# GUIDELINES AND STANDARDS FOR WRITING ASSIGNMENTS

## DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

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# PREFACE

This document was prepared by the members of the Communications Committee of the Electrical and Computer Engineering Department during the 1993/94 academic year. A few modifications were made in 1994/95 academic year to accommodate the needs of Foundation Coalition Team. A few additions to support teamwork and meetings were made in the 2000/01 academic year. The intention of this document is to assist Electrical and Computer Engineering students in developing skills consistent with industry standards for capturing and documenting information while performing experiments in the laboratory, preparing laboratory reports, project reports, and working out homework problems.

Written reports are vehicles for communicating, and the clarity of your written report is as important as the technical content and accuracy of your results. In laboratory courses, you will be required to perform experiments, maintain a lab notebook, and write detailed reports. In addition to performing the experiments accurately, you should also concentrate on collecting the necessary data. The data should be collected in a manner that you will be able to use when preparing a detailed report at a later time.

The purpose of homework assignments is to give you the necessary practice in each course topic. Your homework assignment performance is a good indication of your comprehension of the lecture material. Therefore, you can use your homework grade as a measure of your daily or weekly progress. Reviewing homework assignments is one excellent way to prepare for exams. Consequently, performing the homework assignments in a logical, orderly, and neat way will assist you in preparing for exams.

The faculty of Electrical and Computer Engineering Department are in agreement with the standards presented in this document. They will enforce the standards for accepting and grading your laboratory work and homework assignments.

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# 1. OVERVIEW OF TECHNICAL REPORTS

Success in the engineering profession will require excellent written and oral communication skills as well as technical competence.

To write good technical reports, you need to gain a working knowledge of the subject matter you are exposed to in each course, and a familiarity with the general terminology of the engineering profession. You must develop a style that is clear, objective, easily read, and understandable.

Most of your professional work will be presented in writing. Writing can be learned in the same way science and engineering can be learned. You must learn about report types, variations in format, standards for abbreviations, the use of tables and figures, and the backgrounds and expectations of the individuals who will read your technical reports.

Writers often fail to sufficiently limit their topic. Technical writing concentrates on a specific topic. While you are outlining the topic and subtopics for your report, you should also pay attention to topic limitation. You will find it easier to write a coherent report, if you define your purpose and audience clearly and properly.

## 1.1 The Substance of Technical Reports

Technical reports are vehicles for informing and communicating to accomplish specific tasks. Organizations produce technical reports for both internal and external use. Professors write reports and books for colleagues and students. Students write about what they have done and learned in the laboratory.

Technical reports have the following characteristics:

- The writing is an objective approach to the subject.
- The purpose is spelled out in the first few paragraphs.
- The vocabulary is specialized.
- Sentences are highly specific and factual.
- Numbers and dimensions are frequent.
- Signs, symbols, and formulas are often used.
- Figures and tables are used extensively to supplement the narrative.

Accurate audience analysis is critical: you must know your audience and your objectives. You need to adapt your style and material to both.

## 1.2 Attributes and Qualities of Good Reports

To write clear and effective reports, you should build upon the natural talents you have in communicating ideas to others. Qualities of good reports vary, depending on the audience and the objective.

A good report has the following qualities:

- o Makes a good impression.
- o Can be read selectively.
- o Reads coherently from beginning to end.
- o Anticipates readers' questions.
- o Conveys an overall impression of authority, thoroughness, and honesty.
- o Is accurate: free from typographical errors, grammatical slips, and misspelled words.
- o Has a table of contents and substantive headings.
- o Has the necessary front matter (summary and introduction) to characterize the report and disclose its purpose and scope.
- o Has a body that provides essential information logically, defines terms, and spells out acronyms.
- o Explains criteria used to evaluate evidence.
- o Presents conclusions and recommendations arranged in descending order of importance.

# 2. COMPOSING TECHNICAL REPORTS

The purpose of this section is to show you how writing techniques can be used as tools to help you fulfill your various writing purposes. Composition is an important element of all technical reports.

## 2.1 Composition

Composition of a technical report may be divided into three parts.

**Prewriting**
The first part is *prewriting*. During prewriting you think about your audience, your topic, and your purpose. You develop the material you need to satisfy your purpose and your audience. In this stage, you rough out a plan and a preliminary outline.

**Writing and Revising**
The second part of composition is *writing and revising*. In this stage, you write the report. Start by writing a rough draft. Use your developed plan (outline) to write your technical report. Revising is truly rewriting and sometimes even rearranging the rough draft. In this stage, you should be concerned about arrangement, content, and logic.

Try to put yourself in your reader's place. Make sure that your report is arranged in a logical fashion; be sure that you have been specific enough. Make sure your information is accurate. Do not rely on memory for facts and figures of which you are not completely sure. Be rigorous in your logic (Can you demonstrate that A caused B?). Make sure that you have taken into account all contributing factors to draw the conclusions.

**Editing**
The third part of the writing process is *editing*. Editing is the final step before releasing your report. We all know that good writing is good editing. Despite the constant pressure all authors are under to crank out their documentation, they must take time to edit it carefully for clarity and accuracy. Authors must never lose sight of their report purpose and their intended audience.

