Writing a Laboratory Report

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Writing a Laboratory Report

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I. INTRODUCTION

Structure is what distinguishes a *report* from other forms of writing such as a *memo* or a *financial statement*. To deal with a single issue, policy, or procedure, a one or two-page memo is probably the best way to communicate concisely in writing. When several procedures, ideas, or issues need consideration, or a project needs to be described, then you need more structure than a memo format usually provides—you need to write a report. This document gives guidance on how to write an engineering report.

Devices such as a cover page, subject headings, illustrations, an introduction, and conclusion and so forth are what provide a report with its structure. The longer the report is, the more of these devices may be needed. For example, a book-length report might need chapter headings, a table of contents, index, references, and a glossary too. Besides helping you choose and organize devices that efficiently lead the reader through the report on a first reading, this document will also help you get past writer's block (that "I don't know how or where to start" feeling), select the best topics for inclusion in your report, and help with mechanical aspects such as margins, how to write numbers, etc.

There are many style guides for writing reports and other documents. Professor De Boer requires you to follow the Institute for Electrical and Electronics Engineers (IEEE) style guide [1]. The IEEE style guide is based on the American Psychological Association (APA) Style Guide, which in turn is based on the Chicago Manual of Style [2]. You should find a generic writing handbook, such as are mentioned next, and augment that with this booklet and the IEEE style guide. If these guides do not fulfill a particular need, you may consult your instructor.

The books *Write for College: a Student Handbook* [3], and *The College Writer* [4], include many good ideas on how to write effectively and a summary of APA style. Either one can serve as an adequate generic reference for writing engineering lab reports. They each contain mostly similar content but each book is organized differently. Professor De Boer recommends that you purchase one of these books and use the other one as needed by borrowing it from the College library.

In *Write for College* give special attention to the sections on "Writing with Style," "Making Sentences Work," "Developing Strong Paragraphs" and the "Proofreader's Guide." (Specifically sections 046 –

109 and 552 – 851.) Note that section 655 on Numbers is superceded by more detailed information in this booklet.

In *The College Writer* give special attention to Section 6 on “Editing and Proofreading,” and in Section 24 note the “Experiment Report” example which is in the scientific style mentioned later in this booklet. Engineering Reports have many similarities but also some differences. In any case, it helps to understand the style of a Scientific report as shown in this example. Also note Part V, the “Handbook” section, which is generally very useful. Note that the pages 599 and 600 on numbers are superceded by more detailed information in this booklet.

These two books are aimed mostly at writing in the humanities and social sciences, not scientific or engineering writing. For this reason Professor De Boer requires that the IEEE guide be used to supercede *Write for College* on some matters, especially on the style of citations and references. An annoyance in both books is that underlining is used in place of italics. This is a throwback to the old days of typewriters, which could not produce italics. Where *Write for College* and *The College Writer* use underlining, in most cases you should use italics.

You may be interested to know that the American Society of Mechanical Engineers (ASME) also maintains a style guide [5] which is very similar in substance to IEEE’s guide.

To summarize: Follow the IEEE style. Since IEEE style is based on APA and that on Chicago style, and since *Write for College* and *The College Writer* also cover APA style, we can use these books as generic references. There are matters of APA style (equations, number formats, etc.) that relate to engineering report writing but are not covered in *Write for College* or *The College Writer.* This handout supplements these generic reference books on those matters. If you are still uncertain, consult your Professor.

The material in this handout is derived from the various style guides already mentioned, some books mentioned later in this document, and from Professor De Boer’s experience with grading student reports. The material here is focused to help students write one type of document, an engineering report. If you are planning to use this document to guide you in a course taught by someone other than Professor De Boer, discuss this document with your professor first.

II. WHAT MAKES A REPORT GOOD?

This section leads up to a grading rubric based on this perspective: A quality report communicates with completeness, style, conciseness, accuracy, and fidelity to its intended readers.

Completeness means that the report contains all the information necessary so that the reader can understand the context of the project, design, or experiment, can reproduce any apparatus used, and can use the same methods you used to duplicate your results. Usually objectives, specifications, equations, drawings, schematics, block diagrams and other illustrations need to be used in addition to prose in order to achieve completeness.

Style in writing means presenting ideas in a logical order, with good headings and page layout. It also means that the information in the report can be cited in other documents by page numbers, figure numbers, etc.

Conciseness is an economy of quality words. It is always better to use a sentence of fewer words if it does not alter the meaning. When writing, consider each sentence. See if a shorter one will suffice. Showing awareness of conventional rules of grammar (and style guides) for formal writing also contributes to conciseness.

Accuracy requires attention to the exact meaning of your sentences and the details in numbers and equations. It is possible to write sentences that actually do not say what you are thinking. ("Eight new safety glasses were ordered due to the addition of new students in the lab and the deterioration of old ones.") Proper grammar, precise technical details, the use of correct terminology, avoidance of slang and jargon, careful and consistent use of abbreviations and acronyms, proper formatting of numbers and units, all contribute to accuracy. The right technical word or phrase can convey a nuance that a string of simpler words or jargon will cloud.

Fidelity is a broader concept than accuracy. Some might call it integrity or trustworthiness. Writing with fidelity means that even readers having preconceived or wrong-headed notions when they start reading ought to correctly understand and appreciate your message when they are done reading. Writing with fidelity also means that when you use other people's works, you construe them the way that was intended and that you treat controversial statements of other people with charity. Writing with fidelity requires understanding your sources and the intended or expected readers.

Understanding your audience is necessary. For Professor De Boer's classes, pretend your audience is the class of students who will take this same course next year. Write your report to tell them everything they would find interesting about the lab you did. You should explain anything you did that is not obvious from classroom discussions and textbook reading. You should also explain all the alternatives you considered, including the factors that influenced your decisions. If there were tricky procedures, special techniques, or instruments used which were not explained in the lab handout, you should write about them. You should omit details of calculations that should be apparent to your readers. Only give the starting points and ending points of such calculations. With repetitious calculations, consider including a representative example or two in some detail, then include only the results of the remaining calculations. Illustrations (graphs, schematics, etc.) are usually important methods to convey a lot of information quickly and easily. Be sure illustrations are labeled well. An ideal report will generate interest and enthusiasm for the subject besides conveying the facts.

III. THE WRITING PROCESS

A. Searching and Selecting (Finding Information)

The information for your report comes from your notes. In the humanities, a research paper usually starts with a trip to the library (or Internet) to find sources and select information. Imagine going through many books, periodicals, and Web pages but keeping only a few notes on a disorganized assortment of scrap paper. How would you write your paper when you got to the computer keyboard? Memory might serve you, but you would probably also have to go back to the library to get the details straight. Obviously, the quality of notes taken in the library will be the foundation of your research paper—in the humanities that is.

In the sciences and in engineering the lab or fieldwork is the focus of activity—in place of the role of the library. When the lab work or fieldwork is over, all you will have are your notes and your memories. Memories fade. Sometimes a series of several similar events or measurements get confused in your memory. Lab work is usually more time consuming to repeat than library reading. As you do an experiment, create a new design, or do a project, *keep notes*! (If you build a circuit or other apparatus, avoid tearing it down until the report is done, just in case.)

Notes are at least as important as your activities because notes are durable. They are the only reliable record you will have. Your notes should include schematics, diagrams, information on the apparatus used, tables of raw data collected, etc. Keep your notes organized chronologically. You will need some apparatus to keep the notes organized. A paper clip will work if there are only a few pages of paper notes. On a larger project you could use a three-ring binder.

Often there are computer files, photographs, and other items that do not fit conveniently alongside your paper notes. Artifacts like this should be considered part of your notes however. If there are only a few of these items, you could write in your notes where these items are stored and briefly what they show. You can put plastic pouches in a three-ring binder to hold photos and other items. If there are many such items, you may need to find storage places such as a designated shelf, or a cabinet. For really large engineering projects, whole buildings have been dedicated to preservation of artifacts. You may need to invent a way to index and organize photos, circuit boards, or whatever artifacts there are. By all means, keep the record together and organized.

You might supplement your notes by reading textbooks, manuals, or doing library literature review if necessary, and keeping notes on your reading. If so, be sure to keep citation information too.

B. Generating an Outline

After the lab or fieldwork is done, review any handout materials and make note of any open questions, goals, or specifications you find. (Use a highlighter?) You will want to specifically address these items in your report.

After doing the above, identify all the information you want to present in the report and devise an easy-to-understand format for it. To help you identify information, you *could* (optionally) make a timeline of the significant decisions or observations. Some of the results of this process will be obvious to any reader of your report. Your main goal is to identify and organize items that are not obvious. Focus the report on what was not obvious. Keep in mind that thinking chronologically is just a tactic to identify important information. The report is usually not a simple chronology of events. Even if the report is organized chronologically, you want to draw attention to some parts of your work more than other parts.

Raw data has a special sanctity. Be sure the conclusions in your report can be traced all the way back to the raw data. That means that *the raw data must be included somehow in the report*. A common strategy is to present the raw data in the report in some condensed form, say as a graph. Then the actual tables of raw data are included in a detailed appendix.

From the notes, data gathered, and the searching and selecting process described above, decide on the major headings that you will use to outline your report. You could use a traditional IMRaD presentation (described later in this document), or a chronological presentation or procedures could be described in a hierarchical fashion, either top-down or bottom-up, or you could decide on some other format.

C. Writing and Revising

Once the headings are chosen, you can start writing the paragraphs that go under the headings and produce any needed illustrations or equations to go along with the text.

