



Report for

**ECE Class Number**  
**Final Lab Report**

**Lab Section:**

**TA:**

Prepared by  
**Group Names**

Date: September 5, 2006

### ABSTRACT

Summarize in approximately 150-200 words the purpose of the lab project, methods used, key findings, and significant conclusions. The “audience” for your abstract is someone (engineer or manager) who is looking for information and is trying to decide if they should download and read your paper.

- Stress content not intent (leave out the “why”)
- Leave out all extra baggage
- Assume the reader is experienced in engineering but hearing about this project for the first time
- Write the abstract last
- Keep it short (200 words or less ... less is more)
- Make quantitative (use results) not just qualitative statements
- Don’t use equations or other mathematical notation.
- Remember this is written for the first time reader.

Resources on writing technical abstracts:

[http://www.ece.utah.edu/~cfurse/Tutorials/tutorialsUofU.htm/UU Thesis/abstract1.pdf](http://www.ece.utah.edu/~cfurse/Tutorials/tutorialsUofU.htm/UU%20Thesis/abstract1.pdf)

[http://www.ece.utah.edu/~cfurse/Tutorials/tutorialsUofU.htm/UU Thesis/abstract2.pdf](http://www.ece.utah.edu/~cfurse/Tutorials/tutorialsUofU.htm/UU%20Thesis/abstract2.pdf)

Additional information for writing each of these lab sections is available at:

<http://www.ece.utah.edu/~cfurse/CLEAR/writing/index.htm> under Lab Reports.

Additional writing resources (for theses, proposals, etc.) are available at:

<http://www.ece.utah.edu/~cfurse/Tutorials/tutorialsUofU.htm>

“In scientific writing ... passive voice is more readily accepted since using it allows one to write without using personal pronouns or the names of particular researchers as the subjects of sentences (see the third example above). This practice helps to create the appearance of an objective, fact-based discourse because writers can present research and conclusions without attributing them to particular agents. Instead, the writing appears to convey information that is not limited or biased by individual perspectives or personal interests.”

“You can recognize passive-voice expressions because the verb phrase will always include a form of *be*, such as *am*, *is*, *was*, *were*, *are*, or *been*. The presence of a *be*-verb, however, does not necessarily mean that the sentence is in passive voice. Another way to recognize passive-voice sentences is that they may include a “by the...” phrase after the verb; the agent performing the action, if named, is the object of the preposition in this phrase.”

Resources on passive vs. active voice:

[http://owl.english.purdue.edu/handouts/grammar/g\\_actpass.html](http://owl.english.purdue.edu/handouts/grammar/g_actpass.html)

This and other sections of the report should avoid first person (use of I/we/our/you/your, etc.) and should be written in past tense (The lab showed (not shows) this ...)

Information for this handout was compiled by April Kedrowicz and Cynthia Furse from several sources including:

## FINAL LAB REPORT

[1] Alred, G., Brusaw C., and Oliu, W (2003). Handbook of Technical Writing. New York: Bedford/St. Martin's.

[2] Engineering Communication Center at the University of Toronto, Technical Writing in the School of Engineering at the University of Dayton.

[3] Finkelstein, L. (1999). Pocket Book of Technical Writing for Engineers and Scientists. New York: McGraw-Hill.

### **Keywords:**

XXX, XXXX, XXXXX ...

ACKNOWLEDGEMENTS

You can leave this section out of your lab report unless applicable. Most engineering reports will acknowledge anyone who provided monetary support, technical support, or support in-kind. Particularly helpful individuals are also acknowledged.

### EXECUTIVE SUMMARY

Not required in your weekly lab reports, but included here for use in longer reports. Insert a summary of the overall report here. This should be about 1-2 pages in length and should summarize the complete report, including results and conclusions, allowing for a reader to have a grasp of the entire project.

Typically the abstract is very brief and does not include all of the summary details. The executive summary provides a longer description of the summary details. The executive summary is the only part of the report the “average” reader may need. The conclusions and recommendations are generally the most important aspects of this section. The audience for your report is a manager who wants to know “the bottom line” very quickly. Often this reader does not have a lot of technical background, so always include the big picture and significance of your findings in “plain” English. Engineers also read the executive summary, and if more details are desired, THEN the reader will go to the body of the report.

The executive summary is:

- A summary of the complete report, including results and conclusions, allowing the reader to have a grasp of the entire project
- A longer and more in depth description than the abstract, 1-2 pages in length
- Aimed at the “average” reader

The following (Table of Contents, List of Figures, List of Tables) are optional in ece3300 lab reports. They should be created automatically using this template...