You need to edit your work to satisfy the requirements of standard English, and to meet the requirements of a good format. You need to begin by checking mechanics such as spelling and subject-verb agreement. When you are satisfied with your mechanics, check your documentation. Be sure that all notes and

numbers match. Make sure that the headings and page numbers match those in the table of contents.

**Proofreading**
Meticulous *proofreading* is the final critical element to good editing. All too frequently, excellent science and engineering work has been disregarded because it was carelessly presented. Readers assumed that if the author could be this careless in a report, the author's engineering work would probably be equally unsatisfactory. **Of course they were right**; documentation is an essential professional activity.

By the time you have worked on a report for more than a few hours, you are ready to quit and hand it in to anyone who will take it. But it is precisely at this point you must set the report aside for a while and get some distance from it.

You must return to the report with a critical eye, and treat the report as if it had been written by your worst enemy. You **will** find every single oversight and stab it with a red pen; you **will** prove that the author should have been much more careful. This kind of vicious detachment forces you to see what is really on the page, not what you want to be on the page.

Remember, spell checkers find only misspelled words. They do not find wrong words, such as *"do to"* for *"due to"*, or *"there"* when you meant *"their"*. And spell checkers will never remember that inadequate phrases such as *"at this point in time"* and *"at that point in time"* actually mean *"now"* and *"then"*. Similarly, *"due to the fact that"* is always *"because"*. As much as you hate to surrender such pleasant padding, you must reduce the text to an efficient narrative.

You must read critically and carefully at exactly the point in your frustration when you want least to spend another minute looking at the (by this time) **hated report**. Discipline in report writing and editing, as in all things, is essential to success.

Remember each piece of writing must be designed to serve a particular audience. To be a good writer you must know your audience. Then you can provide your audience with the information it needs in a language your readers can understand.

## 2.2 Defining, Describing, and Informing

As a technical report writer, you often need to *define*, *describe*, or *inform*.

**Defining**
You should *define* any term that is not in the reader's vocabulary. For instance, if your reader is not an engineer, then the reader might not know what an ohmmeter is. So, you need to define an ohmmeter as an indicating instrument that directly measures the resistance of an electrical circuit.

**Describing**
As a technical report writer you also need to *describe* mechanisms and procedures. The purpose is to make the reader aware of the mechanism or the process. Most people need the necessary information to understand a new process or a mechanism. There are specific techniques for describing processes and mechanisms.

**Informing**
The *informing* can be done in a chronological or topical arrangement. When you have reason to relate a series of events for your reader, arranging the events chronologically might be a natural way to proceed. Because the arrangement of your material follows the chronology of the events you relate, arrangement is not a problem. However, choosing the level of detail you need may be a problem. If your purpose is to give a broad overview, then you need to limit the amount of detail.

## 2.3 Arguing

When you are exercising your judgment and expressing an opinion, you will need to employ the tools and techniques of argument. Your purpose in argument is to convince your audience that the opinions you are expressing are valid and correct. This skill will be very helpful when you write the conclusions and recommendations section.

You must present your argument in a persuasive way. The use of *induction*, *deduction*, and *comparison* are necessary in arguing. Although verifiable facts may be unarguable, you still need to present criteria to show why you selected these facts, and why they are relevant.

***Inductive*** reasoning moves from particular facts to generalizations. You usually begin the inductive process by looking at a set of facts, making a guess

(hypothesis) to explain the facts, and then investigating to see if the hypothesis fits the facts.

***Deductive*** reasoning is another way to deal with evidence. In deductive reasoning you move from the general to the particular. You start with some general principle, compare it to several facts, and draw a conclusions regarding those facts.

# 3. FORMAT OF TECHNICAL REPORTS

This section of the document describes the standards pertaining to the format of all written reports, excluding memoranda. The appropriate standards for the below items are discussed in the following subsections.

- Title page.
- Table of contents.
- Paper size, margins, and page orientation.
- Section and subsection headings.
- Characters and paragraphs.
- Figures.
- Tables.
- Formulas and equations.
- References (if appropriate).
- Appendices (if appropriate).

## 3.1 Title Page

The title page should contain the following items in the same order as they are listed. You should center each item on a single line.

- Name of the institution.
- Name of the department.
- Experiment or report title.
- Course title and section number.
- Reporting individual's name.
- Team members' names.
- Group or bench number.
- Submission date.

## 3.2 Table of Contents

The table of contents should start on a new page (before the body of the report). The heading for this page should be *Table of Contents***,** and it should be centered. The actual table of contents consists of two columns. The first (left) column heading should be *Section*, while the second (right) column heading should be *Page*.

The Section column will contain a list of the major sections and subsections of the report. The page column indicates the page number associated with the relevant sections and subsections. The table of contents of this document can be used as an example.

## 3.3 Paper Size, Margins, and Page Orientation

The standard paper size for all laboratory reports and homework assignments is 8.5"×11".

You should have 1.25" *left* and *right* margins, and 1-inch *top* and *bottom* margins. With the exception of the title page and the table of contents, each page should have a page number centered at the bottom of the page. You may select the full justification feature of your word processor for all written reports.

