

FINAL REPORT WRITING GUIDELINES

For ECSE Senior Design Courses

Rensselaer Polytechnic Institute

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1. THE WRITTEN REPORT

1.1 Purpose

The final report is a professionally prepared document that presents the detailed design of your project. The usual metrics for preparing a design project report in industry are that the intended reader should be able to:

- a) Understand technical and socio-economic rationale for your choice of the system design concept versus other possible options, based on the results of engineering analysis and experiments.
- b) Reproduce your analysis and testing and build/verify the final design without having to ask you questions.

You should keep these metrics in mind as you write your final report.

1.2 Grading

Each member of the project team contributes a proportional share of the actual written material. You will be graded for language, format and for technical content and adequacy. Both individual and team grades will be assigned. The report must receive a passing grade for you to pass the course. Rewrites are allowed until a passing grade is achieved, but once passed, rewritten reports will not be accepted for grade improvement.

1.3 General Guidelines

Begin each chapter on a new page.

Use IEEE-recommended abbreviations with no periods (see Appendix 1). Use abbreviations when a unit is preceded by a number (2 cm); spell out if not (e.g., *the scale is calibrated in centimeters*).

References and appendices (if any) should be included in the Table of Contents. Do not number these as chapters but align them in the Table of Contents with the *chapter titles*, not with numbers.

Use lower case Roman numerals for preliminary pages:

- i. Title page (*not* numbered on page)
- ii. Abstract
- iii. Table of Contents

The text of the report begins with Arabic number 1. Number *all* pages.

Margin boundaries:

- 1-inch left margin
- 0.5-inch margin on the other three sides

The maximum number of pages is 25. Use Times New Roman, size 12 font throughout the report, unless otherwise specified.

1.4 Writing Assistance

You can get help with the writing process, including questions of style, grammar, and organization, through the Writing Center at Rensselaer (Sage 4508, writingcenter@rpi.edu). The PowerPoint document RPI_technical_writing_handout.ppt gives a summary of some of the most important information found in most technical writing classes and texts. This is intended to be a reference to help you develop your writing style to a professional level. It is recommended that this handout is used as a starting point in making this transition. For more information on any of the topics discussed, please seek any of the references provided at the end of the document.

2. FORMAT

2.1 Title Page

The title page is the unnumbered first page. The correct style is:

TITLE (*font size 16-20*)
by
Name of Authors and affiliation (*one per line, font size 16*)
ECSE-xxxx Senior Design Project
Project Advisor: Professor xxxx xxxxxxxxxxxx
Date
Rensselaer Polytechnic Institute

2.2 Abstract

The Abstract is short (200 words or less) and provides enough of a summary of the paper for the reader to decide whether to read the entire document. State very concisely what your project does, and the major points of its design and performance testing. It is important not to confuse an abstract with an introduction. In some contexts, an abstract is called an Executive Summary. The first sentence should give the subject of the report and the last sentence should state the primary conclusion of the report. The abstract should be written in the present tense. The abstract page is numbered *ii*.

2.3 Table of Contents

The table of contents is on a separate page and is numbered *iii*. The table of contents lists the sections of the report along with the page on which they begin. The table of contents serves as both an outline of the report and a means for locating specific sections. The table of contents makes the hierarchical nature of the report evident to the reader, meaning that titles of major section can be differentiated from those of subsections. Some type of numbering or lettering scheme makes this differentiation easier. Use the Table of Contents of these guidelines as your example.

2.4 Body

The body of the report begins on page 1 (Arabic numeral). All subsequent pages are numbered. An outline of the subject matter of the body is given in Section 3.

2.5 References

The references must list all published information sources that are directly quoted or used to support the technical discussion or equations. Reference to these sources must be made at the appropriate points within the report text. Use IEEE style (see Appendix 2) with numbers enclosed in brackets in the text [1]. Each reference is preceded by a bracketed number in the list of references. Example for textual referencing:

Chen [2] states that the horizontal deflection . . .

The list of references is the last section of the text of the report.