Some students prefer to just start writing whatever thoughts come to mind. Then they organize the writing and use a word processor to move the text into the correct sections of the outline. Others write in order to fill in an outline, as discussed above. Actually, a blend of the two methods might work best. As you write you might start thinking along a tangent. If so, then maybe it will be best to keep going and later move the tangential thought into the proper part of the report, or possibly modify the outline to accommodate the new thought.

It is a good idea to put a report away overnight and look at it again in the critical light of a new day after a good night's sleep. Many errors, both typographic and substantial, can be caught this way. Use a computerized spelling and grammar checker, but sea that you do not rely two much on it! (That is supposed to be humor!)

D. Grading the Report—Completeness, Style, and Accuracy

After the first draft is done, try to grade the report yourself (or have a classmate try to grade it) according to the rubric below. Then go back and modify the report as needed.

Professor De Boer considers three factors, each with about equal weight unless one category is much worse than the other two, in which case the lower grade will be given more weight. Below are a number of example questions in three categories. If virtually all the questions in a category can be answered favorably, the grade in that category is an "A." If most can be answered favorably, the grade is a "B" or "C." The list of questions cannot possibly be comprehensive.

1.) Completeness: Does the introduction give an overview of the report? Does the conclusion clearly denote what was accomplished?

Are the objectives of the project presented? Objectives may be explicitly given in your assignment, in which case they can be incorporated into the report by reference (that means you do not have to copy them, just tell the reader where to find them). On the other hand, objectives may be of your own creation, in which case it is important that you discuss them. Often objectives are a combination of givens and your creations.

Does the project, design, or experiment satisfy the objectives? Does the report contain all the information necessary to prove your claims? Can a reader replicate everything you are reporting on? In particular, do you have complete drawings, schematics, block diagrams—whatever is appropriate engineering documentation—for the final design, or experiment? Are the methods given and alternatives discussed? Are the results explained? Is the importance, uniqueness, or value of the project or other work discussed? Are the variables used in equations defined properly?

2.) Style: Is the material in the report organized well? Do the headings clearly outline the content in a logical order? Are the results and important conclusions easy to find and appreciate? Conversely, does the report just parade an undistinguished chronology of bland events or procedures past the reader without explaining the significance of them? Has the level of the presentation been correctly adjusted to the intended audience? Is the writing concise? Is it easy to read?

Are equations, figures and tables displayed in a simple manner and captioned for those who to want scan the report quickly? In tables, should the numbers be aligned vertically at decimal points? (Usually they should be.) Functionless decorations, including most borders and shading, should usually be omitted. Borders or hatching may be used only where necessary to help the reader understand.

Are conventional rules of writing (IEEE style, grammar, double-spacing, spelling, etc) obeyed? Are there page numbers, dates, and other information to aid readers who wish to cite your work?

3.) Accuracy: Is the project or design supported by appropriate theory and calculations? (In contrast, was the project built, tested, and rebuilt over-and-over when analysis or simulation would have produced a similar or better optimization with less effort or uncertainty?) Does the report face up to and explain anomalous data? Would a reader with a bias or a preconceived notion of the situation come to appreciate your point-of-view (or at least not be offended)? Is correct technical terminology used? Are equations correct? Units too? Are significant figures used correctly?

IV. IMRAD

Scientific writing is highly structured, or stylized. Scientific reports usually follow this general outline: **I**ntroduction, **M**ethods, **R**esults, (**a**nd) **D**iscussion. This style of scientific writing is known by the acronym “IMRaD.” (The acronym omits mention of the abstract, references, etc.)

In engineering reports (and many scientific reports), the IMRaD sections can usually be easily identified, but with a twist. The names of the headings are made topical so that they also communicate an outline of the paper to the reader. For example, instead of “Method,” the heading might be “Decomposition Technique,”—the name of the method. Consult any engineering journal article and see if you can find the correspondence to IMRaD. It is usually not too difficult. One actual engineering report contains the headings shown in Table 1.

Since you will be writing an engineering report and not a scientific report, you have flexibility in the headings you use to discuss methods and results. Consider the IMRaD style as a way to get started if you are stymied.

The next section of this booklet explains more specifically the elements of an *engineering* report.

Actual Headings Used	**Correspondence to IMRaD**
Abstract	
I. Introduction	Introduction
II. Theoretical Background III. Decomposition Method IV. Decomposition Techniques	Methods
IV. Experimental Results	Results and Discussion
VI. Conclusion	
References	

Table 1. Example of actual headings compared to IMRaD [6].

Day's book, *How to write & Publish a Scientific Paper*, [7] 4th edition, includes a section that describes the IMRaD format. (See page 11 and following in the book, Dordt College Library, T11 .D33 1994). This book gives specific suggestions on how to write each section of such a report. You might find these pages of the book particularly helpful.

Elements of the Scientific Paper, by Katz [8] (Dordt library, T11 .K34 1985) also discusses the IMRaD style, more by way of example and less by way of discussion than Day's book does.

What engineers write is usually not scientific writing, therefore the books by Day and Katz ought not to be adhered to literally for engineering writing. However, since science is a foundation of engineering, engineers ought to understand the scientific style of writing and use it where appropriate.

Another book, *Handbook for Preparing Engineering Documents*, by Nagle [9] (Dordt Library, TA190 .N34 1996) is specific to engineering. There are good sections on how to produce illustrations, how to layout pages and use typefaces effectively and how to distribute documentation and keep track of revisions. Engineers must be able to write a variety of documents including memos, proposals, reports, bids, reviews, instruction manuals, and so forth. Nagle's book addresses this breadth. It also has excellent discussion of the lifecycle of these documents from writing, through production, printing, distribution, and revision.

V. THE ELEMENTS OF AN ENGINEERING REPORT

An engineering report should follow this order:

- Cover Page

  Not for published reports, only manuscripts.

- Table of Contents

  Only if the report is very long, say more than 20 pages. Not used for reports published in journals because the journal will have its own table of contents.

- First-page Heading (mandatory, even if a cover page is used)

  Gives title, then on the next line(s), authors. Does not include page number. The first-page heading is different from all the other page headings.

- Abstract

  Especially for published reports, usually omitted otherwise.

- Introduction
  May have another name, e.g. "Summary"
- Body, but not usually called "Body."
  Will include appropriate headings, figures, tables, equations, and other illustrations. The body is the "MR" part of "IMRaD" if you choose this style.
- Conclusion
  May have another name, e.g. "Discussion"
- Acknowledgment
  Optional, usually only to provide recognition for grant funding. Definitely not used to acknowledge services paid for. For example, do not acknowledge your professor's assistance.
- Glossary including mathematical nomenclature (optional)
- Appendix (if any)
- References (Omit it if there are no references cited.)
- Bibliography (Optional—usually not permitted in journals)
  A list of writings not specifically cited in the report itself but topically related to the report.
- Index (only for very long reports—never used in journals)

In any actual engineering report, these elements play themselves out in different forms. Some of the elements mentioned above are described in more detail next.

A. Cover Page

For this class, use a cover page. Center the title of your report about 1/3 of the way down the page. The title may occupy more than one line if it looks pleasing that way. About 2/3 of the way down the page, list the authors, usually one name per line. After a double space or more, put the date the report is to be turned in or the date the report was actually turned in, whichever is later. You may adjust the spacing of the elements (to something other than 1/3, 2/3) to achieve a more balanced looking page if there is a long list of authors for example. See the example in Figure 1.

POSSIBLE LOCATIONS
for
A NEW MUNICIPAL BUILDING
in
SIOUX CENTER, IOWA

Melissa K. Van Hatten
Terry M. Galvin
W. Paul Jones

October 10, 2003

Figure 1. An example of a cover page.

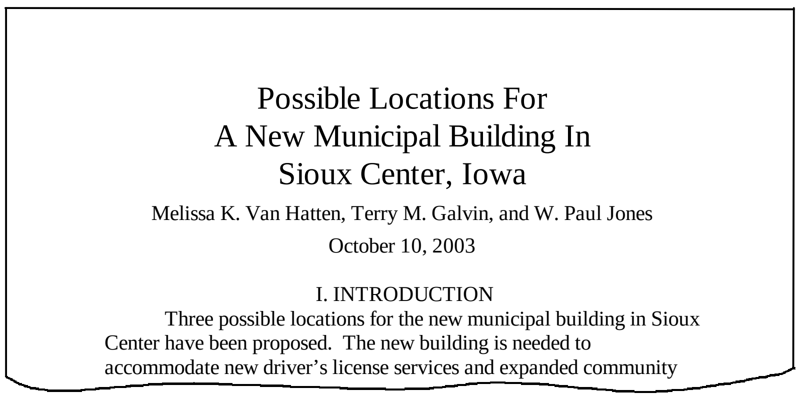
More complicated cover pages are possible but not recommended for this class due to the time it takes to make them. For example a cover page may include an illustration, the author's company name or logo, the name of the person or company the report was written for, etc. The cover page should be only as fancy as the situation calls for. You need not adhere dogmatically to stylistic guidelines, but neither should guidelines be ignored.

Fancy and colorful bindings to put your report in are available at the bookstore. You do not need them for Professor De Boer. The cover page serves that function. Usually a staple in the upper left corner is best. If you get a job where the company provides binders for reports (with the company name or logo on them for example) you should find out the guidelines for their use.

B. Page Headings

The first page should have a special heading that gives the title the author's names and the date. Leave the usual margin of about an inch above the title. The title should be centered and usually in a slightly larger text size to distinguish it. On the next line place the author's name. If there are several authors, place them on one line if possible. Otherwise use a minimum number of lines, each as nearly equal in length as possible. The author's names should also be centered. Finally, center the date on a line by itself. Note that the first page does not have a page number although it is still called page number 1.

Most word processors have built-in features for headers and footers. You can specify a special header for the first page and many other options. Usually these features are well worth learning how to use. Usually the online help system of your word processor has adequate instructions.


