow one of two basic formats. There may be small differences due to individual preferences of the instructor, but for the most part, all of the components of the report will be identical.

Style:

Third-person past tense is generally accepted as the most formal grammatical style for technical reports. However, in some isolated instances, it may be most effective to stress a point or to emphasize that a particular statement is primarily the opinion of the writer. An example of each of these styles is shown below.

Third-person: Equation (6) is recommended for the final calculation procedure as a result of the limitations of the data as discussed above.

First-person: We recommend Eq. (6) for the final calculation procedure as a result of the limitations of the data as discussed above.

As you can see, in the first-person statement, the writer is making the recommendation on a much more personal basis than in the third-person statement. The selection of the proper statement often depends on many factors, including the consideration of the people who will eventually read the report. In most cases, the third-person statement will be most preferable, however, if you have completed an engineering study for a particular individual, the first-person usage may be more appropriate. As most of the work that you will be completing will require a formal report, ***the third-person style is to be used.***

Format:

All reports must be typed or near letter quality (NLQ) printed. All work should be double spaced, one side only. All pages must be trimmed or neatly folded to 8.5" x 11". Reports should be bound, such that the back of a page is on left and the front of the page is on the right (no binder, paper clips). Block format with separated side headings or an indented format with center of side heading may be used. This is an individual choice for the writer. Paragraphs may or may not be numbered, but all pages must be numbered. All pages should have identical margins. A reasonable set of margins is 1.0 inch at the top and the bottom, and 1.5 inches at the left, and 1.0 inch on the right. These margins allow for ease of binding, as well as clarity of reading.

Rules for the Plotting of Data:

One of the more common tasks in completing engineering reports is plotting data. This section contains some rules to follow when making graphs. Automated graph-making programs such as *Excel*, *Lotus*, or *SigmaPlot* often take care of many of these details for you, but you are responsible for checking that these guidelines are followed.

All axes must be drawn in a location on the page, which will allow the numbering, and labeling of the scales to occur without entering the margin. Each axis must be labeled and the proper units given. The lettering on the page must be oriented such that it is readable from either the bottom or the right-hand side of the page. This becomes important if the plot is drawn in landscape mode (i.e., sideways) on the page. The independent variable is always plotted along the abscissa (x-axis), and the dependent variable on the ordinate (y-axis).

Choose convenient scale factors for each of the scales, generally using multiples of 1, 2 or 5. An axis, with divisions of 2.5 or 3.33, is very troublesome when it is desired to read intermediate values from the curve, to say nothing of the difficulty you will experience in plotting the data. The plotted data points should be clearly marked by drawing a small circle about each point. These should be drawn with a template for neatness and usually are not more than 3/32 of an inch in diameter. Normally, this formality is automatically done when commercial computer graphing packages are used. If points for more than one curve are to be plotted on a single graph, or the data of different observers is to be indicated, a differentiation can be made by using small squares, triangles or other symbols in addition to the circles. On the other hand, the calculated points used in plotting a curve representing *theoretical results* should not be marked with such symbols. Only the curve itself (and not the points used to plot it) should be shown.

In most cases you will be required to draw a best-fit curve (with a French curve, not freehand!!) through the data points. It is not necessary that the curve intersect all data points or even the first and last data points. It should, however, be a smooth curve which best represents (in some average sense) the data. The curve should not be allowed to pass through the circles or other symbols surrounding the points. The purpose of this is

to leave the points visible so they may be checked at any time. Calibration curves and correction curves are drawn with small sections of straight line joining the points. This is done because the errors are mostly random and do not conform to a mathematical law.

Curves are drawn to as large a scale as is consistent with the precision with which the measurements are made. That is, the scale should not be so large that the curve can be read to a precision greater than that of the measured data, nor should the scale be so small that the curve cannot be read to as great a precision as that to which the measurements are made.

