

**University of Puerto Rico at Mayagüez
Department of Electrical and Computer Engineering**



Writing Formal Reports:

**An Approach for Engineering Students
in 21st Century**

Third Edition

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Writing Formal Reports

Third Edition

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Printing History:

Writing Formal Reports
Copyright © 1992, by Nayda G. Santiago
Electrical and Computer Engineering Department
University of Puerto Rico at Mayagüez

Writing Formal Reports: A Laboratory Approach, Second Edition
Copyright © 1992, 1995, by Manuel A. Jiménez and Nayda G. Santiago
Department of Electrical Engineering
Michigan State University

Writing Formal Reports: An Approach for Engineering Students in the 21st Century, Third Edition
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Electrical and Computer Engineering Department
University of Puerto Rico at Mayagüez

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Preamble

This document attempts to bring to young audiences the authors' experiences in writing and evaluating formal, technical reports. Rather than establishing a set of hard rules for technical writing, our purpose is to provide to early writers in the academic environment, especially in engineering fields, a handful of easy to follow ideas that might result useful when it comes to formally presenting the results of their work.

In this new edition, we have included suggestions and ideas on how to describe design constraints considerations, teamwork efforts, and multidisciplinary issues in a practical way. Also included are highlights for dealing with web-based material and the usage of contemporary editing tools.

*Nayda G. Santiago
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Credits

Cover design and picture by M. Jiménez

Selected topics in this document were adapted from the following sources:

1. Blicq, Ron S., Writing Reports to Get Results: Guideline for the Computer Age, IEEE Press, 1987.
2. Lloréns, Baldomero, Class notes ELEG 4165, Univ. of Puerto Rico at Mayagüez, 1991.
3. Michaelson, Herbert B., How to Write & Publish Engineering Papers and Reports, 3rd Edition, Oryx Press, 1990.
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1 Introduction to Formal Reports

A formal report must be written keeping in mind that it is an important document. Its information must be appropriately placed, distributed, and spaced with the purpose of creating an impression of confidence from beginning to end.

1.1 Report Components

The six main components of a formal report include:

- Abstract
- Introduction
- Discussion
- Conclusion
- Future Work
- Appendix

The following diagram summarizes the contents of each part of the report:

Main Message	Abstract	A summary of the purpose, main results and findings
Background	Introduction	Previous knowledge of the situation, purpose and scope of the project
	Theory	Short development of the technical content of the report
Facts and Events	Discussion	Detailed description of the project, including approach, presentation and analysis of results
Results	Conclusion	Summary of main results and findings
	Future Work	What action must be taken, if any
Support	Appendix	Detailed data: Evidence to support the discussion

1.2 Additional Parts

Additional parts provide completeness to the report. The list below outlines the most commonly included parts in a report. Essential parts for completeness are in **boldface**, and the numbers on the left suggest numbered sections.

Front Cover

Title Page

Abstract

Table of Contents

List of Figures (if necessary)

List of Tables (if necessary)

- 1. Introduction**
 - 2. Theory**
 - 3. Discussion**
 - 4. Conclusion**
 5. Future Work (when necessary)
 - 6. References**
- Appendix**
Back Cover

2 Structure of Report Components

Descriptions of the different parts of a report are included in more detail in the following sections.

2.1 The Title Page

This is the first page that must appear in any technical document. The title page contains four main elements:

1. Complete title of the report. It must be informative without being too extensive.
2. Name of the organization and, in some cases, name of the person for whom the report has been prepared.
3. The name of the organization and persons that prepared the project.
4. The date when the report was written, and, sometimes, a report number.

A title page must have aesthetics yet be simple and dignified. Every line is suggested to be centered. Remember to leave a larger margin at the left of the page. This side of

the page is usually covered by a binder or punched for multiple-ring binders. Figure 1 shows a sample layout for the margins in a typical report page.