Possible Locations For
A New Municipal Building In
Sioux Center, Iowa

Melissa K. Van Hatten, Terry M. Galvin, and W. Paul Jones

October 10, 2003

I. INTRODUCTION

Three possible locations for the new municipal building in Sioux Center have been proposed. The new building is needed to accommodate new driver's license services and expanded community

Figure 2. An example of a first-page heading.

The pages after the first page should have a header (or possibly a footer or both), made as simply as possible to give the date, title, and page number. If any single page of the report is photocopied, the date, title, and page number should end up on that photocopy so that the source of the copy can be identified exactly. Note that page number 2 will be the first page with the standard heading because page number one has a special heading. Be sure the page numbers shown are correct. In other words, do not number the second page as page 1. Page 1 is the one with the special header and the next page is page 2.

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as shown in Figure 1. Another consideration that ranked high was accessibility for handicapped people and people arriving by means other

Figure 3. An example of a normal page heading.

C. Abstract

Abstracts are not required for Prof. De Boer's lab reports. If one is needed, work on it last, after you have written the rest of the report including the introduction. (Although you write it last, place it ahead of the introduction.)

The purpose of an abstract is to assist with the task of information retrieval. An abstract should be a short summary of the entire report. Publishers limit abstracts to about 50 – 200 words. In many electronic indexing services, abstracts are made available to the public free. Access to the report in full requires payment. (For example, http://ieeexplore.ieee.org or http://www.ingentaconnect.com) Keeping this in mind helps focus your attention on what to include in the abstract. Usually you want to give as much information as possible in the limited length of the abstract. Do not hold back key results for paying customers only. If there is no substance in the abstract, readers will expect the same of the full report and not purchase it.

There are two general approaches to writing an abstract. Most desirably, an abstract is directly *informative*. The goal is a miniature version of the entire report. Often a report is too long for this to work effectively. Then, an *indicative* style can be resorted to for all or some of the abstract. An indicative abstract describes the type of information and results contained in the report.

The use of key words within the abstract helps with computer assisted searches for information and with indexing. An abstract often has a terse style. The particular words chosen need not flow with grace, but each sentence must have a correct grammatical structure. These techniques are used to keep the abstract understandable within the given word limit and without omitting essential information. Here is a typical example:

> A saddle-point approximation (SAP) method to compute the pairwise error probability (PEP) of trellis-coded modulation (TCM) schemes over Rician fading channels has been derived. The approximation is applicable under several conditions, such as finite and ideal interleaving, ideal coherent and pilot-tone aided detection, and differential detection. The accuracy of this approximation is demonstrated by comparison to the results of numerical integration. When ideal interleaving is assumed, an asymptotic approximation for the PEP of ideal coherent pilot-tone aided or differentially detected TCM is derived. This asymptotic approximation of the PEP is in a product form and much tighter than the ordinary Chernoff bound on the PEP. Also, error performance of the TCM schemes over Rican and Shadowed Rician channels is studied. Keywords: communications, phase-shift modulation, error correction. (This example of about 130 words is modified from [10].)

The “Keywords” phrase at the end of the abstract bears special mention. Some journals allow this non-grammatical appendage in order to increase the probability of the article being found by an electronic search. Keyword lists seem to be gaining popularity but they are easy to abuse. Besides maximizing the number of valid hits on the abstract, it is also necessary to minimize the number of false hits. The “keywords” are too easily made overly general.

Notice that in the example there are a large number of technical words. This paper would be found by a search on the phrases “saddle-point approximation,” “trellis coded modulation,” or “Rician fading,” or any of the other such technical words and phrases in this abstract. It would also be found using some popular abbreviations such as, “SAP,” and “TCM.” The scope of the paper and the improved quality of the results are indicated, but conclusions are not given here (indicative style). The abstract is designed so that a reader interested in this subject material will (1) find the abstract if searching via an index and (2) want to read further, probably the introduction and conclusion sections next. A good abstract also helps those who are not addressed by the paper to know immediately that the paper is not of interest to them.

D. Introduction

Typical material for the introduction includes (1) a technical thesis that serves to orient the reader to the purpose(s) of the work being reported on (2) the nature and scope of the problem investigated and (3) a review of any relevant literature which the reader might not be familiar with. You may assume the reader is familiar with lab handouts and textbooks, therefore there usually is little or no literature review in the lab reports for Professor De Boer's classes. Also include (4) the method(s) used, possibly with a short rationale for the method(s), (5) the principle results, and (6) recommended courses of action or conclusions. Do not hold back key results. An engineering report is not a mystery novel. We want to know right away that the butler did it! [7, p34]

The introduction is the only place in the report (other than briefly in the abstract) to place material that orients the reader to the scope of the problem or research. It is also usually the best place for contextual information such as why the field of interest is important, and how the report fits in with what others have done or are doing in the field.

The first sentence of the introduction is important. It should contain immediate content. "This is a report about . . ." does not have immediate content. (The title should tell what the report is about.)

It is a mistake to open with either drama or banality. Ideas for good openings that that work in the humanities can be a disaster in an engineering report. Do not try to build up to something in the opening paragraph. Get as much information up front as possible, then explain it if necessary. Some examples follow:

Example Introduction #1 (too dramatic)

> On a cold, dreary, rain-slick, foggy morning in March, Rachel, a young single mother, unfortunately ran into a fifty-car pileup on the Eisenhower Expressway. A truck subsequently slid inexorably, with tires squealing their resistance, into Rachel's already crumpled compact car. The impact crushed the life out of poor Rachel. She is survived by three preschool children [1]. The National Highway Traffic Safety Institute reports that there are hundreds of fatalities per year in these types of accidents [2]. This is a report on radar-assisted breaks used to prevent tragedies like this. . . .

Maybe some good data follows all the windage above, but the author has already made a poor first impression.

The opposite type of problem is banality. Here is a tip: Imagine deleting the first sentence. If the introduction is stronger that way, do the deletion. Keep going—can you delete the next sentence too? Example Introduction #2 below is stronger without the first two sentences:

Example Introduction #2 (banal)

> This is a report about brakes, which are very important parts of a car. That makes radar assisted brakes potentially very worthwhile for our daily lives. The National Highway Traffic Safety Institute reports that there are hundreds of fatalities per year in multi-car pileups on interstate highways [1]. The report. . .

Example Introduction #3 (a good example)

> The National Highway Traffic Safety Institute reports that there are hundreds of fatalities per year in multi-car pileups on interstate highways [1]. The report cites poor visibility as the primary enabling condition for these accidents [2]. This new study shows that radar-assisted brakes increase safety when visibility is poor. . . .

Think negatively for a minute. If you were hurriedly scanning through dozens of reports for the best report on radar assisted brakes, which of the above examples would you toss aside first? If you were a persistent reader desiring to improve driver safety, which introduction would frustrate you the most? On the other hand, which of these examples gives the impression of an authoritative report? Assume you are already well aware of the consequences of rear-end accidents, as most readers seeking such information would be. (The examples are fictional.)

The introduction may have another name. Sometimes it is called an executive summary. The introduction should be a section that can stand by itself so that a busy reader can gain the gist of the report without reading anything else. It is much like an abstract, but not encumbered by a particular limit on the number of words in it. Many introductions repeat whole sentences verbatim from the abstract, but they include more.

E. The Body of the Report

In a traditional *scientific* report organized around the IMRaD motif, the body is the “MR” or “Materials” and “Results” sections. However, an engineering report sometimes will vary from this style. For example, there may need to be additional sections on finances, safety, or computer simulations to name some examples. Even in the traditional IMRaD format, the Methods and Results sections may have subheadings (level 2 headings).

Do not use the words “Body” as a heading. Instead, use headings that outline the content of the report. Engineering reports usually replace heading names like “Method” with the name of the specific method used. Your method might have been to use an “Adaptive Filter.” That phrase would make a much more informative heading than “Method,”—or worse yet, “Body.” Headings such as “Abstract,” “Introduction,” and “Conclusion,” are traditional and always used. They give the reader a generic orientation to the report. On the other hand, in an engineering report the reader expects the other headings to signal the specific content of the report.

In many cases, the body of the report includes heavy doses of equations, graphs, schematics, and other illustrative elements—whatever communicates accurately and concisely. In some reports the illustrations and equations are the elements that convey most of the information. Each illustration or equation, etc. needs to be related in prose to the other elements of the report. The prose leads the reader on a tour of the illustrations and equations.

F. Illustrating the Body of the Report

1.) What to illustrate: Present data in the report in the most usable form you can think of. This will often be a graph, diagram, or schematic of some type. Consider using a computer program like Excel or Matlab to produce graphs quickly and neatly. The graphs can then be copied into your word processor. Long tables of data usually are not appropriate for the body of the report. Put them in an appendix.

2.) Black and white is best: Illustrations (and the entire report) must reproduce well when photocopied. Usually only one person will have access to the original report. In an industrial context, the people you want to influence most (your boss’s boss for example) will likely be reading a copy, perhaps even a third or fourth generation copy. This means that colors and shades of grey should be avoided because they will not reproduce via an ordinary copy machine.

Illustrating in black and white is not as simple as printing in black and white. Design the report so that it *prints in black and white* (no shades of gray) *even if the report is printed on a color printer set up to print in color*. In other words, the original report file must not have color or gray-scale in it. Use dashed lines, dotted lines, hatching, annotations, etc. instead of color or shading if such effects are needed.

Times are changing and color is getting more popular, but the risk of having black-and-white copies made of your carefully colored work is still very great. If you ever must use colors, at least choose dark colors that copy well in black and white. Examples are dark blue and dark green. Avoid light or bright colors and all shades of yellow since they do not copy at all. Darker shades of gray will turn black on copies.

