# A GUIDE TO LABORATORY REPORT WRITING

**AT THE**

# ILLINOIS INSTITUTE OF TECHNOLOGY

## THE COLLEGE WRITING PROGRAM

**www.iit.edu/~writer**
**writer@charlie.cns.iit.edu**

**FALL 1999**

## Table of Contents

## Introduction

This Guide is designed to be used in preparing laboratory reports for all general science and engineering courses at IIT. It describes the structure of a good laboratory report, outlines the different sections of the report, and explains the need for each of them. It also introduces some standard conventions and rules for writing reports of professional quality.

Laboratory reports will be graded not only for technical content but also for writing and style. The quality of your written report will strongly affect your grade for the course. Students are required to follow the general rules in this guide and the specific format instructions given to them by their laboratory instructor.

## Need for Report Writing

According to recent nationwide surveys, engineers and other professionals in the sciences spend at least fifty percent of their time writing reports and memoranda. The quality of oral and written reports presented by working professionals is invariably one of the criteria used by their superiors in performance evaluations, making the ability to write a good, professional-quality report is an essential, marketable skill. For these reasons, training and practice in report writing are important parts of your education. IIT is committed to providing you with the incentives, opportunities and guidance to develop this skill.

## Advantages of a Standardized Format

Engineering and science professionals write several different kinds of laboratory reports. The form, length, content and emphasis are determined by the purpose of the report and the intended audience[s]. However, the structure of all reports is similar, and includes sections that describe objectives, methods and procedure, results and conclusions. This is a format that has evolved over time in practice, and, while there is no single perfect format, there are several very good approaches that are similar to one another in most respects. By using a standardized format, you can ensure that the final report is complete and that readers who have different interests and needs can access the information they seek from the report with a minimum of effort. The use of a standard format also cuts down on the time required to write a report.

## Use of Computer-based Word Processing

All laboratory reports for IIT courses **must** be prepared using computer-based word processing. This is the standard practice today in most organizations. If you do not have

independent access to a computer, PC's and Macs, with word-processing software and printers, are available for use throughout the campus. Most word processing software incorporates useful features that significantly enhance the capability to produce a professional-quality report. These features include formatting, graphing, drawing, and spell-check.

## Time Required for Report Writing

The most frequent complaint from students about laboratory courses is based on the perception that an excessive amount of time is needed for the preparation of laboratory reports, and that the return on this investment of time (in terms of the GPA) is not proportional. In fact, however, students who are able to report on their laboratory work in clear, organized reports receive higher grades than those who cannot. While report writing can indeed be time-intensive, the time is well spent because it provides students with the opportunity to develop or improve a skill that will be extremely valuable in their future careers.

A number of strategies can be deployed to lessen the time spent writing reports. Many frustrations and problems related to report writing can be minimized by proper planning. It is essential that students schedule their weekly activities to allow enough time to write laboratory reports. The time required to complete a report varies for each individual. As you become more proficient, the time required decreases. Additionally, using word processing and one standard format in all the laboratory courses will increase your writing efficiency. For longer reports, time is usually spent most efficiently by working on a report in more than one session. A rough draft is written first and set aside. The rough draft is then reconsidered, edited and polished into the final version after one or more revisions. The final version *must be proofread* carefully before submission. You should allow time to write, edit, and proofread the reports ***before*** the final versions are printed.

You are on the path to becoming professionals whose successful careers will be based in part on how well you can communicate in writing. Start practicing now!

## Intended Readership

As a student, you can expect that the grader will read your report in its entirety, but professionals know that only a few experts in their own field will read a complete report—and only if they continue to be impressed by the relevance of each individual part of it. Reports are typically read by a number of different people, with differing backgrounds, interests and needs. Some individuals might be interested in the details of method, analysis, and interpretation. Others might be interested in the significance of the results and the conclusions that are drawn from them. At yet another level, a manager who seeks specific information to make important decisions about a project might look at only a brief summary of the report, together with a set of conclusions and

recommendations. Professional laboratory reports are written to meet the needs of all these individuals.

Because they are an important part of your pre-professional training, laboratory reports written at IIT should also be written to satisfy the needs of this varied readership. Thus, some repetition of information in different sections of the report, perhaps with a difference in emphasis or detail, is often necessary. As in all professional writing, clarity and precision in both language and calculations are essential in a laboratory report. Figures, charts, tables, and graphs should be used whenever they would be helpful. This guide describes a report structure that satisfies these varied requirements.

## Structure of Physics Reports

Laboratory reports may be classified according to whether they are complete reports on a project, short reports on one or more tests, or short reports on one or more techniques. The structure of laboratory reports has evolved to serve the needs of the varied readership described in the previous section.