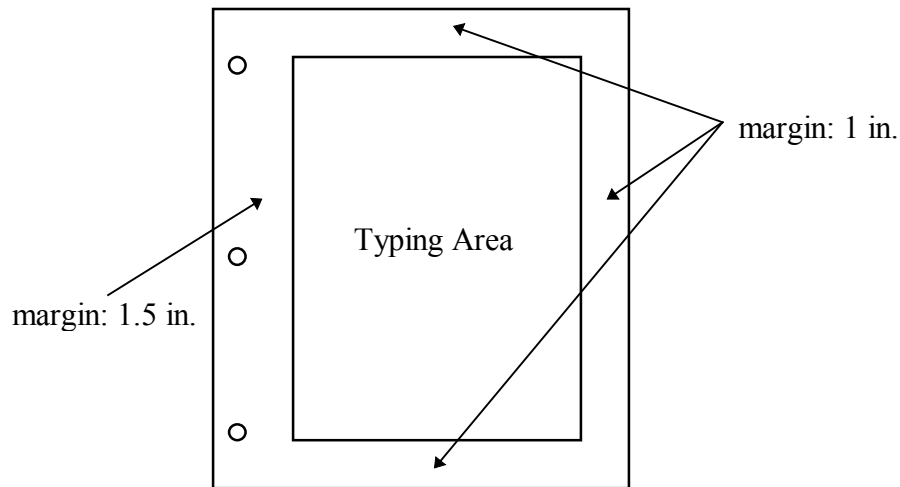


Figure 1: Layout of a typical report page.

An illustrative example of a cover page is provided in Figure 2. Notice the organization of the provided information and its contents.

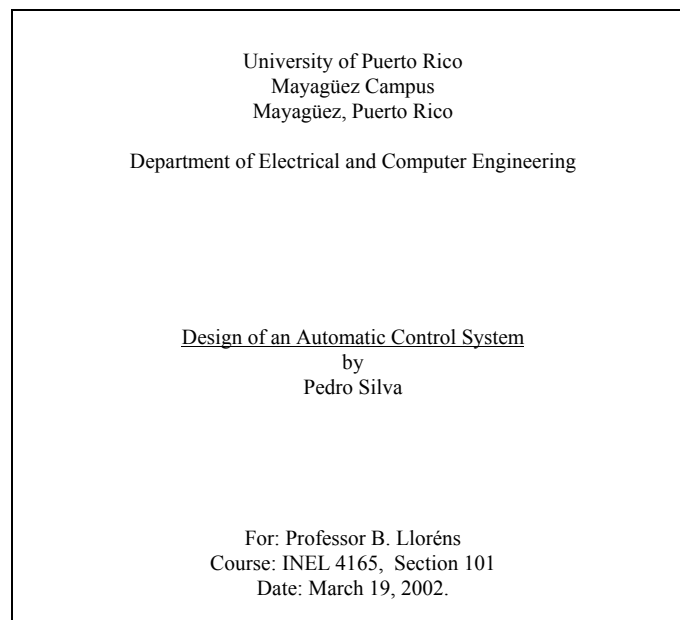


Figure 2: Illustrative cover page

2.2 The Abstract

For an engineer, the abstract of a report serves two basic purposes: (1) For the reader, the abstract reveals the main findings and the importance of the report; (2) For the author, preparing the abstract requires briefly stating the central idea in unmistakable terms.

In the formal report, the abstract is placed immediately after the title page but before the table of contents. The abstract always has a page for itself and it is vertically centered on the page. The abstract page begins with the title "Abstract" and is usually written in passive voice.

Despite its length, the abstract is the most important part of a report since it is the first information that the reader receives. It should motivate the reader to continue reading your report. If the abstract does not do that, it has failed in its purpose. In addition, the abstract should let the reader know whether the information that he or she is looking for is contained in the report or not. If the abstract fails to enlighten the reader about the contents of the report, it will most likely not be read.