2.6 Appendices

Each appendix starts on a new page and has a title that also appears in the Table of Contents. Computer programs, lengthy derivations, relevant technical data sheets, pertinent background material, patents etc. belong in appendices. The last appendix should contain a one-page resume of each team member. No section numbers are assigned to the appendices, but all pages are numbered.

3. OUTLINE OF SUBJECT MATTER

3.1 Introduction

Briefly review and update the material from your project proposal. Describe the function, show the block diagram, and give the performance specifications as they appear in your final proposal. Reformulate specifications. Show that you know what variables are important in your project's performance, and what values they should take on. If in doubt, seek advice. Describe briefly the subprojects into which the project has been divided.

3.2 Design Procedure

Discuss your design decisions for each subproject at the most general level: What alternative approaches to the design were possible, which was chosen, and why is it desirable? Introduce the major design equations, or other design tools used; show the *general* form of the circuits and describe their functions.

3.3 Design Details

Present the detailed design, with diagrams and component values. Show how the design equations were applied. Give equations and diagrams with specific design values and data. (Place large data tables in an appendix.)

3.4 Professional and Societal Consideration

In this section describe how your design choices were impacted by factors such as codes and standards, patents and copyright issues, safety and environmental concerns, ethical dilemmas, or possible diverse economic impact on different segments of society.

3.5 Design Verification

Discuss the testing of the completed project and its major subprojects. Provide solid technical data, and present it in an easily grasped manner, using graphs where possible. Include any standard tests for your type of circuit and all specific ones you feel are needed to prove that the design goals were met.

3.6 Costs

Project costs should be included. Labor cost estimates should use the following formula for each partner:

$$\text{Assumed dream salary (\$/hour)} * 2.5 * \text{hours spent} = \$\text{Total}$$

Include estimates for shop and mechanical hours, as applicable. For parts, use real values when you know them, make realistic estimates otherwise.

3.7 Conclusions

Bring together, concisely, the conclusions to be drawn. The reader needs to be convinced that the design will work. If uncertainties remain, they should be pointed out, and alternatives, such as

modifying performance specifications, should be spelled out to deal with foreseeable outcomes. This is also the place to discuss extensions to the design or future work. Use words only, no equations or diagrams.

4. FIGURES, TABLES, AND EQUATIONS

Figures and tables should be inserted in the text in one of three places:

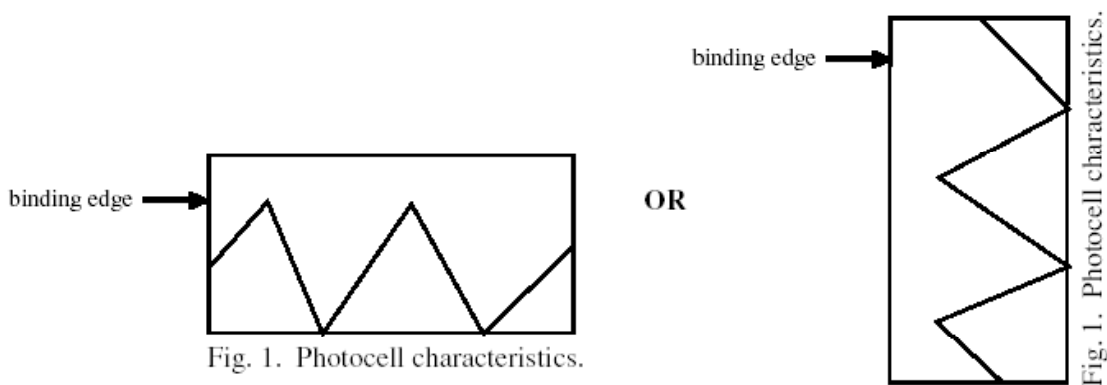
- On the page where they are first referenced
- On a separate, nontextual page immediately following the first reference
- Grouped together at the end of each chapter or at the end of the report

If figures appear at the end of a chapter or the report, at the first mention of Figure 1, make the notation: (*All figures appear at the end of the chapter.*) or (*All figures appear at the end of the report.*).