The standard page orientation is *portrait* (vertical). However, if a page is used completely for a figure, then you can use *landscape* (horizontal) page orientation. In this case, the right margin will become the bottom and would carry the caption.

## 3.4 Section and Subsection Headings

Headings are used to display your report's arrangement to the readers, allowing them to read the report selectively. The heading itself is a phrase that describes what is discussed in the paragraphs that follow. Therefore, each section of your report should have a section number and a substantive heading. You can divide each section into as many subsections as you wish.

The section number and heading should be typed entirely in bold capital letters. The subsection should be numbered and the first character of each word should be a capital letter. The subsection headings should also be typed in bold. Use this document as a guideline.

## 3.5 Characters and Paragraphs

Characters are the letters, punctuation marks, numbers, symbols that you type as the text. Character formatting determines how characters appear on a page. It is recommended that you use a standard font of approximately 12 point size. You can use bold, italic or underlined words to highlight the key words in your text.

Do not indent the first line; use a blank line to separate the paragraphs. A paragraph is a series of sentences. Just as you control the appearance of the individual characters, you should control the appearance of a paragraph. You need to use 1.5 line spacing for all of your written reports; 3 lines between paragraphs (2×1.5).

## 3.6 Tables

A table is any arrangement of data setup in vertical columns and horizontal rows. You need to consider the following when you decide to include a table in your report.

- Tables should be simple, clear, and logical.
- Tables should be referenced in text *before* they appear.
- Tables should be numbered consecutively within a *section* of the report.

The first line of a table is the caption which is the word "Table" followed by a number and a period. Then you should include the table title on the same line. The table, and the table number and title should be centered on a page.

After the table number and the table title, you can proceed with the actual table, which will consist of several columns and subcolumns. Every column and subcolumn must have a heading that clearly identifies the data. If the heading has a dimension or unit, then you need to specify it inside parentheses. An example is shown in Appendix A.

## 3.7 Figures

The figures in your report will include schematic diagrams, drawings, graphs, and photographs.

In constructing the figure, you should consider the following:

- o Keeping the figures simple and clear.
- o Labeling and dimensioning the axes.
- o Centering the figure, figure number, and caption.
- o Referencing figures in the text *before* they appear.
- o Numbering your figures consecutively within a *section* of the report.

The figure number and caption should be placed below the figure. This is the opposite of the table number and title which is placed above the table. An example is shown in Appendix A.

## 3.8 Formulas and Equations

Standard symbols should be used for presentation of the formulas and equations. A spelled word *is not* a satisfactory replacement for a symbol. All formulas and equations should be centered. Equations should be numbered within each *section*, independent of the other graphics.

Formulas and equations should be explained in English, and all factors (symbols) defined. For example:

$$V = RI \tag{3.1}$$

where,

V: Voltage (V)
R: Resistance (Ω)
I: Current (A).

## 3.9 References

You can refer to a book or article by a number inside brackets. The numbers should be arranged in a sequential manner *throughout* the report. Remember that

references are important to the reader. Therefore, each citation must be complete and correct.

The reference section of the report should contain a list of the material to which you have referred. References should be the commonly available publications. Unpublished work or reports of limited circulation should not be referenced. However, it may be necessary to append copies of not readily available articles in one or more appendices.

A reference should consist of the following information, in the same order presented:

- Authors' names separated by commas.
- Report or article title in quotations, book titles underlined.
- Publication's name and volume number, or the book publisher.
- Date.
- Page numbers.

## 3.10 Appendices

Appendices are important parts of your technical report. Many readers want to extract the heart of the report in a very short time. Therefore, many technical reports are limited to 10-20 pages. Consequently, much useful information is transferred into the appendices.

Select appendix information that is relevant, and has been referred in the *text* of the report. Typically the following information are included in the appendices:

- Extended analyses.
- Case histories and variations.
- Intermediate mathematical steps.
- Printout of computer programs and runs.
- Computer diskettes, or CDs.

# 4. INTEGRATION

Integration in this context means pulling together all of the elements of a report to present a coherent document to your readers. The principal elements will be text, graphics, equations and formulas.

The purpose of a professional report is to educate and inform potential readers **in order to get something done**. Scientific reports often require that authors include graphical and tabular information as well as text. The following brief discussion will offer some hints regarding the most effective way to integrate the elements of a technical report.

Good writing is good editing, and you should not discount the importance of the editing work.

## 4.1 Writing from General to Particular

Science is usually conducted inductively: from particular to general. However, science writing is *deductive*: from general to particular. Authors must state their conclusions first, then show how those conclusions were reached and what criteria were used to evaluate the evidence presented.

This deductive writing technique is often difficult even for experienced engineers and scientists, because they want to present their material in the order they discovered it (inductively) and *save all the good stuff* until the end (this is the wrong way to write a technical report).

Unfortunately, most readers have neither the *time* nor *patience* to wade through an entire report. They want the conclusions stated clearly and succinctly ***up front***, preferably on the first page of the document. The best way to achieve this is to write a summary of the report, **after** the report is finished. Present it up front as the first section of the report.

## 4.2 Graphics

For this discussion, graphics will include figures, tables, pictures, sketches, formulas and equations.
Graphics should be stand alone elements. In other words, the graphic can be lifted out of the report, pasted on the wall, and be understood without the benefit of any additional text.