2.2.1 Types of Abstracts

There are three main *types of abstracts*:

1. Indicative or Descriptive: This type of abstract establishes the main subject of the document. To achieve this, it uses qualitative descriptions. A simple vocabulary is recommended so that the contents of the report can be easily understood.
2. Informative: An informative abstract points out the discoveries and results in a short and quantitative way. It is a condensed version of the engineering work without discussion or interpretation. Sentences are made with technical terms, intended to be understood by experts in the subject.
3. Informative-Indicative: This last type of abstract combines the two previous styles. It provides both specific information about the findings and results, and general information and explanations about the rest of the document.

The kind of abstract to write depends on the subject of the project and the audience for whom of the report was written.

An *Informative*, or *Informative-Indicative* abstract, typically has the following parts:

1. *A main sentence* where the problem is established.
2. *An explanation of the approach taken in solving the problem.* The approach could be an analytical method, a design technique, a trial diagram, etc. Note

that although you might reference a diagram, an abstract should never contain such.

3. *The main result of the project.* This includes theoretical and experimental results such as: the new improved characteristics of the system; the recommended course of action to be taken; etc.

2.2.2 Dos and Don'ts About Abstracts

The following guidelines provide useful hints in writing effective abstracts:

1. Write the abstract after everything else in the report has been written.
2. The information to write the abstract should be obtained from:
 - The introduction (particularly from the *purpose* section of the introduction)
 - The discussion (pick out the most important highlights)
 - The conclusion and future work sections of the report (the outcome or result of the project)
3. Make the abstract as short, interesting, and informative as possible. A reasonable length of is approximately from 5% to 10% of the report. In general terms, an abstract of 50 to 100 words is good for a short article, while one with around 200 words is good for an extensive article. An abstract usually contains only one paragraph.
4. Keep in mind who will read the report in order to include the details of interest to him or her.
5. Do not use illustrations, tables, or references. Do not use information *not* contained in the report.
6. Do not include the following items in the abstract:
 - A literature revision with references to work previously done in the area (this should be in the *Introduction*)
 - A discussion of the importance of the report for the company (leave this for an *Executive Summary*)
 - An evaluation of a new technique or a discussion of the validity of the results (usually part of the *Conclusion*)

A few abstract examples taken from "How to Write and Publish Engineering Papers and Reports":

1. **Descriptive Abstract:**

"The successful design of cost-effective solar energy systems depends mainly on the development of higher conversion efficiencies. A theory is given for the thermal

performance of a new solar collector array that combines reflected and refracted light rays. The theory is applied to the design of a complete system for solar heating of a building. Dynamic operating characteristics for a one-month interval are given for the collector array and heat transfer devices, and cost efficiency is compared with that of conventional designs."

Notice its characteristics: Short, provides the key elements of information and serves as a miniature table of contents.

2. Informative Abstract:

"In the design of a solar energy system using arrays of multiple solar panels, the Hottel-Whillier-Bliss (HWB) model is generally used to evaluate steady-state efficiency. The HWB equation did not accurately predict dynamic thermal performance for the present system, which uses a novel collector array. The theoretical limit of energy gain for this new array is 6.5×10^6 BTU, which extends into the nonlinear mode of the HBW equation. A modified form of the equation was, therefore, developed for improved linearity, effective for collector efficiencies up to 54%. An optimum ratio of 64/36 was determined for the proportion of propylene glycol to water. Dynamic performance tests during the month of July 1980 in Phoenix, Arizona, yielded an average efficiency of 49% for a gross collector area of 721 m^2 when the array faced south at an angle of 35° from the horizontal. Losses between collector and storage tank were 3.8×10^8 J per month. The cost efficiency of the system was a 9% improvement over that of the SOLTHERM system operating in Phoenix during the same month."

Notice its characteristics: Specific and quantitative. It only provides essential data.

3. Informative-Descriptive Abstract:

"The successful design of cost-effective solar energy systems for heating buildings depends chiefly on high-efficiency conversion of light energy into heat. A theory is given for the thermal performance of a new solar collector array. The Hottel-Whillier-Bliss (HWB) model is modified for accurate prediction of the energy gain of the new solar array. This three-stage collector, using the principle of successive concentrations, was incorporated into the design of a complete solar energy system. An optimum ratio was determined for the proportion of propylene glycol to water for the fluid transferring energy from the array to storage tank. In dynamic tests during July 1980 in Phoenix, Arizona, the average efficiency was 49% for a gross collector area of 721 m^2 when the array faced south at 35° from the horizontal. Losses between collector and storage tank were 3.8×10^8 J per month. The cost efficiency compared favorably with that of the SOLTHERM system operating in the same area that month."