To update the fields (tables, figures, etc. and make them appear in the table of contents, etc.):  
 Edit – Select All – F9

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## 1.0 INTRODUCTION

(A few Paragraphs) The introduction should include the purpose (what was tested), problem (why was the experiment conducted), and scope (what was analyzed) of the report. In addition, introductions can sometimes include justification of the experiment's importance. It can also refer to relevant theory and important previous studies. The goal is to supply sufficient background for readers to understand and evaluate the experiment and its results without having to read previous publications.

Include:

- Overview of the lab.
- Describe the problem of interest ("This lab is part three in an eight-part series to design a wireless communication system for a cardiac pacemaker. In this lab, the electrical properties of the human body are evaluated in simulation and measurement, and an artificial material made from water, salt, and sugar to replicate these properties is produced. It is important to know the electrical properties of the human body in order to design an antenna that can be matched in the body, and also to determine how much power will be lost in the body for a given design. This impacts the communication range of the system and the safety of the patient.")
- Give a survey of what is known in the field about this problem and potential solutions (particularly for longer reports ... this is sometimes called a "literature review", lots of references here). If this section is really long, it is sometimes given as a separate section on BACKGROUND. At the end of a literature review, be sure to tell what gap in the literature this project will fill. For a short report such as this lab, a few sentences or paragraph describing what is already known ("Hartsgrove, et al. produced tissue stimulant materials for muscle, brain, and ... at ..., ..., and ... MHz. [4] This lab utilizes a similar method to develop 2/3 muscle stimulant material for 440 MHz.")
- Be sure to tell how this report/project relates to the larger engineering design problem or project, what you expect to observe, and why.

## 1.1 Heading 2

Insert text here. Use subheadings only if each section is distinct. There are two ways to format headings / subheadings:

1. Cut and Paste old headings, and type in new text.
2. Format – Styles and Formatting. This will show format bar. Then highlight desired text and click on the format you want it to have.

Here is how to handle equations. The capacitance of two parallel plates is given by [4]:

$$C = \frac{\epsilon A}{d} \quad (1)$$

Where  $\epsilon$  is the permittivity of the material between the plates, A is the area (in m<sup>2</sup>), and d is the distance between the plates (in meters). To make an equation: Insert – Object – Microsoft Equation Editor. To insert Greek Letters: Insert – Symbol

Here is how to handle tables. Be sure to talk about Table 1-1 in the text before it appears on the page. To insert the reference to Table 1-1 above, Insert – Reference – Cross reference – table.

**Table 1-1 Insert caption here (Table captions go above tables)**

(Toolbar menu: Insert – Reference – Caption, Option Label: table)

To make a table: Table – Insert Table

Table text	Table text

*1.1.1 Heading 3*

Insert text here...

Make sure your lines/font are big enough to read, add arrows or markers to guide the reader to see what you see in your figures, and be sure all axes are labeled (with units). Whenever possible, try to make the lines in your figures so they will show up not only in color (how you probably plotted them), but also in black and white (how you or others will probably print them). Do this by having colored lines with different line types, markers, etc.

**FOR BETTER MATLAB FIGURES:**

See <http://www.ece.utah.edu/~cfurse/Tutorials/tutorialsUofU.htm/matlab/Figures/figureformat1.m>

Also download <http://www.ece.utah.edu/~cfurse/Tutorials/tutorialsUofU.htm/matlab/Figures/startup.m>

Put the startup.m file at the beginning of your Matlab codes, and it will make large fonts and heavy lines that are easier to read.

**To Store Matlab Figures:**

Use a \*.fig file. This allows easy changes or corrections later.

Save As \*.jpg or similar to put in your word document

Insert-Picture-From File

**Figure 1-1 Insert caption here. Figure captions go below the figure. Be sure the figure and caption stay on the same page. (Toolbar menu: Insert – Reference – Caption, option Label: figure) Be sure the caption and figure stay on the same page in the final formatting.**

## 2.0 METHODS

Divide this section up into four parts: Give methods and results for each section

### 2.1 Dielectric Properties of Materials (Lab 1)

### 2.2 Transmission Line Losses (Lab 2)

### 2.3 Antennas and Matching (Lab 3)

### 2.3 FSK System (Lab 6)

The methods section should include a description of the apparatus or equipment used, and a description of the process or procedures followed *in chronological order*. This section should include enough detail so that another researcher could duplicate the experiments (graphs, diagrams, or spreadsheets should be included). Also include any calculations used to conduct the experiments.