3.) Label graphs and illustrations well: Every graph must be well labeled. This means an *x*-axis label (including units, if appropriate, such as Hz or seconds or sample number), and a *y*-axis label (including units if appropriate). Each illustration should be captioned with a figure or table number, and a descriptive sentence. See figures and tables in this document for examples.

Caption labels are proper nouns and should be capitalized. “See Figure 8.” is correct. “See equation 3.” is not correct. Captions should be text that is separate from the figure. This way if editing reorders the figures, you only need to edit the text, not the figure itself. If you set the captions up properly most word processors can also automatically renumber figures as they get reordered by editing..

4.) No messy erasures: Illustrations may be drafted in pencil (for this course) but all erasures must be complete and clear—no smudges allowed. Get a new eraser or harder paper, or both, if yours smudges. (Pink erasers, common in elementary schools and on the ends of ordinary pencils, are inferior. Try a white plastic eraser, for example the Pentel “Click” eraser.)

5.) Neat but not time wasting: For block diagrams, schematics, and similar illustrations, use a straight edge to draft all straight lines and other simple drafting tools such as a circle template (or improvised substitutes), where appropriate. Neat hand lettering is acceptable within illustrations—do not use cursive handwriting. Your ordinary handwriting might not be neat enough even if you print. Draft each individual letter of each word carefully.

You may use a CAD program, but consider the time you will invest. Be sure you will actually save time. Engineers are not required to be expert graphic artists. In an industrial context, illustrations can often be left to a graphic artist when higher quality is needed. On the other hand, illustrations made by engineers must not look like messy free-hand sketches either. Clear concise communication is the goal. Elaborate CAD drawings might not contribute significantly to that goal; however, sloppy free hand sketches certainly would be difficult to read.

When you get a job standards may be different. For example if you are a consulting engineer in a small firm you might not have a graphic artist on your staff. Then, to make your reports look competitive, an engineer would need knowledge of page-layout strategies and laser-printed output would be *de rigueur*. Colorful documents printed on an ink-jet printer might also be desired.

6.) big, Big, BIG: Make illustrations large enough to be easily read. This means they must be a full column wide (margin-to-margin, not paper-edge-to-paper-edge) and two inches tall for the very simplest illustrations. If the illustration does not actually fill the full width between the margins, then center it between the margins. The text flow skips from the top of the illustration to the bottom, leaving white space on either side of the illustration. (In some word processors, set the text wrapping to “none” to achieve this.) It is acceptable and may be convenient to place all graphs and illustrations at the end of the report. It is not necessary to copy illustrations that appear in books, lab handouts, etc. You may refer to illustrations in the lab handout by citation with a figure number.

7.) Use white paper: Print or hand-draft your illustrations and the entire report on ordinary white paper (or nearly white such as egg-shell, but not pink or sky-blue). The paper should have a smooth appearance with no background lines, texture, or artwork. These specifications seem to be necessary now only because modern word processors and office supply stores can tempt one to add decoration that is not effective for engineering reports.

Engineering pads or graph paper are also not appropriate for graphs and illustrations in reports. Perhaps this is surprising since you have been encouraged to use these for homework. Homework and reports have different standards however. If you need a grid to assist with hand drafting an illustration, consider placing a blank page of engineering paper or graph paper under your white paper while you draw. Under good light, you will be able to see the grid faintly through the white paper.

If appropriate, you may scan your hand-drafted illustrations and electronically paste them into your report. Alternatively, you may paste them in with real glue. A glue stick (best) or rubber cement (next best) works well for this. Ordinary white glue (Elmer's or equivalent) will dry stiff and wrinkly.

8.) On the use of landscape format: You may turn a page to landscape format for illustrations that reproduce best that way. The illustration needs to be large enough and must be the only thing on the page. The top of a landscape format page is the side that was on the left before the page was turned. In other words, if most of the document is in portrait format, a quarter turn in the counter-clockwise direction of the illustration is needed prior to insertion. Captions must appear on landscape pages as usual. They go on the long edge of the page at the bottom of the illustration when the paper is held with the illustration right-side-up. A landscape page also must show headers, footers, and page numbers in the same style as the rest of the document. They may appear in either landscape or portrait format.

9.) No borders or boxes around figures: Some word processors place a black border or box around each figure by default. If yours does this, find out how to turn off that feature. Do not use borders and boxes as a matter of routine. Use them only when they communicate some information or are needed for some sense of separation.

G. Conclusion—the Climax

This section of the report should summarize each outcome, decision, or recommendation mentioned in the earlier parts of your report, with brief discussion and justification. Everything in the conclusion needs to be backed up with further detail in the report. In deciding what ought to be included in the conclusion, think about the original design specifications. Were they met? With margin? Also consider obstacles you encountered. How were they bridged? Were there alternatives worthy of mention? Here is an example of a conclusion: (fictional—but inspired by [10])

> Comparison of the exact and approximate methods for calculation of the PEP show that the maximum error for the approximate method is no more than 10 percent when a first order approximation is used. By incorporating higher order terms the error can be further reduced, but the additional complexity of the approximation then is similar to the complexity of the exact computation.

> The SAP approximation method is better than computer simulation for evaluating TCM bit error performance over Rican fading channels. It can be computed faster and gives higher confidence in the results since it eliminates the need for many Monte-Carlo iterations in simulation.
>
> The remaining difficulty of calculating coefficients for the PEP approximation suggests this as a topic for future research.

In the above example each paragraph itemizes and summarizes an important point that is further developed in the body of the report. In the body of the report the reader can expect further details, such as the exact complexity and speed of the calculations, the variance of typical simulations, and potential avenues for improving the approximation.

In contrast to the above good example, here is a bad example: “This was a hard lab to do right, but it does highlight that the math relationships do hold in reality within the limits of experimental uncertainty.” That is an example of the “squid technique.” The authors are unsure of the results; consequently they retreat behind a cloud of ink instead of putting forth some concrete conclusions [7, p45].

The conclusion is also not a place for gratuitous remarks such as, “This experiment was a valuable learning experience for us.” Students occasionally let something like this slip in, obviously with no idea of how obnoxious it seems to faculty members. Frankly, there is no place for brown-nosing in a report. (If the experiment truly was a valuable learning experience, the quality of the report itself will give ample evidence of that.)

The word “conclusion” does not imply a sort of winding-down of the report. In a novel or short story, there is a climax followed by a denouement. A conclusion in an engineering report *is the climax*. There is no denouement. The conclusion must spotlight all that is unique and good about the work being reported on.

In an engineering report, this section might be called the “Recommendations” section. In a scientific report this section is always called “Discussion.” In other words, “Conclusion,” “Recommendations,” and “Discussion” are three different names for the same thing. Whatever it is called, this thing is mandatory.

H. *Appendix*

An appendix is, by definition, extra information. (Look up the word in a dictionary.) If the report cannot stand alone without the appendix, then the appendix is not an appendix. Move that information into the body of the report. On the other hand, anything that can be separated out of the main body of the report to make the report easier to understand should be put in an appendix if the author thinks the reader might need it. A long proof, a computer program supporting some calculations, details of a procedure, or a table of raw data supporting a graph, would all be good candidates for placement in an appendix. Usually an appendix is included for the sake of completeness, or to allow the reader to extend the results, or just to give extra detail.

If there is more than one appendix, label them with letters of the alphabet, "Appendix A," "Appendix B," and so forth. The headings "Appendix" or "Appendix A," etc. are level one headings, the same as "Introduction," and "Conclusion." Any headings within an appendix are level two or lower.

You might refer to the appendix once in the body of the report to explain its purpose. (As in: "See Appendix A for a precise table of the data.") If you are compelled to refer in detail to an appendix (As in: "See the second line of data in Table B2 in Appendix B") then the material is not extra—not an appendix.

I. *References and the Citation Order System*

For this class, do not use footnotes. Use endnotes instead. All the references (the complete descriptions of the sources) should follow the appendices (if any) or the conclusion. Use square braces enclosing a number to make a citation. You might think of the citation as a hard-copy version of a hypertext link.

Usually a citation is tacked on to the end of a sentence just before the closing punctuation. Here is an example: "The details of IEEE style are published on the World Wide Web [1]." It is acceptable to consider the braced citation to be a noun in the context of a sentence. For example: "A standard reference at Dordt College is [4]." The citation may appear anywhere in a sentence except at the start. Do not write, "[4] is a standard reference." Place the citation at the close of the most appropriate phrase if it does not apply to the whole sentence. For example, "There are many style guides. IEEE [1] and ASME [5] each offer their own similar versions.

Arrange the endnotes under a first level heading such as "References" or "Works Cited." *List them in the same order they are* *cited* in the report. This technique is called the *citation order system*. It is completely standard now in all engineering writing. This tends to cause the references listed near each other in the endnotes to be topically related. This helps researchers quickly find related literature. Listing references in order of citation is usually not recommended in the humanities. For those interested, Day, who is not an advocate of the citation order system, has a discussion of two alternatives along with his reluctant acknowledgement of the wide acceptance of the citation order system [7, pp. 53–55]. (Professor De Boer does not agree with Day on this matter but you might like to read the other side of the story.)

Page numbers in references are needed when you cite a specific quotation or paraphrased section or in some other way work with a specific section of the work. If you reference the work in a general way, omit page numbers. If a reference is cited only once, the page number can be put at the end of the citation in the "References" section. For example, this might appear in the body of the report:

> The maximum power transfer theorem [84, pp. 59–61] does not apply in this situation because the system is nonlinear. A good explanation of linearity can be found in [85]. An impedance match is also needed in order to prevent reflections on the transmission line [84, p 352]. A general book on electromagnetics, for example [86], contains all the theory needed to understand these topics.