Notice its characteristics: It provides fewer details and emphasizes the contribution of the author.

2.3 The Table of Contents

The table of contents is included at the beginning of the report, mainly for the purpose of aiding the reader to find specific information. A secondary purpose of the table of contents is to let the reader visualize how the author has organized the information, and which topics have been covered.

Factors to take into account when writing a table of contents:

1. Each heading in the main topics of the report must be included on the table of contents.
2. The headings of topics must appear exactly as they are written in the report.
3. The headings or titles of report subtopics may be omitted from the table if including them makes the table too long or unclear.
4. All appendixes must be included, with the complete titles obtained from the first page of every appendix.
5. If diagrams or illustrations are included in a separate section of the report, the section must be included in the table of contents.

2.4 Other Lists of Contents

List of Figures (if necessary): The List of Figures, when included, is placed after the Table of Contents. Its purpose is to aid the reader to find the location of specific figures when their number is large in the report.

List of Tables (if necessary): In a similar way, when the number of tables in the document is large, a list of tables aids the reader to find specific tables in the report. When included, the list of tables is placed after the List of Figures.

2.5 The Introduction

The Introduction prepares the reader for the details that follow in the discussion. It presents the circumstances that led up to the project, the reasons for the project's existence, and why the report was written.

The Introduction has three main components:

1. The Background: Describes the events leading up to the existing situation, what projects (if any) have been made before (including different approaches), and why the project or study is necessary.
2. The Purpose: Defines what must be obtained out from the project or study, who authorized it, and the focus of the project.
3. The Scope: Points out the constraints imposed on the project by the persons who authorized it or did it, and/or by the conditions under which the project was completed. These constraints include economical, environmental, ethical, and social factors that generally affect the cost, completion time, depth of the study, and other factors that might or might not be included.

Other parts typically included in the introduction are:

- The Problem Statement: Describes the problem that has to be solved in such way that the reader appears as the person who is solving the problem. This

section may appear as an individual section of the report just before the Introduction, or as part of the introduction itself.

- The main contributions of other persons who worked previously in the problem.
- A Brief reference to the technical content that will be shown in the rest of the report.

How much information and orientation does the reader require? For readers with expertise in the area, too much information will be inappropriate. For less experienced readers, too little information will leave them ignorant on the subject. The author has to consider the audience when he or she is writing the introduction.

2.6 Theoretical Background

This section is where the theoretical background and the engineering design criteria necessary for the solving problem are presented. Considerations on economical, environmental, ethical, and/or social constraints should be addressed in this section as well as the project logistics and timing limitations. This section should also detail the analytical methods used to reach the results.

To support the purely technical or mathematical aspects of a project, it is not necessary to derive all used formulas. If a derivation can be found somewhere else, a reference to the source where it is located should be enough.

The theoretical background section is not the place to explain in detail how the results were obtained, but rather, to present the design methods in a general way. Details are saved for the results section of the report.

2.7 Discussion

This is the central section of your report, where the development of the project is described in detail. A few important points about this part of a report follow:

1. The word "discussion" should not be part of the title(s) or heading(s). This part of the report may physically have one or several sections, as required to fully describe how you arrived to the solution given to the problem being solved.
2. The discussion may begin immediately after the introduction, either on the same page or on the next. In the former case, the aspects addressed by the *Theoretical Background* should be distributed between introduction and the discussion. If the discussion begins on a new page, all succeeding sections should also begin on a new page.

The distribution and organization of the discussion section(s) is very important. Throughout this part, the logical organization and solution approach followed in solving

the problem should be evidenced. Otherwise, the reader might not follow the author's logical reasoning.