When *figure*, *table*, and *equation* are followed by a number in the text, capitalize them, e.g., *Figure 1.2*, *Table 3.1*, *Equation (2.5)*. Spell out the words *Figure* and *Equation* if they are used at the beginning of a sentence. Otherwise, within the text, you may abbreviate (Fig., Figs., Eq., Eqs.).

4.1 Figures

Each graph, diagram, etc., should have a figure number and a title typed *below* it. The type style should be the same as the text. If figures must be turned 90° on the page, the caption is placed on the nonbinding edge. See the two versions of Fig. 1 for examples.



Captions must be typed.

Each figure should be referenced by number in the text: “. . . as shown in Fig. 1.”

Number figures consecutively (Fig. 1, Fig. 2) or by chapters (Fig. 1.1, Fig. 1.2, Fig. 2.1, etc.). Whichever numbering system you use, make sure that you follow the same system for tables and equations.

4.2 Tables

Each table should have a number and title typed *above* it, preferably in caps. The type should be the same as the text. See Table 1 for an example.

TABLE 1. COMPARISON OF MEASURED AND CALCULATED POWER

| | |
|-------|-------|
| _____ | _____ |
| _____ | _____ |
| _____ | _____ |

Refer to each table in the text by number: “In Table 1, one can clearly see” The same rules for location of figures apply to tables.

4.3 Equations

Center each equation on a separate line. Number equations consecutively in parentheses at the right margin. Equations may be referenced by number in the text, using parentheses around the number. Example:

The horizontal deflection is

$$x = A \sin \omega t \quad (1)$$

and the vertical deflection is

$$y = B \cos \omega t \quad (2)$$

Squaring and adding Eqs. (1) and (2) yields

$$x^2 / A + y^2 / B = \sin^2 \omega t + \cos^2 \omega t = 1 \quad (3)$$

Only those equations referenced in the text require a number.

APPENDIX 1. RECOMMENDED ABBREVIATIONS

| Unit or Term | Symbol or Abbreviation | Unit or Term | Symbol or Abbreviation |
|---|------------------------|------------------------|------------------------|
| alternating current | ac | footcandle | fc |
| American wire gauge | AWG | footlambert | FL |
| ampere | A | foot per minute | ft/min |
| ampere-hour | Ah | foot per second | ft/s |
| ampere-turn | At | foot poundal | ft-pdl |
| amplitude modulation | AM | foot pound-force | ft-lbf |
| angstrom | Å | frequency modulation | FM |
| antilogarithm | antilog | frequency-shift keying | FSK |
| atomic mass unit (unified) | u | gallon | gal |
| audio frequency | AF | gallon per minute | gal/min |
| automatic frequency control | AFC | gauss | G |
| automatic gain control | AGC | gigacycle per second | Gc/s |
| automatic volume control | AVC | gigaelectronvolt | GeV |
| average | avg | gigahertz | GHz |
| backward-wave oscillator | BWO | gilbert | Gb |
| bar | bar | gram | g |
| barn | b | henry | H |
| beat-frequency oscillator | BFO | hertz | Hz |
| bel | B | high frequency | HF |
| billion electronvolts* | BeV | high voltage | HV |
| binary coded decimal | BCD | horsepower | hp |
| British thermal unit | Btu | hour | h |
| calorie | cal | inch | in |
| candela | cd | inch per second | in/s |
| candela per square foot | cd/ft ² | inductance-capacitance | LC |
| candela per square meter | cd/m ² | infrared | IR |
| cathode-ray oscilloscope | CRO | inside diameter | ID |
| cathode-ray tube | CRT | intermediate frequency | IF |
| centimeter | cm | joule | J |
| centimeter-gram-second | CGS | joule per degree | J/deg |
| circular mil | cmil | joule per kelvin | j/K |
| continuous wave | CW | kilocycle per second | kc/s |
| coulomb | C | kiloelectronvolt | keV |
| cubic centimeter | cm ³ | kilogauss | kG |
| cubic foot per minute | ft ³ /min | kilogram | kg |
| cubic meter | m ³ | kilogram-force | kgf |
| cubic meter per second | m ³ /s | kilohertz | kHz |
| curie | Ci | kilohm | kΩ |
| cycle per second | c/s | kilojoule | kJ |
| decibel | dB | kilometer | km |
| decibel referred to one milliwatt | dBm | kilometer per hour | km/h |
| degree Celsius | °C | kilovar | kvar |
| degree Fahrenheit | °F | kilovolt | kV |
| degree Kelvin** | K | kilovoltampere | kVA |
| degree (plane angle) | ...° | kilowatt | kW |
| degree Rankine | °R | kilowatthour | kWh |
| degree (temperature interval or difference) | deg | lambert | L |
| diameter | diam | liter | l |
| direct current | dc | liter per second | l/s |
| double sideband | DSB | logarithm | lg |
| dyne | dyn | logarithm, natural | ln |
| electrocardiograph | EKG | low frequency | LF |
| electroencephalograph | EEG | lumen | lm |
| electromagnetic compatibility | EMC | lumen per square foot | lm/ft ² |
| electromagnetic unit | EMU | lumen per square meter | lm/m ² |
| electromotive force | EMF | lumen per watt | lm/W |
| electronic data processing | EDP | lumen second | lm•s |
| electron volt | eV | lux | lx |
| electrostatic unit | ESU | magnetohydrodynamics | MHD |
| erg | erg | magnetomotive force | MMF |
| extra-high voltage | EHV | maxwell | Mx |
| extremely high frequency | EHF | medium frequency | MF |
| extremely low frequency | ELF | mgacycle per second | Mc s |
| farad | F | megaelectronvolt | MeV |
| field-effect transistor | FET | megahertz | MHz |
| foot | ft | megavolt | MV |

