ECE 618: LaTeX Report Template

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***Abstract*—Write your abstract text here.**

I. Getting Started

Before you can start using LaTeX you need to get your computer set up for it. If you don't want to go through the process of installing a few different programs on your computer, you can sign up to use Overleaf. This is an online LaTeX editor that Purdue students and faculty have access to for free. It is fairly easy to use and has nice features to enable collaborating on documents.

If you want to use LaTeX on your computer, you first need to install MiKTeX. If you google it you should be able to quickly find the download instructions. Once you have that installed, I recommend using an additional "editor" on top of that which has additional features to improve the usability. I personally use TeXstudio because that is what was recommended to me initially and I haven't spent any time shopping around for a different tool because it seems straightforward and capable enough.

Note that I am using the IEEE template for formatting in this document. You can easily swap to a different journal's template by substituting in their class file (replacing the IEEEtran file with something else) and making a few other edits to the main TeX document. This kind of swap can be a little tedious, but it is typically substantially easier than trying to swap between two Word document templates from different journals. I will say that the IEEE template can be a little annoying with formatting when the document you are writing only has a small amount of content in it. It usually starts to do a better job once the document gets filled in more, but if you have lots of long equations it can still struggle. These issues are why there is occasionally some weird spacing between certain sections in this document. LaTeX is doing its best to try and move things around on the pages to make it look good and match the IEEE format, but sometimes more control of these issues can be needed. I usually leave this to the editorial staff at a journal to fix, since they are going to mess with whatever you submit most of the time anyway.

II. Introduction

To type basic text, you just type it into the TeX document like this. If you want to do different kinds of formatting you need to use the appropriate command, such as *italics* and **bold**. You can reference different parts of the document such as Section II or Section III. Depending on the TeX editor you are using, you may need to keep your different sub-files open for the editor to recognize the cross-reference labels you have declared in different sub-files.

To cite a reference, you just use the following command [1]. You can also cite multiple references at once like this [1]–[3]. The TeX compiler will automatically order your reference list for you based on the order that you call them in the document you are generating. If you change the document substantially and the references aren't getting automatically reordered, you may need to delete the .bbl file that gets generated when you compile to force the compiler to regenerate the .bbl file from scratch.

III. Equations

We can also introduce additional section structures in the following way. We can reference this section like Section III.

A. Background

Here is some text within a subsection. We can reference this section like Section III-A.

1) Even Finer Background: We can even go to subsubsections if we want to. We can reference this section like Section III-A1.

B. Equations

Writing equations in LaTeX can be done in many ways. You can do inline equations by first typing $ $ and then input your math environment commands between the dollar signs. In this text within the TeX file, I had to include a backslash before the dollar sign so that LaTeX knew I wanted to actually type the dollar sign into the text and not use it to open a math environment. Now as an example of an inline equation, consider $E = mc^2$. It is a matter of practice to learn the various commands to include various mathematical operators and symbols, but many of them are fairly intuitive and can be learned quite quickly. I include here examples of a few different equations and equation environments to help you get the hang of things. In general, there are very useful online references that list out different mathematical symbols and it is usually fairly easy to "google" how to do just about anything you can think of in LaTeX.

We can remember that Faraday's law is

$$\nabla \times \mathbf{E} = -\partial_t \mathbf{B} - \mathbf{M}. \tag{1}$$

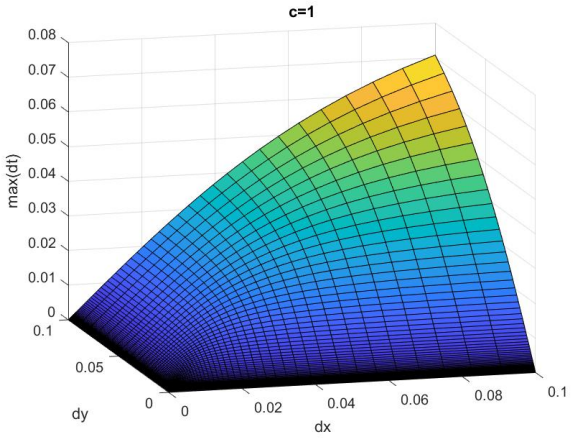


Fig. 1: Example of caption text.

We can reference this equation like (1). If we want to manually adjust the spacing between different symbols we can use the following approaches:

$$\nabla \times \quad \mathbf{E} = -\partial_t \mathbf{B} - \mathbf{M}, \tag{2}$$

$$\nabla \times \mathbf{E} = -\frac{\partial}{\partial t}\mathbf{B} - \mathbf{M}. \tag{3}$$

Here are some examples of more mathematical operators:

$$\int_\Omega \left[\left(\nabla \times \mathbf{W}\right) \cdot \overline{\boldsymbol{\mu}}^{-1} \cdot \left(\nabla \times \mathbf{E}\right) - \omega^2 \mathbf{W} \cdot \overline{\boldsymbol{\epsilon}} \cdot \mathbf{E} \right] d\Omega = 0. \tag{4}$$

