# ECE385 Experiment #2


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## I. INTRODUCTION

THE are highly encouraged to use LaTeX for your laboratory reports. LaTeX is a high-quality typesetting system; it includes features designed for the production of technical and scientific documentation [1]. The idea is that with LaTeX, the authors would not need to worry about the appearance of the document and can instead concentrate on producing the best contents. Despite the intention of making the life easier for scientific writers, LaTeX can have a steep learning curve. Therefore, we are providing this guide and template to make your learning experience as easy as possible. This guide is not meant to be an exhaustive tutorial, otherwise it would be over 200 pages long instead of only 6. Rather, we provide this guide to get you started and direct you to the best resources available.

## II. WHY LATEX?

The main reason why we ask you to prepare your laboratory reports in LaTeX is for consistency. In previous years, students have struggled with (and received significant grade penalties) basic report formatting. While we realize that many of you are quite capable of using Microsoft Word and other word processing tools, very few of you have extensive experience with you figure captions, tables, and the structure of a professional looking report. Moreover, by using LaTeX, the content is what will make your report stand out, not how good you are at using word processing tool. Finally, if you are considering a career in academic (or industry) research, knowing LaTeX will be very beneficial, as it is the most commonly used software for preparing academic manuscripts for professional conferences and journals.

### A. *Do I **have to** use LaTeX?*

While you are strongly encouraged to use LaTeX, you are not *required* to do so. You are, however, required to produce a document that adheres to the styles presented in this template. If you choose to use something else (such as MS Word), your final document should be indistinguishable from a report produced using this template. That includes the section and subsection headings, the abstract, title, caption placement for figures and tables, footnotes, and references. You are likely to spend significantly more time on formatting your word processing tool than what it would take to learn this template – consider yourself warned.

## III. SETTING-UP LATEX

The links to the software presented in this section can be found on the ECE469 course website [2]. There are two basic components that are needed to work with LaTeX, a LaTeX compiler and a LaTeX editor. The most common LaTeX distribution to use on Windows is MiKTeX. When downloading MiKTeX, choose the *net installer* from *Other Downloads*, instead of the basic installer, so that all packages are installed. The 32-bit version is recommended even if you have a 64-bit machine, to maximize compatibility. Linux and Mac users can use Tex Live and MacTex respectively. One LaTeX editors that is recommended is Texmaker for its ease of use and cross-platform support for Windows, MacOS and Linux.

## IV. USING THIS TEMPLATE

Different from the common WYSIWYG (what you see is what you get) typesetting software such as MS Word, LaTeX compiles the source file and creates a pdf as the final output, much like a simple programming language. The source codes for this template can be downloaded as a zip package from the course website. The files included in the package as well as their functions are listed in Table **??**. When reading this guide, you should open the LaTeX source file and compare the contents of the source and the contents of this guide. The source is commented to make it easier for you to understand. After you have gone through this guide, you should be able to start on your first report by modifying this guide or the report guide given in a separate folder.

To compile a LaTeX document using `Texmaker`, open the *latex_guide.tex* and click on arrow to the left of *Quick Build*. Texmaker should compile the latex document and open the resultant pdf file with a built-in pdf viewer. You can also use the keyboard shortcut, *F1*. By default, Texmaker should use PDFLaTeX as the build tool. If not, or if you are using other latex editors, please make sure that you choose PDFLaTeX as the toolchain. In addition, if you are making LaTeX document in linux environment or if you are using editors other than Texmaker or Texstudio, you may have to add "-shell-escape" option in the PDFLaTeX command in the confiugration of your LaTeX editor.

## V. Writing with LaTeX

### A. Basic syntax

Commands and special characters in LaTeX are invoked by using the backslash '\'. For example, `\section` indicates the start of the section and `\centering` makes the contents to be center aligned. Double backslash '\\' makes a line break while paragraphs are separated by an empty line. Characters that follow % are comments and will not be interpreted by the compiler. A basic flow of the LaTeX document is shown on the next page.