| Unit or Term | Symbol or Abbreviation | Unit or Term | Symbol or Abbreviation |
|-------------------------------------|------------------------|-----------------------------------|------------------------|
| megawatt | MW | pulse-repetition rate | PRR |
| megohm | M Ω | pulse-time modulation | PTM |
| metal-oxide semiconductor | MOS | pulse-width modulation | PWM |
| meter | m | radian | rad |
| meter-kilogram-second | MKS | radio frequency | RF |
| mho | mho | radio-frequency interference | RFI |
| microampere | μ A | resistance-capacitance | RC |
| microfarad | μ F | resistance-inductance-capacitance | RLC |
| microgram | μ g | revolution per minute | r/min |
| microhenry | μ H | revolution per second | r/s |
| micrometer | μ m | roentgen | R |
| micromho | μ mho | root-mean-square | rms |
| micron† | μ | second (plane angle) | ...'' |
| microsecond | μ s | second (time) | s |
| microsiemens | μ S | short wave | SW |
| microwatt | μ W | siemens | S |
| mil | mil | signal-to-noise ratio | SNR |
| mile per hour | mi/h | silicon controlled rectifier | SCR |
| mile (statute) | mi | single sideband | SSB |
| milliampere | mA | square foot | ft ² |
| milligram | mg | square inch | in ² |
| millihenry | mH | square meter | m ² |
| milliliter | ml | square yard | yd ² |
| millimeter | mm | standing-wave ratio | SWR |
| millimeter of mercury, conventional | mmHg | steradian | sr |
| millimicron‡ | | superhigh frequency | SHF |
| millisecond | ms | television | TV |
| millisiemens | mS | television interference | TVI |
| millivolt | mV | tesla | T |
| milliwatt | mW | thin-film transistor | TFT |
| minute (plane angle) | ...' | transverse electric | TE |
| minute (time) | min | transverse electromagnetic | TEM |
| nanoampere | nA | transverse magnetic | TM |
| nanofarad | nF | traveling-wave tube | TWT |
| nanometer | nm | ultrahigh frequency | UHF |
| nanosecond | ns | ultraviolet | UV |
| nanowatt | nW | vacuum-tube voltmeter | VTVM |
| nautical mile | nmi | var | var |
| neper | Np | variable-frequency oscillator | VFO |
| newton | N | very-high frequency | VHF |
| newton meter | N•m | very-low frequency | VLF |
| newton per square meter | N/m ² | vestigial sideband | VSF |
| oersted | Oe | volt | V |
| ohm | Ω | voltage controlled oscillator | VCO |
| ounce (avoirdupois) | oz | voltage standing-wave ratio | VSWR |
| outside diameter | OD | voltampere | VA |
| phase modulation | PM | volume unit | vu |
| picoampere | pA | watt | W |
| picofarad | pF | watthour | Wh |
| picosecond | ps | watt per steradian | W/sr |
| picowatt | pW | watt per steradian square meter | W/(sr•m ²) |
| pound | lb | weber | Wb |
| poundal | pdl | yard | yd |
| pound-force | lbf | | |
| pound-force foot | lbf-ft | | |
| pound-force per square inch | lbf/in ² | | |
| pound per square inch§ | psi | | |
| power factor | PF | | |
| private branch exchange | PBX | | |
| pulse-amplitude modulation | PAM | | |
| pulse code modulation | PCM | | |
| pulse count modulation | PCM | | |
| pulse duration modulation | PDM | | |
| pulse position modulation | PPM | | |
| pulse repetition frequency | PRF | | |