Give a full description of the method used to complete each lab. Insert figures, tables, etc. AFTER they are mentioned in the text, and be sure to mention every figure/table/etc. in the text. Number all figures, tables, and equations. Put captions under all figures and above all tables, and reference everything that comes from a book, website, or other source. Include an equipment and/or materials list and step-by-step instructions so that a peer could do each lab without your help. If detailed derivations, tutorials, etc. are needed, they can be included in appendices. Mention all appendices in the text. Avoid use of "I/we/you".

When writing the methods section:

- 1) Describe equipment (part numbers and type/nature/functionality of equipment)

"An xxx time domain reflectometer was used in this lab to measure the step function response of different types of cables and terminations."

- 2) Describe the process (a step by step of the important actions)

"The TDR was connected to one end of a cable with a termination on the far end. The step function response was observed on the TDR screen and manually recorded/sketched."

- 3) Describe/explain what parameters were measured

"A TDR measures the voltage step function response of a cable by sending a step function down the wire and reading the total (incident plus reflected) response at the input."

- 4) Discuss potential sources of error (possibly yielding unexpected results, but also possible that it didn't cause any problems in this lab).

"The TDR has a limited rise time step, which clearly shows up in all of the measurements. The ideal response has an infinite rise time, but the TDR does not. This will reduce the precision to which

lengths can be measured and may also result in difficulty in observing faults or other problems very near the TDR test point.”

## 2.4 Heading 2

Insert text on a sub area of the above text.

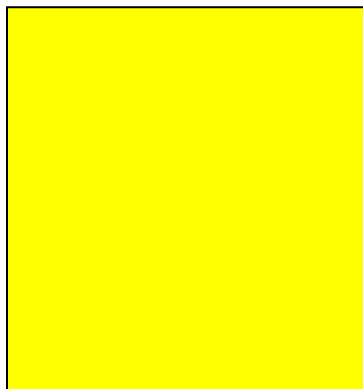
**Table 2-1 Insert caption here**

(Toolbar menu: Insert – Reference – Caption, Option Label: table)

Table text	Table text

### 2.4.1 Heading 3

Insert text here...



**Figure 2-1 Insert here**

(Toolbar menu: Insert – Reference – Caption, option Label: figure)

Style Heading 4

## RESULTS

The results are the data that the experiment yielded. Give a full set of observations and results using clear language and past tense. Include graphs and/or tables as appropriate. Your observations should ‘prove’ that each lab did what you said it would in the introduction. Be specific and quantitative whenever you can. For instance, it is better to say, “The power decreased by 3 dB”

instead of “The power went down.” Although results should be stated in verbal form, also include tables, charts, graphs, or calculations. Remember to label them! A clear statement drawing attention to the results will help readers interpret any figures. Do not include all of your raw data in this section. Extract that which is important to prove what you said the experiment would do, and put the rest (if applicable) in an appendix. Remember to reference any appendices as necessary.

Describe the results of the simulations in detail

- Include plots, tables, etc as needed for clarity and precision

“Plot the magnetic field along the y-axis for a rod extending from  $z = -\pi/2$  to  $\pi/2$  meters having a current distribution of  $I(z) = \cos(z)$  in the z-direction.”

- Include (always!) detailed information on how close this is to what is expected. “The data were close to what was expected” is NOT good enough. “The data were within x% of expected values.” is good. Include measured and expected responses on the same graph, for instance.

“It was expected that the field distribution away from the antenna would fall off first as  $1/r^3$ , then  $1/r^2$ , and then as  $1/r$ .” Plot these curves on the curve that you obtained from simulation, and show which regions fit the  $1/r^3$ ,  $1/r^2$ , and  $1/r$  expectations.

- Comment on your results.

Comment on the size of your antenna relative to the size of the  $1/r^3$ ,  $1/r^2$ , and  $1/r$  regions. How far away from the antenna do you need to be (relative to its height) before you are in the far field ( $1/r$ ) region?

### 3.0 DISCUSSION

The discussion presents an interpretation of the data. This is the most important part, because it is here that the experimenter(s) demonstrate understanding of the experiment(s) and related concepts. The purpose of the discussion section is to **explain, analyze, and interpret**. The significance or meaning of the results should be communicated. Focus this section as appropriate by: comparing expected results with actual results, analyzing experimental error, explaining results in terms of theoretical issues, relating results to the experimental objectives, comparing results to similar investigations, and analyzing the strengths and limitations of the experimental design. Tip: Summarize the degree to which the experiment achieved its goals.

