A LaTeX Tutorial

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Abstract—The demand for engineers have increased in recent years; however, with that follows the amount of documentation needed to support what they have done. With this demand, these engineers must learn to professionally document their work. Which is why with LaTeX's macros, the students turn to it as a language to learn. Here I will help cover the basis of such an extensive document language.

Index Terms—Macros, Equivalence point

1 Introduction To LaTeX

THE purpose of this tutorial is to help engineers create a document in LaTeX. For many of us engineers, we have be exposed to Microsoft Word or Notepad; however, these programs do not have as much capability as LaTeX. And even though LaTeX was released in 1985 [1], many of us have not familiarized ourselves with just a powerful "document markup language." An instance of LaTeX having advantages over these programs are like the **macros** LaTeX have produced, commands which are encoded in .tex file. These macros produce a more qualitative document, just like the one you are reading. Another advantage that LaTeXhas over other markup languages would be having an environment where a user can edit, compile, and view their document. Some of the general ways a user can edit, would be having tags or commands in a .tex file, which, depending on the editor used, will interpret and compile the file and display the information in a document form.

1.1 Why will this tutorial be helpful writing in LaTeX?

As described in the **Introduction**, LaTeX has many commands and documentations to write. In this tutorial, I will be teaching you the basic principles LaTeX has to offer.

1.2 Why should you learn LaTeX?

As we go further down our career, many of our employers and peers will want documentation about what you have accomplished. However, to someone, a written report in Microsoft Word programs will not meet the requirements of a professional report. Therefore, we turn to LaTeX in order to help present such a formal style of writing.

2 Creating a .tex file

2.1 Environments

The start of a LaTeX file must start with `\begin{*environment-name*}` and end with `\end{*environment-name*}`. This is the structure of a LaTeX document, in order to signal when someone starts their document and when they end. So, let us start by putting `\begin{CE185 Tutorial}` `\end{CE185 Tutorial}`.

2.2 Reserved characters

According to the LaTeX manual [3], there are certain characters reserved for the macros used for LaTeX. These reserved words are as followed: `# $ % ^ & _ { } ~ \`.

Each of these reserved characters are meant for different commands. Take `\` for example, this macro is used to signal the start of a command. The start of a command starts with a

name containing only letters, but some commands still need arguments which are followed by other reserved characters, which are `{ and }`.

Another reserved character is the `~`, which is useful to produce a "non-breaking space between two tokens" [4].

Furthermore, to continue with more reserved characters, we have the `\\`. Here we use these reserved characters to start a new line.

Lastly, the reserved character `%` is used in LaTeX for commenting on a .tex file. Thus, allowing the user or reader a more understanding of the commands or references to the code written.

Let's say that we want to display one of these reserved characters as text rather than to run the command on LaTeX, then one way to go about that would be to use the command `\verb`.

2.3 Preamble

Another section of LaTeX is preamble, which is the first section of the document. The reason to have a preamble is to tell LaTeX the type of document and the format needed for document. To start the preamble, you start with `\documentclass{class}`. In the parameters where "class" is, we specify the style of the document to be written in. There are many different types of document one can write in, for this tutorial how about we start by using `\documentclass{IEEEtran}`. This command will help style the document into an article with IEEE Transaction format.

Along with the including the type of documents, LaTeX is always being modified and new features are being added. If one would want to use some of these features, here we would add the extra add-ons with the command `\usepackage{}`. Packages are a feature in LaTeXthat are add-ons that include special features such as graphics, bold text, math functions, and more. A way to do this would be to type `\usepackage{color}`, which would allow for color text.

The last part is to signal LaTeX when the document has started, here we use the command `\begin{document}` and to signal when the document has ended we use the command `\end{document}`.

2.4 The title and header information

Now that you got the basic setup, assuming you followed the procedures stated; next comes the title and header of the document. The standard setup is as such: title, author, and date. To include these into your LaTeX document, we use the commands `\title{title of document}`, `\author{The author of document}`, and `\date{the date created}`.

Lastly to successfully complete the standard title and header, we use the `\maketitle` command. This will create the separate page for the title, author, and date.