### B. Typing math

Perhaps one of the most compelling reason to use LaTeX to typeset a scientific paper is the relative ease of typing out beautiful math equations and symbols. There are two modes of displaying math in LaTeX, inline math and displayed math. Inline math is used when you want to include some math symbols and equations in an ordinary sentence. It is done using `$$` environment; everything inside the `$$` is interpreted in math mode. For example, `$ R_1=10.1 \, \Omega $` gives $R_1 = 10.1\,\Omega$. Please note that white space is automatically ignored in the math environment, but can be added using '`\,`' or '`\.`'. Displayed math is used when you want to write important equations that occupy a whole line themselves. For example,

### C. Making plots

Graphs and plots are essential in every scientific writing. This LaTeX template can display a number of different image formats, such as Encapsulated Postscript (EPS), PDF, PNG and JPEG.

*1) Matlab:* This is the recommended way. Make your plot using Matlab and then export the figure into eps or pdf format. After you have plotted a figure, just use *save as* in the *file* tab of the figure window to save it as an eps image. You can also do it with text commands and we provided a short Matlab script to show you how to do that. You can find it under the Matlab folder in the ECE469 LaTeX starter's package. Figure **??** shows an example plotted by Matlab.

*2) Using Excel:* Even though Excel does not produce the most professional looking charts, it is probably the easiest and most commonly used. To import the chart plotted in Excel to LaTeX, first you need to export the chart to pdf format. This can be done in Excel 2013 by selecting the chart and choose *export* under the *file* tab. In previous versions of Excel, you probably have to use *save as* to save the chart as a pdf. Unfortunately the exported pdf will occupy a whole page. To crop out the white space surrounding your chart, we recommend using Inkscape. Open Inkscape, and select *import* from the *file* drop-down menu. After importing, choose *Document Properties* and below *page size*, expand on *resize page to content* and then click on *resize page to drawing or selection*. You chart will then be cropped properly. Save the modified chart to pdf and include it in LaTeX using `\includegraphics` explained in the next section.

### D. Figures

Images are included with `\includegraphics`. With the packages we added, there should be no problem adding image with common formats such as png, jpg, eps and pdf. We recommend using png for low resolution photos/screen-shots, jpg for high resolution photos and eps/pdf for graphs and circuit diagrams. It is usually desirable to put all the image files into a separate sub-folder such as the *images* folder in this template. The included graphics is put into a figure float environment and caption is added at the bottom. Please make sure to look at the source code to see how it is done. An example is shown in Fig. **??**. You can use Inkscape or your favorite image editing software to add annotations to your plots and oscilloscope screen-shots. Sometimes you would like to group a few related figures together like shown in Fig. **??**, and this is done using `subfloat` environment.

An example of a circuit diagram is shown in Fig. **??**. All electrical components of a circuit should be labeled as well as the relevant voltage and current. In addition, please note the use of dots to show connections at the wire intersections and the use of arrows to indicate current. This circuit is made using *XCircuit*, which is free and open-source. It is specifically designed to draw beautiful circuit diagrams and the download link is provided on the course website. You can also use Microsoft Visio or other software that you are familiar with.

### *E. Referencing figures and tables*

In reports, frequently you have to refer to your figures and tables in your text so that your readers can follow. Instead of you labeling each figure and table in the correct order and remembering their numbers when you reference them, LaTeX can do all the work for you. All you need to do is to add `\label{key}` in the figure or table environment and replace key with any character string you like. When you want to reference it, just use `Fig. \ref{key}` or `Table \ref{key}`. LaTeX will automatically sort the labels for you and insert the correct label to your text. Please use sensible key names so that you can easily remember which key you assigned to a particular figure. It is usually easier if you categorize your reference by starting your key string with `fig:` for figures and `tab:` for tables, etc. You can even add reference to equations and text sections using `\label{key}` so that you do not need to remember the equation and section numbers either.

## References

[1] Latex project site. [Online]. Available: http://www.latex-project.org/
[2] Ece469 course website. [Online]. Available: http://courses.engr.illinois.edu/ece469/software/
[3] Latex wikibook. [Online]. Available: http://en.wikibooks.org/wiki/LaTeX/
[4] P. T. Krein and R. C. N. Pilawa, *ECE 469 Lab Manual*. University of Illinois, 2013.