Issues arising from engineering decisions with impact on the sustainability, manufacturability, and/or safety of a solution are to be included as part of the discussion. If the impact of these decisions is so broad that they might have implications as far reaching as in healthy or political arenas, they should be discussed as well. Multidisciplinary collaboration is crucial for properly addressing these issues. Therefore, the observations and comments from experts in those areas become vital for properly reporting such implications.

The discussion usually ends with a presentation of the results obtained from applying the methodology or solution derived from your project, along with an analysis of their significance. This is the place where both, positive and negative aspects of a solution are presented and analyzed.

The guidelines in these last three paragraphs could make the difference between approval and rejection of the conclusions given by the author.

Three factors with particularly negative effects on readers include:

1. Writing which is beyond the reader's comprehension; that is, usage of technical terms and jargon that may not be understood by the target audience.
2. Writing without answering doubts and without satisfying the reader's curiosity; that is, does not anticipate their reactions to the facts, events, and concepts you present.
3. Writing in such a way that underestimates or overestimates the reader's knowledge; that is, assumes they know more (or less) about the topic than they really do.

2.7.1 About Figures and Tables

Illustrations such as drawings, plots, graphics, and photographs provide a very useful way to help the reader visualize complex topics. However, illustrations should be chosen and inserted in the document very carefully following these guidelines:

1. They must always serve a useful purpose.
2. They must supplement, not duplicate, what is written.
3. They must be referred to in the text.
4. They should be simple, clear, and easy to understand.
5. They must be together with a caption and, sometimes, with explaining comments. Figure captions usually begin with the word "Figure", followed by a sequential figure number used for reference and the caption itself. These captions are placed underneath the figure in the same page where the illustration is located.

6. Ideally, they should be smaller than a whole page, so that some text appears before or after them. Illustrations that take a whole page tend to disrupt the continuity of the report.
7. Large, wide, horizontal illustrations occupying a full page are always positioned so that they are read from the right. It is correct for the titles on these illustrations to appear sideways.

Tables, in general, follow the same guidelines as illustrations, with a few exceptions:

1. Table captions begin with the word “Table” instead of Figure, and are placed on top of the table. Tables have their own sequential numbering.
2. It is recommended to include multi-page tables as an appendix.
3. Before inserting a table of numbers in your report, consider if a plot of the same data could be more informative. In many cases, for numeric data, a plot could be much more informative than a table.

A final remark about web-downloaded and scanned tables and illustrations. It is violation to Copyright law and to ethical principles to use such material without the consent of the original author. References to the sources of such information must be included in your report even when permission for their usage is granted.

2.7.2 Reporting Comparisons

If a comparative analysis is being made, the alternatives should always appear in ascending or descending order considering how appropriate the alternatives are. This means that:

- In ascending order, the least likely choice appears first and the most likely choice (the alternative the report writer will recommend) appears last.
- In descending order, the best alternative is exposed first, and the least likely alternative is placed last.

2.8 The Conclusion

The conclusion provides a summary of the discussion's results. It is important to remember that, when writing the conclusion, there should never be surprises. That is, it should not present new information, implying that all that appears in the conclusion must have been discussed in previous sections. *To write new ideas in the conclusion section is one of the most common mistakes done in report writing.*

The conclusion section may be placed right after the discussion section or may begin on a new page. If the introduction section begins on a new page, the conclusion section should appear on a new page.

General guidelines for writing a conclusion include:

1. Be as short as possible, considering the most important points of the concluding paragraphs of the different portions of the discussion section.

2. Be presented in descending order of importance, that is, primary conclusion first, followed by subsidiary conclusions.
3. Never promote a certain action to be taken.
4. Satisfy requirements established in the Introduction section.
5. If there are many secondary conclusions, they should be presented in enumerated subparagraphs.

2.9 The Future Work

The future work section usually becomes necessary when reporting a project that has not been completed yet, or if extensions on the same subject are possible, increasing the scope of the work. In this section, the writer should clearly establish the actions to be taken in order to complete or expand the reported work. The recommended actions should present realistic goals. The reader should not be led to establish goals that are impossible to meet.