In order for graphics to be self-contained, they must carry clear captions, clear labels for axes, and even legends to explain every line or bar on the graphic.

## 4.3 Substantive Headings

Headings are considered *cues* for the reader. Properly written, substantive headings will tell a story: a reader should be able to scan the headings and understand in brief what the report is about.

All headings must be substantive. That is, instead of saying merely **Resonance** in a heading, the author would say **Resonance Due to Circuit Capacitors and Inductors**; instead of **EMF's**, say **EMF's as a Source of Cancer.**

## 4.4 White Space and Numbering

Additional *cues* may be provided by standardizing white space (both vertical and horizontal) between sections and paragraphs of text, and by numbering sections 1., 1.1, 1.1.1.

## 4.5 Numbering Figures, Tables, and Equations

Authors in the engineering profession are advised to learn and practice the standard conventions of numbering figures and tables in reports based on the standards of Section 3. Figures and tables should be numbered *consecutively* within *sections*. For example, Figure 1.1 (first figure in section 1); Figure 2.3 (third figure in section 2).

Also, equations should be numbered *consecutively* within *sections* of a report.

## 4.6 Explaining Mathematics in English

Although it is not always standard practice, some authors find that their audiences benefit greatly from some narrative explanation of the function of a particular

equation. It is a common fault of authors to write down a lot of mathematics and not provide any explanation of its relevance.

Sometimes, we fear, authors do this because they are merely *plugging and chugging* (a polite term for mindless copying) and couldn't explain the mathematics if they had to.

## 4.7 Locating Supporting Graphics

If the purpose of a report is to inform the reader and make it easy for the reader to understand, then graphics must supplement the text in context: words and graphics work together to provide greater clarity. Properly structured, a report will be nearly impossible for the reader to misunderstand.

Graphics should appear in the report either surrounded by supporting text, or in close proximity to relevant narrative. Authors must not merely *bundle up* all of their graphics, pile them at the back of the report, and tell readers to go find them. (In some reports we have read, authors have even neglected to tell the readers where to find essential supporting documents.)

## 4.8 Using Appendices and Attachments

Appendices (formal reports) and Attachments (informal reports) are necessary documents placed at the back of a document to support the conclusions reached in the narrative. In most cases these supplementary documents are too detailed to be included in the regular narrative; but appendices and attachments may also include letters of endorsement, expert witness testimony, or even computer disks and CDs.

The rule of thumb here is that this collateral material must be referred to in the text of the report and it must be relevant. Appendices are not junk boxes where authors can pitch everything which they couldn't find a place for in the narrative.

# 5. WRITING STANDARDS

In this section, the guidelines and standards for a few relevant writing assignments are discussed. We will concentrate on the following:

- o Lab logs.
- o Informal reports.
- o Memoranda.
- o Formal reports.
- o Instruction manuals.
- o Proposals.
- o Progress reports.
- o Homework.

You should follow these guidelines and standards when preparing reports.

## 5.1 Lab Logs

The *lab log* is a permanent record of all experimental and theoretical progress made in the laboratory. Its purpose is to record *everything* whether correct or incorrect.

The *lab log* is a notebook with a sewn binding (not loose-leaves). Pages must be numbered consecutively from front to back. All entries must be in ink, and must be made in chronological order from the front of the notebook to the back. **No** pages may be left blank. Each page must be dated as the notebook is filled, and each page must be initialed by the owner and the laboratory partner(s). Pages should never be removed.

The *lab log* should contain sufficient information so that every experiment or measurement made in the laboratory can be repeated in detail. The log should be the primary, if not only, reference used to write the laboratory report.

The *lab log* should contain a schematic of **every** circuit tried or used in the laboratory. Instrument connections to the circuit should be shown on the schematics, and each instrument should be identified so that exactly the same equipment can be reassembled for further or repeated measurements. If you need to discuss a circuit operation (or non-operation) with your instructor, refer to the schematics or calculations in the *lab log* rather than the jumble of hardware at your bench. **Make sure that your schematics and your hardware are in exact agreement.**

All data, all observations, and all calculations used to design experimental systems and refine data should be recorded in the log. Preliminary (but neat) plots of results should be made in the log. These preliminary plots should enable you to determine whether sufficient data has been taken and to identify *bad data* that must be retaken.

There is no reason to have any *scrap* paper or other notebooks in the laboratory. All trial calculations (right or wrong) should be in the log. All designs and design corrections should be recorded. If the lab log is used properly, it will be impossible to keep it neat and concise. You should attempt to keep the entries legible, the plots should be carefully made with titles and labeled scales, and the evolution of your progress should be clear. Every false start and wrong idea as well as successful effort will be recorded along with comments as to why you decided to do something else. Your errors will probably not be included in reports drawn from your *lab log.*

## 5.2 Informal Laboratory Reports

Informal reports communicate results in a very time-efficient manner. They are neither a history nor a mystery. The information is organized into a pattern that is easiest to understand rather than presented in a chronological order. The results are presented immediately rather than at the end of the report. The reports are brief!