The endnotes for the above quotation might be as shown below (The first 83 endnotes are not shown here.)

[84] A.S. Sedra, K.C. Smith, and J.M.F Moura, *Microelectronics*, 3rd Ed., New York, NY: Oxford University Press, 1991.

[85] W.H. Hayt, Jr, and J.E. Kemmerly, *Engineering Circuit Analysis*, 4th Ed. New York, NY: McGraw-Hill, 1993, p 156.

[86] D.F. Dumber, *Engineering Electromagnetics*, Spearfish, SD: St. Nobel Press, 1984.

Note that reference [85] has a page number at the end to identify the location of the "explanation of linearity" but references 84 and 86 appropriately have no page numbers.

For other matters relating to the format of endnotes, use the IEEE style guide. If that does not cover the need, use APA style, reinterpreted as needed to blend unobtrusively with IEEE style. In other words, see what content an APA style reference would have, then arrange it so that it looks like an IEEE style reference. Also, when there are two or more authors, list them all in the style illustrated above and in the order they are listed on the title page (not the cover) of the original work.

Most word processors can automatically number citations and references. In Microsoft Word, from the top menu line click on **Insert | Footnote**. . . to insert an endnote citation and the reference. Word also annoyingly and automatically inserts a short line above the reference section. You should remove it. To do this, click on **View | Normal**, then start again: **View | Footnotes**. A new window opens near the bottom of the screen. In that window there is an “Endnotes” box. In that box, select “Endnote Separator.” Then delete the separator. To get out of this special editing mode, click the “close” box in the lower window and then return the view to your usual mode, probably **View | Print Layout**.

If a work is cited more than once, reuse the reference number. This is called a *cross-reference* in some word processors. In Microsoft Word, click on **Insert | Cross-Reference**. . . to reuse a reference number.

For details on how to automatically manage numbering of citations and references, see your word processor’s help system. In Microsoft Word, the section on “working with long documents” contains the help on endnotes. Alternatively, get a book from the library on using your word processor. One example is *Using Microsoft Word 2000* [11] which is usually on reserve and available electronically via the Dordt College Library. There are many of these types of books. Take some initiative on your own if needed to find other books. You can find one to meet you at your level of ability. If you need a book of your own, browse the shelves at a large bookstore like Barnes & Nobel so that you can thumb through a goodly number of books before purchasing one.

Automatically numbered items are usually clickable hypertext in a word processor. Clicking on a citation field will switch your view to the reference and vice versa. If the reference is to a web site, clicking on the URL in the reference will usually get you to the web site. These automatic features might not be worth the effort if you only have one or two sources. In that case, just type them as ordinary text.

VI. FONTS

Usually when people speak of a "font," they really are talking about a "typeface." Many people do not use these words correctly—they use these words interchangeably. In the printing industry these words have been distinctly defined for over a hundred years.

A typeface is a style of type, such as Times New Roman or Arial. There are also families of typefaces. Times New Roman and *Times New Roman Italics* and **Times New Roman Bold** are three separate typefaces—they have different styles—but they all belong to the Times New Roman family of typefaces.

A font is a complete specification of type in a given size and typeface. "Ten Point Times New Roman" is the name of a font rather than a typeface because it completely specifies the characters (size, effect—no italics or bold in this case, and face). Before the age of Microsoft (and mechanized typesetting in general), the *font* for "Ten Point Times New Roman" was a *tray* which contained many pieces of lead type—all the letters of the alphabet, both upper and lower cases, with punctuation marks and numbers. Understanding that the people who operated the printing presses incurred monetary expense for each font (tray of type) they used will help you understand why it is traditional to minimize the number of fonts in a document.

Typesetters used to rely on one, two or three *fonts* (not typefaces) to produce a document. These fonts were carefully chosen in order to enhance the readability of the document at minimum cost. Using a word processor eliminates the economic penalty of including more fonts in your document, but too many fonts causes other problems. If you ignore the past traditions, you will end up with documents that are hard to read. Only criminals like lots of fonts—for ***R****a***n**S**o**m nOtes! [9, p147]

The typefaces you use are meaningful. Consider this example:

"This Do In Remembrance of Me"

"This Do In Remembrance of Me"

and this example:

Shootout at the OK Corral

Shootout at the OK Corral

In the top example the Gothic typeface conveys reverence and respect for the age-old words of Christ. In the bottom example the Playbill typeface suggests a western theme. In both cases, a judicious selection of the typeface adds appropriate meaning to the words. For this reason, choose business-like typefaces for a business-like report. There are *some* cases where a decorative font is appropriate, usually for the title.

There are three categories of fonts used in business writing. The categories have names. The *title* category is used only on the cover (and possibly on the inside first page—the title page—if there is a title page) for the main title of the document. The *display* category is used for most headings, text in figures and graphs, and other text outside the main flow of the text. The *body text* category is used for the main flow of the text. To cut the number of fonts from three to two, you may use the same font for the body text and title categories. To cut it down to one font, use the same font for all three categories.

People assign each style in a document to a particular category of font. Here I am using the word “style” in the sense that modern word processors define the word, but typeface and font in the traditional senses that typesetters of ages past have used. If you are unfamiliar with “styles” in word processing, check your word processor’s online help. In Microsoft Word, click on **Help | Microsoft Word Help | Contents tab | Formatting | Formatting with Styles**, and read from there. Whether you decide to use the automatic styling features of your word processor or instead decide to set all the typefaces, text sizes, and other effects manually, the information in the online help system can help you understand the following paragraphs.

Some typical styles that are usually used in an engineering report are, “Title,” “Heading 1,” “Heading 2,” “Body Text,” “Caption,” and “Endnote.” That list names six different styles, but there are only three categories of fonts used for the design of all six styles. As an example, here is how a document could be styled:

Suppose the title category is assigned the Brush Script MT 15-point font. The display category is assigned to the Arial Bold 10-point font. The Body Text category is assigned to the Garamond 10-point font. These assignments are not done in the word processor—this is a human decision. Now turn to the word processor and set up the styles. (In Microsoft Word, **Format | Style**. . .) Either edit the Title style or create it and set the typeface to Brush Script MT, set the text size to 15 points, and the paragraph formatting to “centered.” Then continue in this manner to set up the other styles. When you set up Heading 1, be sure to use the Arial typeface, set the size to 10-points, and make it boldface. This is because you wish to assign the Heading 1 style to the Display category of fonts. In addition, you might decide that Heading 1 will be all capital letters, centered, and numbered with Roman numerals. All these things can be specified when you set up the style. Later, when you type a first level heading you can select the text, and then specify that it is in Heading 1 style. Your word processor will then set all the attributes of that text automatically. In a similar manner, set up the Heading 2 (use the display font), Caption (display font), Body Text (Body Text font), and Endnote (Body Text font) styles. If you are completely traditional, there will be at most only three fonts in the entire document. A traditional style will typically rely heavily on paragraph and character formatting (right justified, centered, indented, numbered, all capitals, etc.) to convey differences because of the limitation on the number of fonts.

In our times, you may usually depart a bit from tradition by using three *families* of typefaces, increasing the number of fonts in a document. A family of typefaces includes all the effects and sizes. For example, the Times New Roman *family* includes all sizes of regular, italics, bold, bold italics, underlined, strikethrough, and so forth.

Some typefaces are serif faces and some are not. A serif is a fine line (or little decoration) projecting from the main stroke of a letter to guide the reader's eye on a horizontal line. The body text of this handout is done in a serif typeface. A sans-serif typeface omits these decorations. The word "sans" is derived from French and means "without." "Sans serif" could be said to mean "without decoration." Research has shown that most people can read a serif typeface faster then a sans-serif typeface. For this reason serif typefaces are usually preferred for the body text category of styles.

The body text and display categories of styles are usually assigned complementary typefaces. If one is a sans serif typeface, the other should be a serif typeface. Usually the display category is assigned the sans serif typeface. Sometimes the assignments are vice versa, but they should be complementary unless only one family of typefaces is used, in which case both should be the same.

An example of a common pair of typeface families used for business writing is "Times New Roman" for the body text and title categories and "ARIAL" for the display category. (When only two families of typefaces are used, the title is usually done in the body text family of typefaces, but larger and possibly with an effect like bold or italics). Furthermore, it is possible to use only one family of typefaces for all three categories.

Many people perceive that the more text sizes and typefaces that are used, the more fashionable or trendy the document appears to be. Usually trendy is not the effect you want for an engineering report. If you want to project authority and professional workmanship, one or two families of typefaces might be more effective. Compare the typesetting in a popular magazine (e.g. "Sports Illustrated") to that in the Encyclopedia Britannica!

	One Family	**Two Families**	**Three Families**
Title	Garamond	Times New Roman	Brush Script MT
Display	GARAMOND	**Ariel Bold**	**Ariel Bold**
Body Text	Garamond	Times New Roman	Garamond

Table 1. Some example possibilities for assigning typefaces.

Using fonts in a more traditional manner tends to help your reader focus attention on the content of your writing. Every new font, and especially every new typeface that does not fit a pattern causes distraction. The reader is likely to skip forward and glance at an unusual typeface before actually reading the preceding text. That makes it harder for the reader to follow your discussion because the reader is not actually going through the text in the order you intended. On a previous page, did you read "This Do In Remembrance of Me" out of context before reading the accompanying text?

Flip though a journal, magazine, or book and see if you can understand how the publisher designed styles using the three categories of fonts.

VII. VOICE, TENSE, PERSON

Lab reports are written in the past tense and in the third person with respect to decisions and observations. Correct: "The meter needle deflected to half-scale." Use present tense for states of being. Correct: "The meter is connected in parallel with a shunt resistance."