This section may follow the conclusion, either immediately on the same page or on the next page. If the conclusion begins on a new page, then the Future Work section should appear on a new page.

2.10 The References

The references section contains a list of the documents that the author used while conducting the project. Each reference describes the source of a specific piece of information, and must provide enough information to allow the reader to access the document if he or she wants to refer to it.

The references are enumerated and appear in the same sequence as the information provided in the report.

References Example: (Paragraph taken from S. M. Sait, "Integrating UAHPL-DA Systems with VLSI Design Tools to Support VLSI DA Courses", *IEEE Transactions on Education*, vol. 35, no. 4, Nov. 1992, pp. 321-330. Additional sample entries added for illustration.)

Integration of various hardware design tools into a complete design automation system enables designers to gracefully interact DA systems can smooth on and speed up the flow of digital system design from specification to manufacture. It also provides an excellent teaching environment for DA of VLSI, a discipline that has been introduced in the undergraduate/graduate curricula of several universities [1], [2].

The UAHPL-DA system uses a high-level computer hardware description language (CHDL) called UAHPL to model the complex digital system to be implemented [3]. A multistage, multiplication compiler which supports a wide spectrum of design and test activities has been implemented for UAHPL [4]. The design described by the...

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Note the suggested styles used to refer to entries in: journals [1], conference proceedings [2], magazines, manuals [4], theses and dissertations [5], books [6], [7], and web pages [8]. Although web references have become commonplace, caution should be exercised in its usage due to the volatility of on-line material. Whenever possible, at least until more permanent on-line sources become available, references to printed material are preferred over those to on-line material.

2.11 The Appendix

Appendixes contain complex analyses, statistical information, manufacturer data, tabulated data, calculations, specifications, large drawings, photographs, detailed results on experimentation, cost comparisons and specifications, and in summary, any information that could interrupt the continuity of the report's lecture if placed somewhere else in the report. Sometimes, the appendixes section has more pages than the rest of the report.

Several guidelines apply to the preparation of the appendixes section of the report:

1. Appendixes must appear always in the order in which they are referred to in the document for the first time, and of course, there must be a reference for every appendix.
2. Appendixes can be considered individual documents, and as such the pages of each one could be enumerated independently beginning with "1". This however is a seldom-used rule and in most cases, the page numbering is done sequentially along with the main document.
3. An identifying letter is to be assigned to every appendix: "Appendix A", "Appendix B", etc.

Because the appendix can be considered a separate document, sometimes the appendix has its own references. References could be enumerated at the end of the document or treated as footnotes.

3 Suggestions for Report Writing

Although there is no universal methodology for the writing of a formal report, there are several hints that come handy when writing one. These include:

- *Begin writing when you have something to write.* You will usually become ready to begin writing when a great part of the design and required results are obtained.
- *Make an outline.* To begin, make an outline of the preliminary content of the research or project. This will help you organize your ideas and will be useful as a preliminary table of contents.
- *Organize your references.* Write a list of references before beginning to write; this will allow you to cite them while writing the report.
- *The golden rule of order.* Begin by writing the theoretical background section, then the discussion and results and finally the introduction, the conclusions, and the future work section. Leave the abstract for last. The introduction and the abstract are to be written after the rest of the report has been completed because the introduction must provide some information on how you arrived at the results, and the abstract includes some aspects of the results and the conclusions.
- *Coordinate team effort.* When reporting the work made by a team of collaborators (multi-authored reports), always have one person, typically the group leader, coordinating each member responsibility and overseeing the overall report structure. Even when different people write different sections, this division of chores must be transparent to the reader. The report must be perceived as a single entity. It is generally recommended having only one person writing the conclusion, introduction, and abstract of the report.
- *Number all pages.* Remember to enumerate all pages and refer to every section in the table of contents. Although this might seem an insignificant detail, not doing so will render useless the table of contents, making difficult to navigate through the report.