The outline of the report should be:

A. What was the problem?

> State the laboratory problem in your own words. Use only a few sentences. This is a condensed summary of the intent of your efforts.

B. What is the answer?

> Present your results, preferably in tabular or graphical form with clear explanation. You are expected to compare theoretical and measured quantities. Schematic diagrams often clarify the quantitative results.

C. What is the source of your answer?

> Your results must have come from analyses and measurements. A logically organized (not chronological) description of the steps and processes that

led to your results must be presented. Any result not derived from this description must be considered wrong, regardless of whether the answer is correct or not. Items addressed in this portion of the report should include:

a. Equipment and methods used to make measurements.
b. Schematic diagrams that show how the measurements were made and the types of instruments that were used.
c. Sample calculations.
d. Theoretical derivations.
e. Error analysis.
f. Arguments that led to your results.
g. Discussions and analysis of unsuccessful measurement attempts only if your results are incomplete.

If you used references, such as your textbook, to assist your analysis, they should be specifically identified.

## 5.3 Memoranda

Often a short report will be written as a memorandum. Memos typically stay within an organization, and they are written to someone that you know quite well. The recipient will be familiar with most of the background information. Therefore, you should come directly to the subject and purpose of your message. Avoid irrelevancies. The best approach is to be objective.

The header block of a memo lists the recipient, initiator, date, and the subject. A typical format of a memo is shown below.

To:
From:
Date:
Subject:

Text of your memo is limited to one or two pages.

Note that you need to place your initials after your name. This confirms that the memo has been checked and is ready for release. Therefore, a memo does not require your signature at the end.

A good plan for the text of a memo is:

a. Begin by telling the reader the subject and the purpose.
b. Develop your subject. You need to use the same techniques used for the longer reports. However, you should remember that you need to be brief. You can include figures and tables in a memo to reduce its length.
c. Conclude by telling the reader your conclusions, decisions, and recommendations. Then tell the reader that you will be happy to follow up with additional information, personal consultations, or appropriate action.

## 5.4 Formal Reports

Preparation of formal reports is an important skill that must be acquired by all students. A formal report consists of the following sections:

1. Summary
2. Introduction
3. Body
4. Conclusions and recommendations

**Summary**
The *summary* should contain a summary of the key information in your complete report. In writing the summary, you should limit yourself to the material that is essential to your purpose. Remember that the summary should be able to stand alone, and it is a substitute for the entire report. Therefore, you must include the purpose and major conclusions and recommendations. The summary will be written after you have finished the report.

**Introduction**
In your *introduction*, you should announce four things immediately: subject, purpose, scope, and plan of development of the report. Announce your specific subject loud and clear as early as possible in the introduction. Your statement of the purpose should tell the reader why you are writing about the subject you announced. The statement of scope should further qualify the subject. It announces how broad, and conversely, how limited the treatment of the subject will be.
Toward the end of the introduction tell your reader how you plan to develop your report. If you tell your readers what you are going to cover, they will be more prepared to comprehend your report.

**Body**

The *body* of your report will be its longest section. Your purpose and your content will largely determine the form of this section. You can break the body of laboratory reports into two major subsections:

- o Description of Concepts and Anticipated Results.
- o Experimental Verification of Results.

In the description of concepts and anticipated results part, you should describe the concepts and analyses of expected theoretical results. In the experimental verification of the results, you should describe what was done in the laboratory. This should not be merely a copy of the lab instruction sheet. In addition, you need to compare the experimental results with the theoretical results. You also need to devote some effort to analysis of errors and discrepancies.

**Conclusions and Recommendations**

In the *conclusions and recommendations* section you should argue inductively and deductively to present the conclusions. Remember that conclusions are the inferences drawn from the factual evidence of the report. They are the final link in the chain of reasoning. All conclusions presented should be supported by evidence in the report.

Recommendation is the statement that some action be taken or not taken. The recommendation is based upon the conclusions, and it is the last step in the process. Frequently, there is a major recommendation followed by additional recommendations of less importance. You do not need to support your recommendations when you state them in the conclusions and recommendations section.

## 5.5 Instruction Manuals

A common engineering task is to instruct someone to follow a procedure. When the procedure is done by many people or is done repeatedly, written instructions must be provided. The instructions can be very short, or exceedingly complex and technical.

An instruction manual typically contains the following six sections:

1. Introduction
2. List of Equipment and Material
3. Theory of Principles of Operation

4. Description of the Mechanism
5. Performance (Operating) Instructions
6. Trouble-Shooting Procedures

**Introduction**

The *introduction* is usually short and to the point. It indicates what the instructions cover and for whom they are intended. Know your audience background and write the instruction manual in a way which is easily understood by your audience.

**List of Equipment and Materials**

The section devoted to the *list of equipment and materials* should tell your reader what they will need to accomplish the process. Each item is listed by the name and the device (or manufacturer) number. There is no need for any further explanation. The list is typically presented in a tabular or bullet form. If certain items cannot be easily obtained, you need to tell your reader where they can find the hard-to-get items.