*Deprecated: use gigaelectronvolt (GeV).

**Preferably called *kelvin*

†The name micrometer (μ m) is preferred.

‡The name nanometer is preferred.

§Although the use of the abbreviation psi is common, it is not recommended. See pound-force per square inch.

APPENDIX 2. IEEE REFERENCE STYLE

Reference numbering in the text for IEEE publications should look as follows:

[1]

[3], [4]

[5]-[7]

These are all to be on the line and within punctuation marks.

Journal Articles

C. D. Taylor and C. W. Harrison, "On thin wire multiturn loop antennas," *IEEE Trans. Antennas Propagat.*, vol. AP 22, no. (if you have it), pp. 407-413, May 1974.

Books

R. G. Harrington, *Time Harmonic Electromagnetic Fields*. New York: McGraw-Hill, 1961, pp. 264-316.

M. Abramowitz and I. A. Stegun, Eds., *Handbook of Mathematical Functions* (Applied Mathematics Series 55). Washington, DC: NBS, 1964.

R. L. Byer, "Optical parametric oscillators," in *Treatise in Quantum Electronics*, H. Rabin and C. L. Tang, Eds. New York: Academic, to be published.

P. K. Cheo, "CO₂ lasers," in *Lasers*, A. K. Levine and A. J. DeMaria, Eds. New York: Dekker, 1971, ch. 2, pp. 111-267.

The Rand Corporation, *A Million Random Digits with 100,000 Normal Deviates*. New York: Free Press, 1955.

Reports

R. C. Hansen, "Tables of Taylor distributions for circular aperture antennas," Hughes Aircraft Company, Culver City, CA, Hughes Tech. Memorandum 587, Feb. 1959.

C. E. Baum, "On the singularity expansion method for the case of first order poles," Air Force Weapons Laboratory Interaction Note 129, Oct. 1972.

Papers

P. Bokley and G. A. Thiele, "On efficiency measurements of electrically small antennas," presented at the Twenty-Third Antenna Symposium USAF Antenna Research and Development Program, Urbana, IL, Oct. 1973.

J. Shapira, L. B. Felsen, and A. Hessel, "Rays and modes for fields excited and observed near a concave surface," in *Dig. URSI Symp. on Electromagnetic Wave Theory*, Imperial College of Science and Technology, London, SW 7, England, July 9-12, 1974.

MiscellaneousManuals

Bell Telephone Laboratories Technical Staff, *Transmission Systems for Communications*, Bell Telephone Laboratories, 1970.