You should prefer to use the active voice. Writers sometimes confuse instructions to write in the third person and construe that to mean that passive voice is preferred. This is not the case. Passive voice is drab. It tends to be wordy and full of meaningless prepositional phrases needed only to string the ideas in the sentence together. At least half of your sentences, or even three-quarters of them, should be in the active voice.

Here is an easy technique to avoid passive voice: Write so that the subjects of your sentences do things. The subject does not have to be a person. Here are some examples:

First Person (to be avoided even though it is active): We used power resistors due to the high environmental load." Here is the sentence edited to use third person (good) by resorting to passive voice (dull-sounding): "Power resistors were used due to the high environmental load." Here is how it can be written in the active voice: "The high environmental load required the use of power resistors." Now the point gets brightly punched right through to the reader. Note that in the passive sentence the power resistors do nothing of their own nature—they merely "were used." The sentence must labor on to explain why. In the active sentence the "environmental load required"—the subject did something by its own nature.

Another example. . . First Person (to be avoided even though it is active): "We confirmed the abnormal behavior of the circuit with oscilloscope measurements." Passive (even worse than first person): "Confirmation of the abnormal behavior of the circuit was obtained by oscilloscope measurements." Active (best): "Oscilloscope measurements confirmed the abnormal behavior of the circuit."

Passive: "A fast-acting fuse is required by the electrical code to protect the electronics." Active: "The electrical code requires a fast-acting fuse to protect the electronics."

Passive voice does have a proper role when you want to draw attention to the receiver of action more than the doer. For example, "The motivation for this technique was to reduce cost." Here the subject, "motivation" is not the most important concept. The passive voice of the sentence appropriately down-plays the subject.

VIII. NUMBERS AND UNITS

A. Units

Units should be abbreviated with only a few exceptions. All unit abbreviations are spaced from the numbers. For example, "12 V" in place of "12 volts" is correct but "12V" is incorrect. Correct: "It took 12 s to charge the capacitor." One exception is that percentages are not spaced. Correct: "The resistor had a 5% tolerance."

Abbreviated units go with numerals and spelled out units go with spelled out numbers. When numbers need to be spelled out, then spell out the units too. Correct (because numbers at the start of a sentence need to be spelled out): “Seven ohm resistors worked best. The power dissipation was only 0.3 W in that case.” Also correct: “The best resistors were 7 Ω.”

All units are lower case except for unit *abbreviations* that are derived from names. For example, K for kelvin, not k. For another example, “15 Hz” for frequency but not “15 hz” and not “15 Hertz.”

Your word processor may have the names of famous people in its dictionary. If so, it might flag words such as “hertz” or “ampere” as being improperly capitalized. Don’t let it fool you. If it is a spelled out unit, always make it lower case. Nine Hertz could be a large family, but nine hertz is a frequency. Maybe you can add the unit to your local dictionary in lower case so that your word processor stops tempting you with bad advice.

A special note on kelvins: the small circle standing for the word “degree” is not used with the unit kelvin. For example, 290 K, not 290 °K. The omission of the “°” for kelvins is a recent development. You may still see it used in older books. It has also become fashionable to say “two hundred ninety kelvins” instead of “two hundred and ninety degrees kelvin.”

B. Abbreviated units must be on the same line with the number.

For example, “the line was regulated to 120 V.” is correct. “The blackout was ultimately traced to a tree branch shorting the 345 kV transmission line” is incorrect. You should use *non-breaking* spaces to make the number and the unit stick together. In most word processors, you type a non-breaking space by holding down the control and shift keys while you type the space. Type, “3 4 5 [hold down the control and shift keys as you type a space, let up the control and shift keys] k V” to type, “345 kV” in such a way that the “345” and the “kV” will stick together as if they make one word. Your word processor might show the non-breaking space via a special character on the screen, but it will print a regular space.

C. Scientific Notation

Scientific notation is superior for conveying either precision or uncertainty because the number of significant digits is obvious in the mantissa. In contrast, engineering notation is better for comparative contexts and conveying an overview of the numbers.

Consistently use either scientific or engineering notation for large or small numbers in your report. If scientific notation is used for large or small numbers, then there should be no numbers in engineering notation except in a few special cases, such as a direct quotation.

If you decide to use scientific notation, the correct format requires the mantissa to be greater than or equal to 1 and less than 10. Prefixes may not be used on units. Negations in exponents and elsewhere should be made with *en*-dashes (see page 37), not hyphens. Examples:

right: 1.56×10^{5} V
wrong: 1.56×10^{2} kV (prefixed unit)
wrong: 156×10^{3} (improper mantissa)
right: $3.2 \times 10^{–1}$
wrong: 3.2×10^{-1} (a hyphen for negation in the exponent)

D. Engineering Notation

Engineering notation is superior for conveying an overall picture of the data and for comparative contexts. In contrast, scientific notation is superior for conveying either precision or uncertainty because the number of significant digits is obvious in the mantissa.

If you decide to use engineering notation, express the number in scientific notation except place the decimal such that the mantissa is greater than or equal to 1 and less than 1000 and such that the exponent is divisible by 3. Then substitute one of these standard prefixes for the exponent:

atto	a	$10^{–18}$	kilo	k	10^{3}
femto	f	$10^{–15}$	mega	M	10^{6}
pico	p	$10^{–12}$	giga	G	10^{9}
nano	n	$10^{–9}$	tera	T	10^{12}
micro	μ	$10^{–6}$	peta	P	10^{15}
milli	m	$10^{–3}$	exa	E	10^{18}

Note that if the exponent is negative, the abbreviation of the prefix is lowercase. If the exponent is positive, the abbreviation is uppercase, with the *exception of k for kilo* so that it is not confused with K for kelvin. (The abbreviation for a kilokelvin is kK.)

Obsolete prefixes (except dB for “decibel” is still OK):

angstrom	A	$10^{–10}$
centi	c	$10^{–2}$
deci	d	$10^{–1}$
deca	da	10^{1}
hecto	h	10^{2}

Combinations of prefixes are obsolete. For example a number like, “10 µµF” was once acceptable. It meant “ten micro-microfarads” or, in pseudo scientific notation $10 \times 10^{-6} \times 10^{-6} = 10 \times 10^{-12}$ F. The modern notation would be 10 pF meaning “ten picofarads.”

Engineering Notation	**WRONG**	**Scientific Notation**
23 kV	23 KV	2.3×10^{4} V
210 nV	0.00000021 V	2.1×10^{-7} V
999 kW	999000 W	9.99×10^{5} W
1.000 MW	1000 kW	1.000×10^{6} W
1.000 mW	1000 µW	1.000×10^{-3} W
15 K	0.015 kK	1.5×10^{1} K (kelvin)
10 km	10000 m	1.0×10^{4} m
500 kJ	500 KJ	5.00×10^{5} J

Table 2. Examples of engineering and scientific notation.

E. Comparative Contexts

With scientific and engineering notation, improper mantissa formats may be used when numbers appear in a comparative context. Examples: “The reference voltage which is nominally 1.00×10^{-6} was actually observed to be 0.94×10^{-6}” or, “The tube was rated up to 750 kV but due to a short in a transformer, over 5000 kV was applied.”

Write Numbers in comparative contexts in the same style:

Correct: “The sample was between eighty and two-hundred years old.”
Correct: “. . . between 80 and 200 years old.”
Incorrect: “. . .between eighty and 200 years old.”
Correct: “There were either 8 or 256 bad bits.”
Incorrect: “. . . either eight or 256 bad bits.”
Incorrect: “. . . either eight or two-hundred-fifty-six bad bits.” (too bulky)

F. Significant digits

Use the correct (or a reasonable) number of significant digits. When scientific notation is used, the least significant digit of the mantissa is assumed to be in doubt due to the limited accuracy of a measurement, or due to round off error.

When engineering notation is used with an integer-valued mantissa ending in zero(s), the number of significant figures is impossible to discern. For example, consider a measurement that is denoted as 100 kV. Maybe it has one, two, or three significant figures. However, if it had been denoted as 1.0×10^5 V then it clearly has two significant figures. Perhaps the actual amount was closer to 0.9×10^5 V or 1.1×10^5 V. There are some situations where engineering notation should not be used since it obscures the number of significant digits.

G. No Leading Decimal Points

A fractional decimal amount must always have a leading zero to call attention to the decimal. The bad habit of omitting the leading zero seems to be getting more common in student writing and in popular media such as newspapers and magazines. In engineering and scientific writing the leading zero is a must. Correct: 0.25 W. Incorrect: .25W.

~~.01~~ 0.01

Figure 4. No leading decimals!

H. No Line Breaks in Numbers

In scientific and engineering notation the mantissa, the exponent, and any abbreviated unit must not be separated by line breaks. Use non-breaking spaces and *en*-dashes (page 35) to fix these problems.

Twice Wrong : "The reference voltage, nominally 5.00
$\times 10^{-6}$ V, was actually observed to be $5.04 \times 10^{-}$
^{6} V." (both line endings above are wrong)

Correct: "The reference voltage, nominally
5.00×10^{-6} V was actually observed to be
5.04×10^{-6} V."

Incorrect: "The cathode ray tube was rated up to 750
V but due to a short. . ."

Correct: "The cathode ray tube was rated up to
750 V but due to a short. . ."

I. Numbers—when to spell out.

Cardinal numbers are *integers* used for counting or showing how much of a quantity. Ordinal numbers show relative order or sequence such as first, second, and so forth. In scientific and engineering writing cardinal and ordinal numbers are spelled out *only if there are no units* associated with the numbers and the number is one hundred or less. There are several infrequent exceptions to that rule. Spell out numbers less than one hundred at the start of a sentence (exception 1) or in sections of the report that reflect common language such as, "The launch followed a ten second countdown." (exception 2)

Correct: "The three leads of the transistors would not fit in the board since two of the holes were undersized." (Normal rules—these are cardinal numbers less than one hundred.)