The introduction described the expected observations. Now, tell if they were actually observed, and if not, why. Also discuss any other observations that might have been unexpected. If something is not what you expected, explain why this might have happened. Be specific and give the SIGNIFICANCE of your observations. For instance, “In this lab, a single stage 10 dB amplifier for a wireless communication system at 400 MHz was designed, prototyped, and tested. The amplifier achieved a gain of 9 dB, which is 1dB less than the design specification. This means that an additional gain of 1 dB in excess of the design specification will be required in the filter design. If

this gain cannot be replaced in other areas of the circuit, the system is expected to transmit 10 feet less than the design specification.”

### 4.0 CONCLUSION AND RECOMMENDATIONS

Remember that many/most people read the conclusions first. This means you should spell out all of your acronyms (such as Frequency Shift Keying (FSK)) here, even though you might have done so earlier in your report. Also, be sure that everything in the conclusion is written “in context”, not assuming that someone has actually read the rest of the report. This section should present overall conclusions relating to the original purpose of the study (which was stated in the introduction and should be restated here) by giving:

- A brief description of the lab (remember, the reader is probably reading this part first!)
- A quantitative summary of the lab (List conclusions in order of importance and link them to information in previous sections of the report. Include a statement of what is known “for sure” as well as any recommendations, such as how to improve performance, etc..)
- A quantitative description of how this relates to the “big picture” (how this will impact other portions of the design, state what actions should be taken based on the results of the study)

## REFERENCES

- [1] A. Author, “Article,” *journal*, date, pages, etc.
- [2] IEEE Reference Format:  
[http://www.ieee.org/portal/cms\\_docs/pubs/transactions/auinfo03.pdf](http://www.ieee.org/portal/cms_docs/pubs/transactions/auinfo03.pdf)
- [3] H. Schimanski and C. Thanner, “Raiders of the lost ark,” *IEEE Trans. Electromagn. Compat.*, vol. 51, no. 5, pp. 543–547, May 2003.
- [4] J. Matula and R. Franck, “A case for two,” in *Proc. 15th Int. Zurich Symp. and Technical Exhibition on Electromagnetic Compatibility*, vol. 1, Zurich, Switzerland, Feb. 2003, pp. 347–350.
- [5] D. Baumann and C. Bruns, *Microsoft Word Theory and Design*, 1st ed., IFH, ETH Zurich, 2004.
- [6] F.T. Ulaby, Fundamentals of Applied Electromagnetics, Chapter 2.1, Prentice Hall, 2004
- [7] J. Knapp, Personal Communication, date (to be used if someone told you something, and you need to use it as a reference)

**How to use references:**

References should appear immediately after the information you reference [1]. If you have a reference for the entire paper, state this in the start of your paper or a footnote. If you want to copy a paragraph or large section (3 lines or greater) of verbage from a paper, indent it and make it a smaller font [4]:

Bla blablablablabla  
 Bla blablablablabla  
 Bla blablablablabla

**What should you reference?**

Anything that someone else thought/designed/wrote/drew/talked about. Better to over-reference than under-reference. Give credit where credit is due, or even where it just might be due.

**In order to automatically add/change the reference numbers:**

Add your reference in the list above. The number will show up automatically. THEN go to where you want to add the reference and click Insert-Cross Reference – NumList – Paragraph and scroll down to find the one that you need. The reference # will automatically appear and will change as you add references, even in front of this one.

**Referencing Figures:**

A figure copied or adapted from a source should have a note of this in the caption.

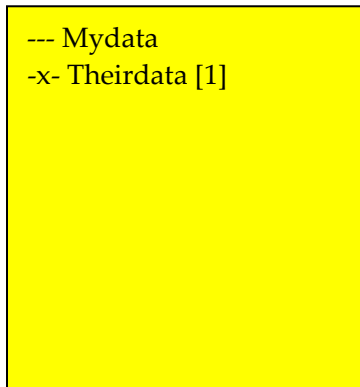


Figure 1: Reflection coefficient of microstrip antenna from [from 2]. OR [adapted from 2] OR Reprinted with permission from [2]. Formal permission to include someone else's figure is required if this is a thesis, published paper, or book. DATA is not copyrighted. You can replot someone's data, and include it without permission, which should then have a reference [from 2]. Often, you might add their data (such as measured data) into your own figure. In that case it is best to include this in the legend as shown above.

## APPENDIX A HEADING 7

Introduction to appendix...

Appendices are commonly used for technical data and details that are beyond what the average reader needs in order to understand your report. Derivations of formulas, full sets of data (when only part is included in figures in the main body), full circuit schematics (when block diagrams are included in the text), data sheets (especially for internal “engineering” reports), instructions for use, etc.

### **A.1 Subheading - Heading 8**

Text on subheading 1...

#### *A.1.1 Heading 9*

**APPENDIX B HEADING 7**