ASTAP (Advanced Statistical Analysis Program), General Manual, GH 20-1271-0, IBM-East Fishkill, Jan. 1973.

Application Notes

Hewlett-Packard, Appl. Note 935, pp. 25-29.

Hughes Aircraft Co., "Tunable millimeter wave detectors and mixers," pp. C-18 - C-19, Aug. 1973.

Catalogs

Catalog No. MWM-1, *Microwave Components*, M. W. Microwave Corp., Brooklyn, NY.

Theses

U. Mingelgrin, "The pressure broadening of the O₂ microwave spectrum," Ph.D. dissertation, Harvard Univ., Cambridge, MA, 1972.

S. Black, "The finite difference method," M.S. thesis, Univ. of Illinois, Urbana, IL, 1986.

Patents

U. Hochuli and P. Haldemann, "Gas laser," U.S. Patent 3 614642, July 8, 1973.

Internet

Computational, Optical, and Discharge Physics Group, University of Illinois at Urbana-Champaign, "Hybrid plasma equipment model: Inductively coupled plasma reactive ion etching reactors," December 1995, <http://uigelz.ece.uiuc.edu/Projects/HPEM-ICP/index.html>.

D. Poelman (dirk_poelman@rug.ac.be), "Re: Question on transformerless power supply," usenet post to sci.electronics.design, July 4, 1997.

Class Notes

J. Greenlaw, "Mentor graphics tutorial: Design of a full-adder," class notes for ECE 290, Department of Electrical and Computer Engineering, University of Illinois at Urbana-Champaign, Spring 1997.

APPENDIX 3. CHECKLIST FOR ECSE SENIOR DESIGN FINAL REPORTS

Pagination/Margins

- ___ Title page unnumbered (counts as i)
- ___ Front matter in Roman numerals (ii, etc.); text begins with page 1
- ___ Minimum of 1-inch left margin on *all* pages (watch those large figures); minimum of 1/2-inch margin on other three sides
- ___ Page number in same location on all pages

Abstract

- ___ On page ii
- ___ Title “ABSTRACT” has same format as chapter titles

Table of Contents

Format

- ___ Preliminary material *not* included (i.e., do not list abstract)
- ___ Chapter titles and subheading format is consistent
- ___ Use leader dots
- ___ Page numbers aligned on right (use right tab function)

Agreement with text

- ___ Wording of chapter titles and subheadings must match table of contents exactly
- ___ Page numbers correct

Figures

Location

- ___ Figures located on same page as first mention in text/next page after first mention
- or*
- ___ All figures located at end of report

Referenced in text

- ___ All figures cited by number in text (e.g., “Figure 1.3 shows . . .”)
- ___ Figures numbered in order of mention in text

Quality

- ___ All wording in figures is readable
- ___ Graphics are clear

Captions

- ___ All figures have descriptive caption (more than just “Figure 4.1”)
- ___ Caption located *below* figure

Tables**Location**

- ___ Tables located on same page as first mention in text/next page after first mention
or
 ___ All tables located at end of report (use same location scheme as for figures)

Referenced in text

- ___ All tables cited by number in text (e.g., “Table 2.1 indicates . . .”)
 ___ Tables numbered in order of mention in text

Quality

- ___ All wording in tables is readable

Headings

- ___ All tables have descriptive heading (more than just “Table 3.2”)
 ___ Headings located *above* table

Equations**Numbering sequence**

- ___ Equations numbered in order of appearance in text
 ___ Numbering scheme matches that of figures/tables

Use of ()

- ___ All equation numbers are within parentheses, whether in display equation or in text
 ___ Equation numbers in display equations are flush with right margin

References**Referenced in Text**

- ___ All references listed are cited in text; all references cited in text are listed

IEEE Style

- ___ References numbered in order of mention in text
 ___ Reference numbers in brackets, e.g., [3]
 ___ Follow guidelines described in Appendix 2

Appendices

- ___ Appear *after* References
 ___ Any figures/tables have some introductory/explanatory paragraph citing figure/table
 ___ Last appendix has team members’ one-page resumes