Incorrect: "The 3 leads of the transistors would not fit in the board since 2 of the holes were undersized." (no units on the numbers and they are less than or equal to one hundred so they should be spelled out.)

Correct: "The 2 ft. pipe extender worked well."

Incorrect: "The two foot pipe extender worked well."

Correct: "Two-foot pipe extenders worked well.

Correct: On average, 2.5 assemblies failed per day.

Incorrect: On average, two-point-five. . . (not an integer)

Ordinal numbers in titles should always be spelled out except in a trademark (exception 3). Correct: "First Bank," "Third Street." Correct because it is a trademark: ". . . the Tru64 operating system." Incorrect: ". . . the True Sixty-Four operating system."

Spell out cardinal or ordinal numbers preceding numerical compound modifiers and use a dash to attach the units to the second number (exception 4). Correct: "In lot 23, four-hundred-forty 750-Ω resistors failed."

Numbers not used for counting or showing order (not cardinal or ordinal numbers) should be expressed as numerals (not spelled out). Some examples are model numbers, figure, equation, and table numbers, lot numbers, serial numbers, statistics, and numbers in addresses. Correct: "A Hewlett Packard model 34 calculator has the necessary functions."

Logic levels 1 and 0 are not cardinal or ordinal numbers, thus they should be rendered as numerals. Sometimes clarity can be enhanced by using "logic-1" and "logic-0" instead of plain "1" and "0."

J. Numbers and Variables at the Start of a Sentence

Sentences may not start out with numerals, awkwardly long spelled-out numbers (more than three words or including "point"), or variables.

Incorrect:	"75 W diodes were workable." (passive too!)
Correct:	"Seventy-five watt diodes worked." (active too!)
Correct:	"The circuit worked with 75 W diodes."
Incorrect:	"4400 volt motors were used."
Incorrect:	"Four-thousand-four-hundred-volt motors. . ."
Incorrect:	"Four-point-four kilovolt motors were used."
Acceptable:	"The voltage of the motors was 4400 V."
Correct:	"The voltage of the motors was 4.4 kV."
Incorrect:	"*X* was 1 most of the time."
Acceptable:	"Input *X* was 1 most of the time."
Correct:	"Input *X* was logic-1 most of the time."

K. Plural Numbers

If a number is plural, add an apostrophe and s. Correct: "The bits were all 1's." (The "1" is not a cardinal or ordinal number, thus it should not be spelled out.) "The defective display just flashed all 8's."

IX. EQUATIONS & VARIABLES

Most modern word processors have good equation editors. In contrast, Mathcad's equations are unacceptable for inclusion in a report. (Unless you are reporting on or including a Mathcad file—in which case you may copy the equations along with the rest of the file.) With WordPerfect and MS Word, the usual mouse sequence to insert an equation is **Insert | Object | Equation**. Actually, the last item might be "Microsoft Equation 3.0" or "CorelEquation! 2.0" or some such variant.

The equation editor allows you to insert radicals like $\sqrt{2}$ and overbars for Boolean logic expressions like $\overline{A}\,\overline{B}+C$. It will handle integrals, summations, and practically everything you could ever need. Be careful to insert spaces as needed between characters with overbars. Note that $\overline{A}\,\overline{B}\,\overline{C} \neq \overline{ABC}$. The equation editor can handle double overbars, such as in Equation 1 below.

$$\overline{A\overline{BC}} = \overline{A} + BC \qquad \text{(Eq. 1)}$$

If you need help getting the equation editor to do what you want, ask your instructor or an experienced user for help. In most cases, the equation editor does a good job of formatting everything for you, but there are some things to watch. Variables are supposed to be in italics to set them off from regular text. On the other hand, if a variable is denoted with the Greek alphabet (upper or lower case), then it should not be in italics because it is apparent from context that it must be a variable. Thus, $f(t)$ is correct and $f(\mathrm{\lambda})$ is also correct (e.g. in $f(\lambda)$ the italic "λ" is wrong).

Units and function names (e.g. "cos") should be in regular type, not italics. They are not variables which is what italics signals.

Numbers in superscripts or subscripts must not be in italics. They are too hard to read in italic type. For example, x^4 is correct but x^{4} is not correct.

If your equation editor is not rendering things correctly (for example, numeric subscripts come out in italics), try the **style | define**. . ., sequence of mouse clicks (from the top menu bar) to see if you can set your equation editor straight. You can look in most engineering textbooks for lots of examples of how a properly formatted equation should look.

A sentence must not start with an equation or variable.
Incorrect: "*T* became zero when a timeout event occurred."
Correct: When a timeout event occurred, *T* became zero.

Equations must not have line breaks in them if they are short enough to fit on one line. For example, $a^2 + b^2 = c^2$ is good but $a^2 + b^2$
$= c^2$ is wrong. If you are typing an equation as text (not using the equation editor) you can use *non-breaking spaces* to make your equations stick together on one line. (Search for "non-breaking space" in your word processor's help system.) If your equation is too long to fit on one line, then it is desirable to place the line break(s) either before an "=" symbol or after a "+" or "–" symbol. If there are three or more parts that are equal and all three parts will not fit on one line, then it is best to start the second line with an "=" symbol. Here are some examples:

$$f(t) = 10\cos(5t) + 9\sin(5t) + 8\cos(4t) + 7\sin(4t) + 6\cos(3t) + \\ 5\sin(3t) + 4\cos(2t) + 3\sin(2t) + 2\cos(t) + \sin(t)$$

$$\begin{aligned} x(2) &= x(0) + x(1)W^2 + x(2)W^4 + x(3)W^6 + x(4)W^8 + x(5)W^{10} \\ &= 2 + (-a - jb) + (-a + jb) + (0) + (-a - jb) + (a - jb) \end{aligned}$$

If you are typing an equation but not using the equation editor, just typing characters in a line of text like, "$(a_1 + a_2)/2 = avg$" then you must set variables in italics yourself, etc. A few details are not so obvious. There must be spaces around operators like "+," "–," "×," "÷," and "=" but no spaces around a "/" or for implied multiplication or around a colon used for a ratio. Correct: "π/2" and "2π" and "8:1" Incorrect: "π / 2" and "2 π" and 8 : 1." The symbols for multiplication and division, "×," "÷," and others such as "±" and "≥" come from the **Insert | Symbols** menu in most word processors.

The symbol for subtraction is an *en*-dash. In most fonts there are three types of dash-like symbols of increasing width, like this "-," "–," and "—." The first symbol is a hyphen. The middle symbol in that list is called an *en*-dash, and it is what you use for the "minus sign." To type an *en*-dash, hold down the control key, and then type the "–" key on the numeric keypad on the extreme right-hand side of the keyboard. *Always use an* en-*dash for subtraction*.

An *en*-dash is also used for negation and to indicate a range of numbers as in, "The line voltage is usually in the range of 115–125 V rms." Use *no spaces* with an *en*-dash for negation or a range of numbers. Use spaces appropriately in math expressions. (e.g. "The current was –3.4 mA, calculated as 2.5 – 5.9 = –3.4").

The longest symbol, "—," is an *em*-dash. When you press the "hyphen" key, located on the top row of keys between the "0" and the "=" keys, you get the shortest mark, the hyphen. In most word processors you "type" an *em*-dash by typing two hyphens in a row with no spaces on either side of the hyphens. Type: "like--this " and you will get, "like—this ". An *em* dash is used as a punctuation mark to indicate a sudden break or change in a sentence. Since an *em*-dash must never have spaces on either side of it, the word processor recognizes the sequence of two hyphens with no spaces and automatically replaces it with a proper *em*-dash. [3, Sec. 591], [4 Sec. 584]

Short equations and expressions may be placed in-line in the text, as in, $a^2 + b^2 = c^2$. Longer or taller equations should be displayed—that is centered on a line of their own such as below. You can give them an automatically generated equation number, just as you might number a figure or table (**Insert | Caption**, and then select an equation label). You should use tabs to center the equation and place the equation number against the right margin. If you need to, you can cite equations by number in the body of your text.

⊥ ⌋

→ $$c_n = \frac{1}{T}\int_0^{T/2} f(t)\cos k\omega_0 t\, dt$$ → (Eq. 2)

In the example above, the arrows (→) represent tab characters which normally do not print. The "⊥" and "⌋" represent tab marks in the ruler line. They also do not normally print. They are shown here just for illustration. If you are unfamiliar with setting tabs, do these things: First, make sure the ruler line is displayed. In Microsoft Word, on the View menu, make sure "ruler" has a check mark by it. Then from the Help menu, click on Microsoft Word Help, then the Index tab, then search for "set tab stops". Note that the upside-down "T" (⊥) is a centering tab mark and the backwards "L" (⌋) is a right-justified tab stop. If you are still confused, ask your instructor for help.

X. OTHER MATTERS OF STYLE

A. Double Spacing, Margins, Page Numbers, Dates

Double-space the text in your report except for the table of contents (if any), text in figures, such as labels or computer code, and references. Put a double space or extra white space between references, as at the end of this booklet. Indent the first line of a new paragraph to make it stand out. Double-spacing facilitates marking the report.

Leave about an inch of margin around the top, bottom, left, and right of the text. Page numbers, dates, headers, and footers when used should appear in the 1 in. margin area, but they may not be obscured by bindings or stapled corners. Use standard size 8.5" by 11" white paper.