The laboratory report should always be written for the convenience of the reader. Thus, for example, each section of the report should be headlined and the sections should be arranged in an appropriate, easily-understood sequence. In the context of the course for which it is written, the laboratory report serves to describe what you did during the laboratory session, how you manipulated the raw data, and what you conclude as a result. While it may seem logical to you to write a report in a chronological or historical sequence, such an approach is not the most useful for your readers, who would find such a report difficult to scan for the items of interest. Think of the document as a performance document, i.e., *proof* that you understand what you did and that you can apply it in practical situations.

By the time you graduate from IIT, you are expected to understand the format for a full report as well as some of the variations that are appropriate in different contexts. The reports described above typically contain many different sections. The sections required to complete your Physics lab reports should be written *in the order* listed below:

1. Title Page
2. Statement of Objective
3. Theory
4. Description of Experimental Setup/List of Equipment Used
5. Procedure
6. Data
7. Analysis of Data
8. Discussion of Results
9. Conclusions
10. References
11. Appendix

The content of each of the sections in a laboratory report is described in the following pages. Most of the descriptions are general enough to be valid for all reports. A few are related to the fact that these reports are being prepared for a laboratory course at IIT.

**1. Title page**

The following information should appear on the title page:

- A brief but informative title that describes the report
- Your name
- Date(s) the experiment was performed
- Date the report was due
- Names of other group members *who were present for the experiments*
- Laboratory section number
- Name of the Teaching Assistant

**2. Statement of Objective**

State the objective(s) of the experiment concisely, in paragraph form. The laboratory manual or instruction sheet will help here. The fact that experiments in laboratory courses are being used to educate students is a secondary objective, and should not be stated in the report. In other words, the objective written in your report should never be to "familiarize students with the use of equipment." Rather, the objective should state the problem that your procedure and data attempts to answer. Some key verbs that you will use in the objective might include "to investigate," "to plot," "to measure," or "to compare." The section should inform the reader precisely why the project was undertaken.

**3. Theory**

A concise description of the relevant theory should be provided when the theory is needed to understand other parts of the report, such as the data analysis or discussion sections. This section is sometimes combined with the introduction and background section, if this results in a more readable report. The relevant equations should be introduced and all the terms to be used in the report should be defined. Equations must be presented as parts of complete sentences. You will find examples of this later in this guide.

**4. Description of Experimental Setup / List of Equipment Used**

Provide a neat, correct and clear schematic drawing of the experimental set-up, showing all the interconnections and interrelationships. Include a *short* textual description that refers to all parts of the schematic drawing. This section should have all the information needed for a reader to duplicate the setup independently.

List all the equipment and materials used in the experiment. Include identifying marks (usually serial numbers) of all equipment. This is a safeguard that allows you to trace

faulty equipment at a later date, if necessary. The reader must be able to connect each item in this section to the item in the Description of Experimental Setup section.

**5. Procedure**

Detail the procedure used to carry out the experiment step-by-step. Sufficient information should be provided to allow the reader to repeat the experiment in an identical manner. Special procedures used to ensure specific experimental conditions, or to maintain a desired accuracy in the information obtained should be described. As with all sections of the report, the procedure describes what *was* done in the lab and should, therefore, be written in the *past tense.* Copying the procedure from a lab manual would be an inaccurate reflection of the work completed in the lab and is not acceptable.

**6. Data**

All the pertinent raw data obtained during the experiment are presented in this section. This section should contain only raw information, not results from manipulation of data. If the latter need to be included in the same table as the raw data in the interests of space or presentation style, the raw data should be identified clearly as such.

The type of data will vary according to the individual experiment and can include numbers, sketches, images, photographs, etc. All numerical data should be tabulated carefully. Each table, figure and graph in the report must have a caption or label and a number that is referenced in the written text. Variables tabulated or plotted should be clearly identified by a symbol or name. Units, if any, should always be clearly noted.

**7. Analysis of Data**

This section describes in textual form how the formulaic manipulation of the data was carried out and gives the equations and procedures used. If more than one equation is used, all equations must carry sequential identifying numbers that can be referenced elsewhere in the text. The final results of the data analysis are reported in this section, using figures, graphs, tables or other convenient forms. The end result of the data analysis should be information, usually in the form of tables, charts, graphs or other figures that can be used to discuss the outcome of the experiment or project. This section must include statements about the accuracy of the data, supported where necessary by an error analysis. Sample calculations, details of calculations, and error analyses should also be included.

**8. Discussion of Results**

This section is devoted to your interpretation of the outcome of the experiment or project. The information from the data analysis is examined and explained. You should describe, analyze and explain (not just restate) all your results. This section should answer the question “What do the data tell me?” Describe any logical projections from the outcome, for instance, the need to repeat the experiments or to measure certain variables differently. Assess the quality and accuracy of your procedure. Compare your results with expected behavior, if such a comparison is useful or necessary, and explain any unexpected behavior.

**9. Conclusions**

*Base all conclusions on your actual results*. Explain the meaning of the experiment and the implications of your results. Examine the outcome in the light of the stated objectives. This section should answer the question "So what?" Seek to make conclusions in a broader context in the light of the results.