**Theory of Principles of Operation**

The *theory of principles of operation* section should describe the theory of operation of the equipment or the device. Telling the operator the purposes behind simple adjustments enable the operator to investigate complex problems. For example, what if nothing happens when the operator turns a knob? Without the appropriate background, the operator will not be able to tell whether the equipment is malfunctioning or this is the normal behavior.

**Description of the Mechanism**

Instructions devoted to the operation of a specific device should include a section *describing the mechanism*. The purpose of this description is to familiarize the reader with the device and its functions. First, you need to describe the overall appearance of the device. You definitely need a photograph or exploded diagram to go along with the description. Then break the mechanism into its component parts and describe how they function. Use as many figures as you can to make the description complete. Make sure that you refer to the figures by figure numbers. At the end of this section you need to describe how all of the functions work together.

**Performance (Operating) Instructions**

The actual *instructions* on how to *perform* the process is the heart of any set of instructions. Adopt a clear and understandable writing style. To achieve this, write your instructions in the active voice and imperative mood: *Turn the power on, wait for a few seconds, observe the waveform, measure the magnitude.* A paragraph

usually contains only one instruction or at the most two or three closely related instructions. Keep each step clear and distinct from every other step. Use familiar, direct language and avoid jargon. Tell your readers to check things or look them over. Don't tell them to conduct an investigation. Fill your instructions with recognized verbs such as *adjust, attach, bend, center, install, replace, turn.* Be generous with graphics and figures. Verbal and graphical description complement each other. The words tell *what* action is to be done. The graphics show *where* the action is to be done and *how.* Annotate the graphics with numbers to allow easy reference to them.

**Trouble-Shooting**
The instruction manual may include a *trouble-shooting* section designed to aid the reader. Typically you specify for each problem what is the *possible cause* and the *possible remedy* for each problem.

## 5.6 Proposals

In business, industry, and government, proposals are the vehicle to initiate a project. The major objective of a proposal is to persuade the reader to award you the contract. Short proposals will be presented as a letter or a memo. Longer proposals will be presented in a formal report format and will be accompanied with a letter of transmittal. Whether large or small, the proposal should be organized for selective reading through the use of headings.

The parts of a proposal consist of:

1. Project Summary
2. Project Description
   a. Introduction
   b. Rationale and Significance
   c. Plan of Work
   d. Facilities and Equipment
3. Personnel Qualifications
4. Budget

**Project Summary**
Proposals are read by busy people. Regardless of the individuals' backgrounds (scientists, engineers, business people), when they are reading a proposal they are fulfilling an executive decision-making role. Therefore, treat them like executives and prepare a *summary* of the key factors of your proposal up front. You need to

point out why the work is relevant to the reader or subject matter area. Clearly summarize the plan of work. Since you cannot write a good summary until you have completed the rest of the proposal, the summary should be the last thing you write.

**Project Description**

The *project description* will break down into four parts. In the introduction you set down everything needed to inform your readers about the objectives of your proposed work. Make the subject and purpose (what and why) of your work very clear. Explain the implications of the work in addition to telling what you hope to accomplish with the work.

In your rationale and significance section you bring your sales ability into play. It is in this section that the readers look to see if they are going to get the value for their money. Therefore, consider the following items for inclusion in this section:

- o Definition of the Problem
- o Immediate Background of the Problem
- o Description of the Solution
- o Benefits from the Solution
- o Feasibility of the Solution

After you have discussed the problem and its solution, you have to tell your reader how you are going to carry out the work. In your plan of work section you will give your readers information on scope, methods to be used, task breakdown, and your time and work schedule.

Projects will require facilities and equipment such as: lab space, technical library, electronic instruments, material for constructing models, etc. Dedicate a section to facilities and equipment and determine what the proposed work will require. Some equipment you may already have. For those items you do not possess, the cost of acquiring them must be included in the cost and financing of the project.

**Personnel Qualifications**

In the *personnel qualifications* section include the names of the project participants and their biographical accomplishments. Lack of experience in someone offering a proposal will reduce the chance of the contract award, whereas successful accomplishment in the past promises success in the future. Therefore, you should cite earlier success with similar projects when you prepare personnel qualifications.

**Budget**

When you set up a *budget*, clearly show where the money is going by using headings such as Material, Labor, Equipment, Travel, etc. You should not commit yourself to work for others without a binding agreement covering dollar amounts, hours of labor, fees and profits, timing, and method of payment.

## 5.7 Progress Reports

The main function of the progress report is to give the company, department, or the individual an accounting of the work that has been done. It explains how you have spent your time and client's money, and what you have accomplished as a result of your work.

A progress report should include the following:

1. Summary of Previously Completed Work
2. Work Done in the Period Just Closing
3. Work Scheduled for the Next Period
4. Work Scheduled for Periods Thereafter

In the conclusion of the progress report you will draw things together for your readers. You need to summarize and review your progress. You need to answer the following questions:

- o Are you on time or ahead of the time schedule?
- o Are you running into unexpected problems?
  (If so, how are you solving them?)
- o Is the scope of the work changing?
  (If so, how and why?)
- o Do you need to consult with your client?
- o What is the financial status of the project?

## 5.8 Homework

Practice is an important part of an engineer's education. Without it, the engineering student does not learn technical material well enough to use it. Homework will provide a part of this necessary practice for your understanding of the material.