Do not place too many curves on one sheet of paper, particularly if the curves cross one another. Typically, this leads to confusion and a cluttered appearance. Prepare all plots on ruled graph paper, however, for computer generated plots this is not necessary. *Do not use quad paper or engineering paper.* If more than one curve is present, label each curve as close to the curve as possible. Do not use colors to distinguish curves, as this distinction disappears upon reproduction. (Use full, dashed, or dotted lines instead). Each curve should have a figure number and a descriptive title such as "Frequency Response of a R-C circuit." Non-descriptive titles such as "Voltage versus Frequency," which are evident from axes labels, should be avoided. In calibration experiments, your name, the date on which the experiment was performed, the instruments manufacturer, model number, and serial or identification number should appear on the figure.

Full page graphs in landscape mode (printed sideways on the page) must have the top of the graph at the left-hand side of the page. As in the text, any bibliographical references may be enclosed in brackets [xx].

A good laboratory report answers the questions: *What was done?*, *How was it done* and *What were the results?*. There are a standard number of sections to each lab report, which helps answer, these questions, and allows the reader the opportunity to move right to the section most appropriate to his or her interest. Basically, any formal lab report consists of the following sections:

1. Title Page & Abstract
2. Table of Contents
3. Introduction
4. Background and Theory
5. Equipment
6. Procedure
7. Results and Analysis (Include uncertainty analysis)
8. Conclusions and Recommendations
9. Bibliography
10. Appendix/Appendices.

A short description of each of these topics follows. Also, as previously mentioned, a sample lab report, which illustrates many of the concepts discussed in this writing guide, is contained in the following section.

Title Page & Abstract:

This is one of the most important sections of your report, and will probably be the most carefully scrutinized section of any report you write. Basically, this section tells a short story about your lab, and very concisely answers the three questions posed above: *What was done?*, *How was it done?*, and *What were the results?*. The abstract is included as part of the title page, so that anyone reading the report can very quickly see who wrote the report, the subject of, and the procedure followed for the lab, and what results were obtained. This section should probably be the last section written, and will summarize all of the work done for the lab. A common mistake is to write this section first, and then force the rest of the report to fit with the abstract.

Table of Contents:

Obviously, the table of contents is nothing more than a listing of headings with the page numbers. However, the table of contents is often a good indicator of the organization of the report, and can be a good tool for the development of the lab report. When figures and tables are used in the report, an independent *List of Figures and List of Tables* is also required.

Introduction:

An introduction sets the context of the experiment, and gives the relevant background to the experiment. This section is very important for the individual who wishes to read the entire report. The introduction should include a concise description of what you were trying to discover, as well as describe what is going to follow in the remainder of the report. It is not appropriate to include results in this section; rather, you are trying to set the stage for what follows in the rest of the report.

Background and Theory:

This section is used to lay the technical and theoretical groundwork for the process being studied. It is in this section that the technical basis for the work that you did is explained. In other words, why are the results that you obtained valid? Discuss the technical fundamentals that lie behind the experiment. This includes describing (and laying the technical groundwork for) the analysis process for the data. This section does not have to be a master's level thesis, but should demonstrate your understanding of the process and the sources of error in measuring it. A well-written background section greatly simplifies discussion of the results.

Equipment:

This segment of the report, along with the section that immediately follows (the procedure section), allows the reader to duplicate your experiment should the need arise.

Any equipment used in the experiment should be listed along with identifying marks (serial numbers, model numbers,...). Any particular settings of the instruments should be denoted in the procedure section. It is especially useful in this segment to include a sketch of the experimental setup. This sketch is especially helpful to avoid any ambiguities that might exist when the experiment is re-run, or when attempts are made to duplicate your results.

Procedure:

A procedure section simply lists what was done in the lab, and the order in which it was done. As previously mentioned, it is this section, along with the equipment section, that allows the reader to reconstruct your experiment, if necessary. This section is most effective if it is written in the form of a list, following a chronological order as shown below.

1. A beaker was filled with 500 ml of water, and placed on a hot plate.
2. A thermocouple was placed in the beaker, and the temperature of the water sampled once every 8 seconds.
3. The recording...

Elements in the list are either all complete sentences, or all short phrases but not both. Overhang paragraph format is good for lists. The procedure section is also the appropriate place to discuss any deviations from the intended procedure. For example, if you originally intended to monitor the temperature of two beakers of water, you might note that only one thermometer was available, and that this was not possible.