Page number one is the page that has the start of the "Introduction" on it (or the "Abstract" if there is one). If two-sided printing is used, page one must be face up in the stack. Often you need to insert a blank page just before the abstract or introduction to make this happen. In other words, the introduction should not be printed on the backside of the cover sheet or table of contents (if present).

As explained earlier in this handout, page number one has a special header with the title, author's names and date. The page number is not displayed on page one; it is obvious from the special header.

Pages between the cover page and page one (if any), the table of contents for example, are numbered with roman numerals starting at "i." (The cover page is *not* page i or page 1. It has no number.) Once again, page "i" should sit in the stack face up, if such a page exists.

You may use your word processor's header or footer feature to achieve automatic page numbering. Type the date as regular text so that the date does not change when the document is opened or printed on a later date. Change the date manually only when the document is edited. This way all printings of the same version will have the same date.

B. Computer Listings

Include textual computer output (such Matlab, or C++ source code, memory listings, etc.) single spaced as a figure. If the listing is short, you may indent it into the text single spaced in the style of a long quotation. The listing should not go over a page boundary unless the listing is too long to fit on a single page. If the program listing is long (say several pages) then it should probably be put in an appendix, with only a few relevant portions copied into figures in the body of the report. For professor De Boer's assignments, always include a complete listing of any source code you wrote somewhere in the report or an appendix.

Use a fixed pitch typeface for computer listings. This makes comments, columns, tables, and indentations appear correctly. You may ignore the usual rule of using only the fonts planned for the categories of title, display and body text. Choose a fixed pitch typeface and font size that blends in as well as possible with the body text. If the body text is a serif typeface, choose a serif typeface for the computer listing as well. For example, `Courier New` works with most serif typefaces.

Do not let long lines wrap. Instead, use a smaller font (8 points is about the minimum acceptable however) or switch the figure to landscape format, or write the source code using shorter lines in the first place. On the next page are good and bad examples.

```
function [out, SEED] = rand_cn(NSIZE, VAR, MEAN, SEED)
   if (nargin == 4) rand('seed',SEED); end
   if (nargin  < 3) MEAN = 0;          end
   if (nargin  < 2) VAR  = 1;          end
% Main code
u     = 2*pi*rand(1,NSIZE);            % Uniform in 0 to 2pi
r     = sqrt(-2*log(rand(1,NSIZE)));  % Rayleigh
out   = r.*(cos(u)+j*sin(u));         % zero mean Gaussian
out   = sqrt(0.5*VAR)*out + MEAN;
if (nargout == 2)
   SEED = rand('seed');
end
```

Figure 5. A good example of a computer listing.

```
function [out, SEED] = rand_cn(NSIZE, VAR,
MEAN, SEED)
   if (nargin == 4) rand('seed',SEED); end
   if (nargin  < 3) MEAN = 0;          end
   if (nargin  < 2) VAR  = 1;          end
% Main code
u     = 2*pi*rand(1,NSIZE);           %
Uniform in 0 to 2pi
r     = sqrt(-2*log(rand(1,NSIZE)));  %
Rayleigh
out   = r.*(cos(u)+j*sin(u));         %
zero mean Gaussian
out   = sqrt(0.5*VAR)*out + MEAN;
if (nargout == 2)
   SEED = rand('seed');
end
```

Figure 6. A bad example of a computer listing—font is too big causing lines to wrap.

```
function [out, SEED] = rand_cn(NSIZE, VAR, MEAN, SEED)
  if (nargin == 4) rand('seed',SEED); end
  if (nargin  < 3) MEAN = 0;          end
  if (nargin  < 2) VAR  = 1;          end
% Main code
u     = 2*pi*rand(1,NSIZE);           % Uniform in 0 to 2pi
r     = sqrt(-2*log(rand(1,NSIZE)));  % Rayleigh
out   = r.*(cos(u)+j*sin(u));         % zero mean Gaussian
out   = sqrt(0.5*VAR)*out + MEAN;
if (nargout == 2)
  SEED = rand('seed');
end
```

Figure 7. A bad example of a compter listing—uses a hard-to-read proportional font.

C. Your Professor's Peeves

1.) Wordiness and redundancy: When it comes right down to it, writers should learn to avoid writing styles which do not help the reader but rather hinder and cloud the content of what the writer is really trying to communicate via the text the writer is writing. Basically, in such a case it is a fact that the writer should know how to recognize wordiness and redundancy, that is, the writer should know what wordiness and redundancy look, *read, and sound* like. Here are some words and phrases that often give a clue *to wordiness*: "the fact that," "in this case," "basically." *This whole paragraph is wordy and full of redundancy. Simply take notice and* watch for repeated themes and empty phrases. (*Read it again without the italicized portions*.)

2.) Polemics: Some students write in an exaggerated style, inappropriately appealing to the reader's intuition or emotion. Here is an example of polemics:

> The circuit dissipated an incredible amount of power. It was practically smoking hot. We judged it unsafe because of the excessive heat and power dissipation going on.

Strong adjectives and adverbs are sometimes a clue to a polemic style. Notice how the words "incredible," "smoking," and "excessive" in the example appeal to your intuition rather than to laws, comparisons, or theories. Now read an example that avoids polemics.

> The circuit dissipated 23 W. The resulting case temperature was too hot for a person to comfortably hold for more than about three seconds, an unsafe condition. A rule of thumb states that one should be able to comfortably touch any part of the case for a long time.

This example is like a mathematical proof in words. One thing implies another because of . . . and then it cites the law or theory, etc.

3.) Acronyms and Initialisms: If you frequently use a long phrase, you may parenthetically define an acronym or initialism the first time you use the phrase. Then use the abbreviation throughout the remainder of the document in place of the phrase. Common problems with this strategy are: (1) never defining the abbreviation, (2) defining the acronym with the second or a later occurrence of the phrase rather than the first, (3) using two or more different abbreviations for the same phrase, and (4) failing to use the abbreviation in every possible instance after it is defined.

A bad example: "In Chicago, most of the electric power is sold by CE. In the summer of 1997 Commonwealth Edison (CE) had problems with brownouts. In a fall advertising campaign, Com. Ed. implied that the problems would be solved by 1998, yet once again the Commonwealth had to institute brownouts." (In this incorrect example Com. Ed. is used without definition and "the Commonwealth" is used as a colloquialism for the full name of the company. Either "Com. Ed." or "CE" should be used consistently in all cases. The initialism, "CE," should have been defined before it was used. A corrected version: "In Chicago, most of the electric power is sold by Commonwealth Edison (CE). In the summer of 1997 CE had problems with brownouts. In a fall advertising campaign, CE implied that the problems would be solved by 1998, yet once again CE had to institute brownouts."

A good example: "Since there were only four input variables, Karnaugh maps (K-maps) could be used to gain insight into these equations. The K-maps revealed that each equation contained an identical essential prime implicant (EPI). Reusing this EPI saved the cost of many gates."

4.) Do not use "implement" or "vast": or any variations (e.g. implemented, implementing, vastly). They are vastly worn-out words. A better word can always be implemented—oops, strike that—deployed.

5.) "Inputted" and "outputted" are awkward words:
"Input" and "output" are usually nouns. "The system has three inputs." "The output was overloaded." They can also serve as adjectives: "The output power was adequate."

When input and output are used as transitive verbs, the sentences become awkward: "Sensors input 500 MB/s to the computer." Worse: "Sensors inputted 500 MB/s. . ." Also awkward: "The amplifier outputted 500 W of power." Much better: "Sensors delivered 500 MB/s to the computer." "The amplifier produced 500 W of power. Similarly, avoid using "inputting" and "outputting."

Bad: "The circuit outputs the nine's complement of a four-bit input. Good: "The output of the circuit is the nine's complement the four-bit input.

6.) Do not write, "we think" or anything like that:
The whole point of an experiment is to show evidence of some sort. The phrase, "we think," focuses on you instead of the evidence. Bad: "We feel our design is best." If it is best, prove it. "This design is best because. . . "

7.) Frequently misspelled words ending in "meter": In spite of word processors with built in on-the-fly spell checking, these words are frequently misspelled: ammeter (not ampmeter), milliammeter, voltmeter, ohmmeter. Also, note that they are single words. Your spelling checker will accept "volt meter," and other amateurish phrases like "voltage meter" or "amperage meter" but these are wrong. These words also follow the normal rules of capitalization. That is, they should not always be capitalized because they are not proper nouns.

8.) Spaces go outside parenthesis : When you use parenthesis (like this) the spaces go outside the parenthesis as shown in this sentence. In some computer languages, for example in C++, people put the spaces inside the parenthesis, as in "`cos( omega )`." That makes the computer code more readable, but in a regular English sentence, it makes the parenthetic remark too obvious(this is wrong in the body of a lab report)and makes reading harder (but this reads easily). Also, word processors do not properly handle a parenthesis at a line break (like this)if parenthesis are spaced wrong, but if they are spaced properly (like this) then the parenthesis will stick to the last word in the parenthetic remark and move as one unit to the next line.

9.) Do not use an underline in place of italics: Underlining is used in lieu of italics only if italics are not available, for example if you are using a typewriter. Many college stylebooks have not yet been updated to accommodate modern word processors that can easily create italics. In many places these textbooks recommend underlining where italics are now universally used. For example, in [3, section 371] every example of underlining should actually be rendered in italics (without an underline).

10.) Do not use quotation marks to excuse colloquialism:
Bad: Liquid crystal displays "delay" fast-moving pictures.
Good: Liquid crystal displays cause fast motion to appear smeared.

11.) Do not use "their" as singular for "his or hers":
Bad: A person can serve God by using their talents.
Good: People can serve God by using their talents.
Acceptable, although a bit awkward: A person can serve God by using her or his talents.

XI. REFERENCES

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