Your work should be done in a presentable manner, so it can be understood by the grader. It is also to your advantage to turn in the homework in an orderly and well presented manner, since your homework will be used to prepare for the final examination.

Engineering paper should be used for homework assignments. You should write on one side of the sheet, using a soft, dark, sharp pencil. The following format should be followed for the homework sets that are being turned in for grading.

1. Cover Page
2. Header
3. Given Section
4. Find Section
5. Solution Section

The cover page must contain the student's name, mail box number, course name, course number and section, due date for the assignment, and a vertical list of all problems assigned.

The header for each new problem should start on a fresh page. Do not present more than one problem per page. Each page of a homework set should contain the course number and the section letter, student's name, problem number, and the associated page number on top of the engineering paper.

In the ***GIVEN*** section you should state the provided information for the problem in clear, concise, and mathematical terms. In this section you also need to draw the diagrams describing the problem.

In the ***FIND*** section you need to indicate the physical or mathematical quantities that should be determined.

In the ***SOLUTION*** section you will carry out the solution steps in a logical order. You should provide enough information to make the logic understandable for the grader, and yourself when you review prior to examinations. You need to start with writing the appropriate equation first. Then substitute the corresponding numerical values in the equation and solve for the unknown. Write the second equation next, and use the numerical value you obtained from the previous equation to solve the next equation. Do all of your work in a logical and sequential manner until you have obtained the final result. Remember to draw a box around each of your results that matches a ***FIND*** in the problem statement. Be sure to provide the units.

## 5.9 Meeting Agendas and Minutes

blah blah blah

## 5.10 Schematic Diagrams

A schematic diagram is a graphical description of an electrical circuit. It is meant to explain how the circuit works, and also show how to construct the circuit. It is NOT a picture of the circuit, or just a wiring diagram. Generally, schematics should not look like a drawing of circuit "as built," and the arrangement of the pins on the symbols should favor functional clarity over physical position. A schematic symbol that has the pins arranged as they are on the chip is almost certainly badly drawn, since this is probably not the clearest *functional* arrangement. You can find an example of an appropriately drawn schematic in Appendix B.

Here are several basic rules for drawing an acceptable schematic diagram:

1. **Label each gate or chip or component with a "package number."**

   For chips and other "unrepairable" components, use a number beginning with U, such as U1, U5, etc. For gates which represent only a part of the chip, you may optionally use a designation such as U1A, U1B, and so on for each gate on the chip. For resistors, use R, for capacitors use C, for inductors use L, for switches use S, for connectors and jumpers use J, for transistors use Q, for diodes use D, and so on. Each component should have a unique number so that you can correctly refer to specific parts on your schematic from the text, just like figure numbers.

2. **Draw a dot where wires are meant to connect and not simply cross.**

   Draw a dot for a connection even if one wire terminates at another in a "T". This allows the crossing of wires in many situations, and makes any connections explicit. If it makes sense to show a wire going nowhere, label the end N.C. for no connection.

3. **Label each chip with a part number indicating its function.**

   Use labels like LM555, or 74LS04. Each instance of a gate should also include this designation. Resistors, capacitors and other discrete components should be designated by value and polarity shown if necessary.

4. **Label the pin numbers outside the component outline.**

   Place the label directly above the line representing each pin.

5. **Each schematic symbol should clearly indicate the function of each input and output.**

   For gates the shape of the symbol makes this clear. For more complex components, the function of each pin should be labeled (use the manufacturer's names if possible) just inside the component outline. Pins should be arranged NOT in the order of pin number but by logical and functional order. Inputs are usually on the left, outputs on the right. Control pins (clock, mode, etc.) are normally shown above any data lines that they affect.

6. **Power and ground connections must be shown for all chips**.

   You should include the correct pin numbers for these connection. Power and ground connections should be shown separately from the chips for parts like gates which are drawn in multiple parts and may be drawn separately anytime the practice helps the neatness of the diagram. Do not use a dotted package outline for gates with a power and ground connection.

7. **Signal flow should normally run from left to right**.

8. **Groups of signals may be run as a "bus" shown as a thick line**.

   The bus should be broken out so that individual signals are shown at the connection to the chip.

9. **Signals which cross from one page to another should be named.**

   Names should be self-explanatory (usually long) and labeled on every page on which they appear.

10. **Schematic diagrams included in a formal report should include a documentation block.**

    The block should appear at the lower right corner and list the title of the diagram, the course and group numbers, names of the designers, and a date and revision number. Revision numbers are always included in commercial schematics so that the design can be easily updated without confusion.

The principles that lead to these rules:

- The schematic's primary purpose is to explain the *function* of the circuit. It should first of all expose the logical flow of the design.
- The schematic should also contain complete information for building the circuit, without a need to refer to datasheets or other references.
- Proper labeling makes it easy to refer from a U number and pin number on the actual circuit to the correct location in the schematic.

If you do not have a schematic symbol for a component, you can easily create one according to the rules above. Some example schematics are shown on the reverse of this sheet. You may wish to draw your schematics in a program designed for that purpose, or hand draw them on a large piece of paper and then reduce them on a copying machine. Engineering paper is especially handy for drawing schematics due to the grid on the back.