3 Sections in LaTeX

A feature of LaTeX is to keep content structured and organized. One way to accomplish this is to use the commands `\section{title of the section}`. These sections may or may not be numbered. As well, there are also some of these other ways to structure a document; such as `\chapter{title}` and `\subsection{title}`.

4 The body text of the document

To structure the document in such a professional manner, one would want to use paragraph breaks. To accomplish such commands in LaTeX, we use `\paragraph{title}`.

Another way to have a well-organized structure is to have subparagraph. These subparagraphs are similar as subsections are to sections. To command a subparagraph, we use the syntax `\subparagraph{title}`. Similarly, we can go one step further and have subsubparagraphs, which are subparagraphs of subparagraphs.

5 TABLE SECTION

5.1 Tables and tabular environments

One instance of using LaTeX file would be to use `\begin{table}`. The use of this command is to construct a table in LaTeX because without these features, "LaTeX is not a spreadsheet" [2] and the data would be incompatible. Using these tables in LaTeX provide a "set of tools" to customize the tables, change the size, combine the cells, and change the color of cells. Similarly, someone using this command might be tempted to use `\begin{tabular}` as well. This command helps create horizontal and vertical lines on the tables.

5.2 Symbols to help with tables

Along with these commands, there are "specs" [3] for the tables, which are as follows: `l, c, r, (vertical bar), \hline, \\ , and &`. To begin with, the `l` in LaTeX adjusts the column to the left; where as `c` centers it, and `r` adjusts it to the right. As for the (vertical bar), it simply displays a vertical bar. The `\hline` starts a new horizontal line. As for the `&` sign, we use this to seperate items from array and tables. Lastly, for the `\\` specifications of a table, this starts a new row after being specified.

5.3 Example of a table

Now that we have some sense of adjusting and creating tables, I will go over a simple example as explained [2]. Let's say we want to create a table with 3 rows and 3 columns and in each cell we display the number to the corresponding cell. In order to achieve such, we use some of the commands described in the previous paragraphs. We start with centering the table, to do this we use `\begin{center}` and `\end{center}`. Next, since we want to create a 3x3, we want to adjust each cell to their corresponding column, to do this we use `\begin{tabular}` and `\end{tabular}` inside the `\begin{center}` and `\end{center}`. Then with each row we type out the data, use `&` to signal the end of data in a cell. Lastly, to proceed to a new column use the `\hline`.

1	2	3
4	5	6
7	8	9

An example of a matrix with numbered cells.

Here with the uses of the table commands in LaTeX, the figures are displayed properly. In order to display the table above properly, you should have the commands as follow:

```
\begin{center}
\begin{tabular}{| l | c | r |}
\hline
1 & 2 & 3 \\ \hline
4 & 5 & 6 \\ \hline
7 & 8 & 9 \\
\hline
\end{tabular}
\end{center}
```

6 USE OF FIGURES IN LaTeX

6.1 Using includegraphics

In LaTeX sometimes as a user, we want to use figures to display valuable information. In order to achieve this, we use the command `\includegraphics[graphic keys] {file}`. All of the graphic key argument can be found in the manual [5] in order to maneuver the file's image to one's preference. Some of these key arguments are width, height, and scale for a figure. As for the file argument, it must be in the same directory as the LaTeX file so when using the argument, the program can look up it's source. Therefore, all we need is to plot the points from [6] the lab data using excel and save the image as a .jpg; which then gets put in the same directory and referenced to as seen below.

6.2 The plot of Titration levels

Here, as the data shows, we see that the data in the middle has a sharp rise. This sharp rise is called the **"equivalence point"** [6]. Thus, this shows that the higher the volume of the base, the more pH levels are.