**10. References**

Using standard bibliographic format, cite all the published sources you consulted during the conduct of the experiment and the preparation of your laboratory report. List the author(s), title of paper or book, name of journal, or publisher as appropriate, page number(s) if appropriate and the date. If a source is included in the list of references, it must also be referred to at the appropriate place(s) in the report.

**11. Appendix**

Details of analysis, computations, etc. that were referenced in the main body of the report should be included in the appendix. If the appendix contains more than one item, each one is designated by a specific letter (Appendix A, Appendix B, etc.) and listed in the table of contents.

## Professionalism: Formatting and Language

As with all other modes of communication, laboratory reports are most effective if the language and style are selected to suit the background of the principal readers. Reports are judged not only on technical content, but on clarity, ease of understanding, word usage, and grammatical correctness. Following are several trouble spots for report writers.

**1. Tables, Graphs and Equations**

All tables, graphs and equations should be introduced by a sentence of explanation. They should also have an explanatory label. The labels should be executed using the same formatting and numbered sequentially throughout the report. Units and variables must always be identified (see sample lab report).

Don't expect figures or equations to serve where sentences and paragraphs are needed. Visual and verbal descriptions must always go together. There are two reasons for this coupling: first, it assures that the information contained in the report is clear; second, it allows the author of the report to take credit for interpreting the significance of the data. **Good reports will demonstrate to readers that the author is more than just a technician plugging numbers.**

**2. Verb Tense**

Reports should be written in the past tense in an impersonal style.

NO: The TA set up the equipment before we began the experiment.

YES: The equipment was set up before the experiment was begun.

NO: We calculated distance using the data from table 2.

YES: Distance was calculated using the data from table 2.

**3. Objective**

The "objective" of the lab is RARELY, IF EVER, to learn how to use a piece of equipment (the exception is the oscilloscope experiment for Physics 221). Use action verbs such as "investigate", "determine", "measure", or "plot" in stating your objective.

**4. Equations**

Equations should be embedded in the text of report and formatted using the "Equation Editor" tool on your word processor, as in the following example:

Using the results listed in Table 1, a percentage difference was calculated for each set of readings taken by the two different instruments (the CMM and Vernier Calipers). Equation 1 was used to calculate this percentage difference. It can be written as:

$$E = \left[ \frac{m_1 - m_2}{\Delta m} \right] \times 100\% \qquad \textbf{Equation 1}$$

where:
$E$ is the percentage difference;
$m_1$ is the measurement by CMM;
$m_2$ is the measurement by Vernier Calipers
and $\Delta m$ is the difference of the two instruments.

It is extremely important to define all variables used, although it is necessary to define a variable only one time in the report (i.e., if $m_1$ is defined in **Equation 1**, it is not necessary to define it again in **Equation 2**). The equations should be numbered sequentially throughout the report.

**5. Section Headings**

Use separate headings for each section. The headings should be in bold type. The format used for the headings should be consistent throughout the report. Allow space between sections.

**6. Language**

As you edit your report, delete unnecessary words, rewrite unclear phrases and clean up grammatical errors.

**7. Note on Plagiarism**

Experiments are usually carried out by groups of students. It is therefore expected that each member of a group has followed an identical procedure in the laboratory and has the same set of data. Members of a group are also encouraged to discuss the analysis of data with one another. **However, preparation of the report and the discussion and interpretation of the results contained therein must be the sole effort of the individual student submitting the report. IIT's policy on plagiarism will be strictly enforced in all laboratory courses.**

## Checklist

The checklist is designed to assist you to write a complete, professional-quality report. It will help you to ensure that all essential information is included in the appropriate place, and that the report has been prepared in the proper format. Careful use of the checklist will result in better grades. **You must submit a completed, signed checklist with each report**.

The graders will pay special attention to the checklist. The following rules will apply:

- A report submitted without a checklist attached at the front will not be graded, and *no credit will be given for that report*.
- If an item on the list is not checked, this will indicate to the grader that it has not been addressed in the report, and *the appropriate number of points will be deducted*.
- If an item has been checked, but has been covered only partially, or incorrectly, in the report, partial credit will be given with an explanation of the omission or error.
- If an item has been checked but it has not been addressed in the report, *grading will be discontinued, and no credit will be given for the report, on grounds of unethical behavior.*

## Getting Help at The ARC (Academic Resource Center)

Assistance is available at The ARC (The Academic Resource Center, in the basement of Galvin Library) for students who would like to improve their writing. By working there

with College Writing Program tutors, students can improve their grades in lab courses. You can also get writing help online by sending email to writer@charlie.cns.iit.edu.

Checklists, a guide to Equation Editor, grammar references, and other help for writing lab reports can be found on the Writing Program's web page: www.iit.edu/~writer.

A sample laboratory report for each course will be available with the TA or at The ARC. Students are encouraged to examine the sample report carefully before starting on their own reports. Please note that these sample reports are provided on a read-only basis, and should not be removed from the office of the TA or the College Writing Program.