# APPENDIX A
# Table and Figure Examples

This appendix contains an example of a properly labeled table, and an example of an appropriately captioned figure.

Table A-1. Summary of the Resistance and Current Values

| VOLTAGE (V) | RESISTANCE (Ω) | CURRENT (A) |
|---|---|---|
| 100 | 10 | 10 |
| 100 | 20 | 5 |
| 100 | 40 | 2.5 |
| 100 | 50 | 2 |

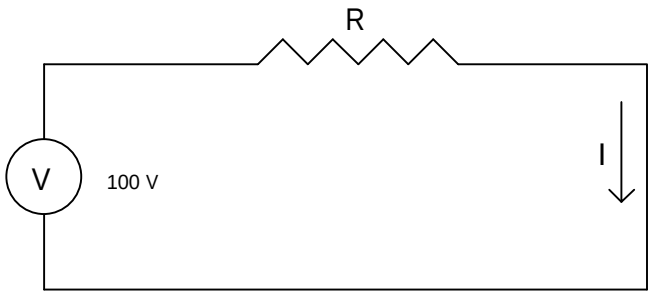
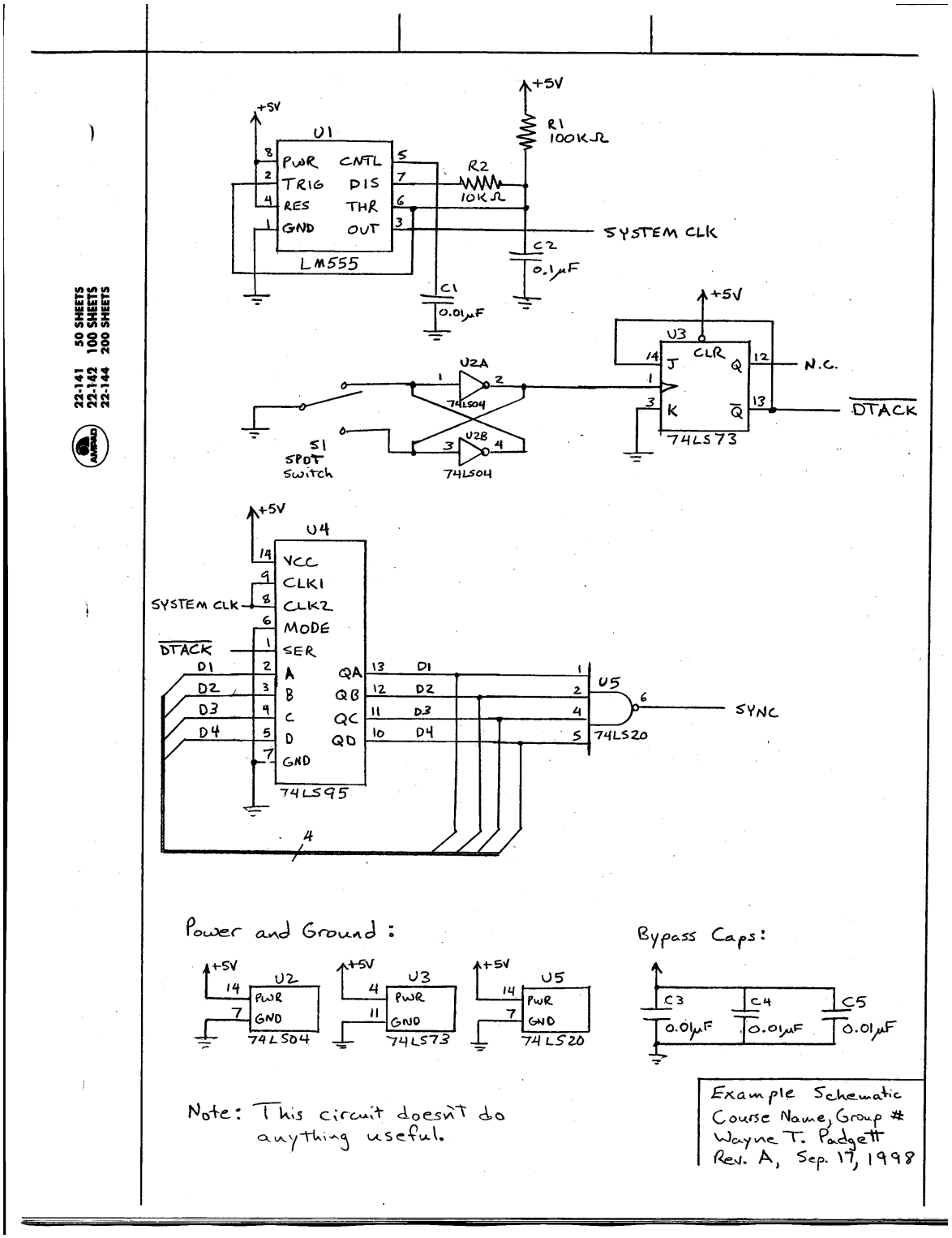



Figure A-1. Electrical Circuit Diagram

# APPENDIX B
## Schematic Diagram Example



# APPENDIX C
# Log-log and Semi-log Plotting

Blah blah blah