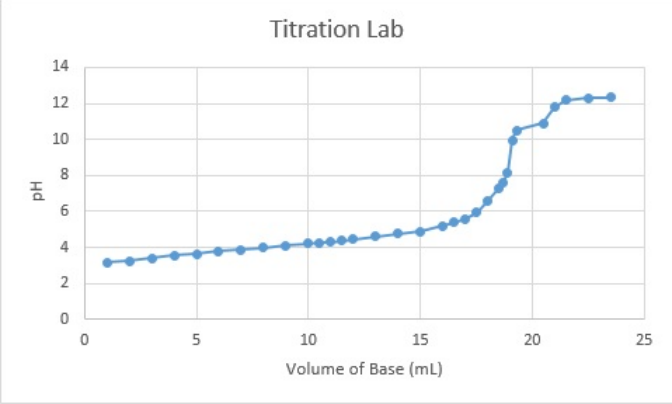

Fig. 1. The Titration levels produced by an unknown weak acid with a strong base (NaOH).[6]

7 Math formulas in LaTeX

7.1 In-line vs display

Another advantage of the LaTeX is the capability it has with in-line vs display. The difference between these two as stated is that "displayed formulas are separate from the main text" [7]. What this means, is that essentially the visuals are bigger when using display. An example of using display would be the following:

$$\int \frac{2t+d\theta}{1+\theta^2}$$

Here the user is able to see a math style equation that has it's own proper line. In the contrary, an example of in-line would be $f(x) = \frac{x}{x+tan(\theta)}$; where the formula is on the same line.

In order to use each of the following methods, in-line and display, we would use the following commands. For display, we would enclose the formula with a `$` followed by the LaTeX commands. For in-line would use the `\(f(x)\)` command, followed by the LaTeX commands.

7.2 Use of symbols

In math, we tend to use a lot of symbols to express terms. In LaTeX there are a variety of symbols that can be used. The basic ones are: + - = ! / ( ) [ ], however using one of these commands: `\alpha, \Alpha, \beta, \Beta, \gamma, \Gamma, \pi, \Pi, \phi, \varphi, \Phi` with `$` in between each greek letter, results in such: α. However, remember to include the following package in the preamble.

7.3 Use of fractions

Another great feature about LaTeX is the use of fractions. Here we can simply use the command `$\frac{numerator}{denominator}$`, in which the program will display the following: $\frac{n}{n}$.

7.4 Use of superscripts and subscripts

Even with the use of these features, there are still many more; which brings up the use of superscripts and subscripts for mathematics. For uses of superscripts, we denote that with a ^, and for subscript, we use _. An example would be a_2^2. These scripts are very useful when dealing with equations that have $\int_{n=0}^{n=\infty}$

8 To Acknowledge in LaTeX

After we finish with the details of the document, one of the last parts that might be necessary is to Acknowledge. We can simply use `\section*{Acknowedlgement}`. The `*` is to have a section without a numbering scheme which fulfills a professional Acknowledgment section.

We use this section to make "any acknowledgments of permission to publish and disclaimers to the content of the work made to/by the author's employer may be added as an Acknowledgment section"[8].

9 How to Reference

9.1 The Bibliography

In order to start referencing and citing sources, we use a reference sections. This section may be set up by doing the following; we use the command `\begin{thebibliography}` and `\end{thebibliography}`. By doing so, we set up the section to which we will write our reference to and signal to LaTeX that this section is dedicated to the bibliography.

A command that is suitable when using `thebibliography`, is the `\bibitem` command. Here, the `\bibitem` is a command used to enter references in a `thebibliography` section of the document.

9.2 Label, Cite, and Reference Commands

Suppose, then that we want to include a figure in the documentation; LaTeX uses the command `\label{figure}`, which properly labels the figure.

Similarly, let's say we want to cite our source in between a quote as I've been doing. To do this we use the command `\cite{bibiography name of source}`. This may be tricky, if a source may not be found in the reference page, then we will end up as such [**?**]. It is always important to match the title of the bibliography cited source to the argument being passed.

Lastly, let's say that you would want to reference to an object. We use the command `\ref{object}` to signal that we are referencing to objects.

10 Conclusion

This basic step by step tutorial offers a start to what seems to be limitless creativity on a text editor. Whereas, Microsoft Word and Notepad might have basic components. As seen, LaTeX can be very useful to set up a professionalized structure to reports and documents.

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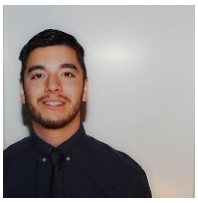

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