Results and Analysis:

This section may be the most crucial for your report. The results and the analysis to obtain these results should be presented here. This section is most effective if written in the past tense. "The data was taken ..."; "the curve was generated..." However, it is appropriate to say such things as 'the data is well represented by a second order polynomial' since this is a fact that extends into present. Additionally, estimate the error in measuring whatever your objective was to measure. Be particularly careful when referring to 'human' or 'round-off' errors that these errors are significant in terms of the discrepancies observed.

Plots and figures tend to be the most effective ways to present data. It is extremely useful to include figures in the text at the point where they are being discussed (a helpful tool is to use the graphic import feature available with many word processors to import figures right into the text).

When graphs or tables will present the ideas clearly, use them, but also include a concise discussion of the graphs and tables focussing the reader's attention on the salient features of data. Do not simply recite numbers or parameters, which should be obvious upon simple inspection of the figures. Moreover, never forget to indicate units. The

location of figures and tables should be included in the *List of Figures/ Tables* in the Table of Contents section of the report.

Conclusions and Recommendations:

By the time the reader reaches this section of the report, most of the conclusions regarding the work should have already been presented. The object of the conclusion section is to gather all of the important results and interpretations in clear summary form. Recommend cost-effective feasible ways to improve the performance of the laboratory. Also remember, there will be many readers who focus only on the conclusion and abstract sections, so it is especially important that they be well written.

Bibliography:

This section should include all references that were cited throughout the report. A standard format should be used such as

"... Smith [11 discusses the effects of temperature..." which would refer to the following citation in the bibliography.

1. Smith, R., Turbulent Natural Convection for a Vertical Plane Surface, Journal of Heat Transfer, Vol.76, p.234, 1979.

Your work will often require you to reference other contributions, not only in this particular course, but in others as well. Learn to do so.

Appendices:

A laboratory report should be a complete, concise, self-contained document without appendices. These sections contain information not appropriate to any other section. For example, raw data, sample calculations, detailed derivations, etc. may be included in the appendices. This is the most 'free' space in the report. For example, you might include a sketch of an improved way to complete the experiment, or to present the data. An appendix can be a very valuable addition to the report.

Hints to Writing

Before You Begin:

It is very difficult to write good lab reports if you don't understand what you were doing when you carried out the experiment. Therefore, before coming into the laboratory, you are urged to carefully read both the experiment sheet and the partially completed laboratory report for that week's experiment. Take advantage of opportunities to discuss with your instructor any questions that you may have regarding the experiment. The experiment tends to run a little smoother if you designate one member of your group as the data taker. He or she is responsible for recording information pertinent to any device calibrated during the experiment. At the end of the lab, each

member of the group should then copy this information directly onto their data sheets. It is this type of information that should appear in your appendices.

Writing the Report:

It is important to write your report as soon as possible after the experiment is completed. This will save you time since the experiment is hopefully, still fresh in your mind. Remember, as always, that each section of the report should answer one of the three basic questions: *What did you do?*, *How did you do it?*, or *What did you find out?*

In terms of these, think carefully about what you did in the experiment. Think about what figures you want to include to help clarify the information. Decide the flow of information before actually sitting down to write. As you write, keep in mind the common rules of English grammar and punctuation. Proofread your report, and keep in mind that your report speaks for you. Does your report give the impression that you would want to make it if you were in person?

Write a sketchy outline itemizing the basic sections of the report and listing the primary points to be made in each section. With the available text processors this should be relatively straightforward. The outline will help organize the report, help establish the flow of information, and can help indicate where figures and graphs are needed.

Once the content of the report is established with a multilevel of detail outline, it is much easier to begin writing. It should be much simpler to concentrate on rules of grammar and punctuation when not having to think about what to say also.

After Getting back your Report:

After your report has been graded and returned to you, take the time to read and understand the comments that have been made. Consider these comments when writing your next lab report. Work with the instructor to improve the quality of your lab reports, and always keep in mind that the ability to write a good lab report is an excellent talent, that will be extremely useful throughout your educational and professional careers.