Sometimes if we have a particularly long equation we will need to spread it out over multiple lines. We can do this with

$$H_F = \frac{1}{2} \iint \Big\{ \epsilon |\mathbf{E}_q|^2 + \mu |\mathbf{H}_q|^2 + \sum_{p \in \mathcal{P}} \left[\epsilon |\mathbf{E}_p|^2 + \mu |\mathbf{H}_p|^2 \right] - \sum_{p \in \mathcal{P}} 2\mathbf{A}_q \cdot (\hat{n}_p \times \mathbf{H}_p) \Big\} d\mathbf{r}. \tag{5}$$

We can do fancy equations that have multiple lines that we want to control how they are aligned with respect to each other in the following way:

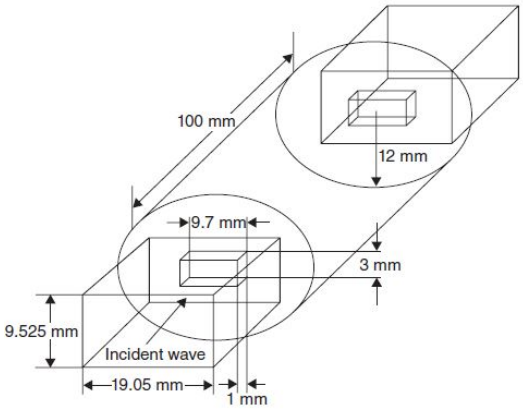
$$\begin{aligned} \mathbf{E}(u,v,w) &= \mathbf{E}^{\text{inc}}(u,v,w) + \mathbf{E}^{\text{ref}}(u,v,w) \\ &= E_0 \mathbf{e}_T(u,v) e^{-j\beta w} + \Gamma E_0 \mathbf{e}_T(u,v) e^{j\beta w}. \end{aligned} \tag{6}$$

We can also do matrices of various types using commands like:

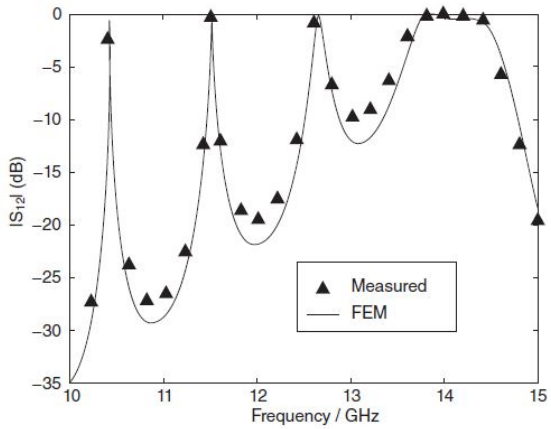
$$\overline{\boldsymbol{\Lambda}} = \begin{bmatrix} \dfrac{s_y s_z}{s_x} & 0 & 0 \\ 0 & \dfrac{s_z s_x}{s_y} & 0 \\ 0 & 0 & \dfrac{s_x s_y}{s_z} \end{bmatrix}. \tag{7}$$

IV. Figures

Including figures is very easy in LaTeX. It is also usually very easy to get them to appear at a desired location (e.g., the top of the page) by using simple adjustments to the figure



(a)



(b)

Fig. 2: Use of wave ports to analyze a cylindrical cavity resonator. (a) The geometry analyzed and (b) the comparison of numerical and measured results (from [1]).

environment. To learn more about how figures get positioned within a document (e.g., if it isn't doing what you want) you should know that they are referred to as "floats" in LaTeX terminology. If you google about positioning of floats in LaTeX you will likely quickly learn how you can reconfigure your TeX document to get the desired effect.

Here are some examples of how to include figures and subfigures. We can reference them like this: Fig. 1, Fig. 2 is broken into two subfigures, which we can reference like Fig. 2(a) and Fig. 2(b).

Here is dummy text to fill out the document to help with getting the floats positioned. The quick brown fox jumped over the lazy dog. The quick brown fox jumped over the lazy dog. The quick brown fox jumped over the lazy dog. The quick brown fox jumped over the lazy dog. The quick brown fox jumped over the lazy dog. The quick brown fox jumped over the lazy dog. The quick brown fox jumped over the lazy dog. The quick brown fox jumped over the lazy dog. The quick brown fox jumped over the lazy dog. The quick brown fox jumped over the lazy dog. The quick brown fox jumped over the lazy dog. The quick brown fox jumped over the lazy dog. The quick brown fox jumped over the lazy dog. The quick brown fox jumped over the lazy dog. The quick

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V. Reference Management

There are various programs you can install to try and help manage your bibliography. I personally found those to be a bit annoying to use so I just maintain a BibTeX database (.bib file) for my various projects where I compile the references that I frequently use. The format to catalog all of the reference information for different BibTeX entries can be a little annoying to figure out, which is why it is rather nice that Google Scholar and some publishers directly provide the citation information in BibTeX format that you can just copy and paste into your .bib file. For instance, with Google Scholar you can search for an article, click the ” symbol below the article name and info, click the BibTeX entry at the bottom of the list, and then copy and paste what comes up into your .bib file. This usually does a pretty good job, but it will sometimes mess up certain capitalization in names/titles so it is good to check the information and edit it appropriately. You can make these edits to the .bib file within your TeX editor by opening the appropriate file. Usually, if you add a reference to your .bib file it won't appear in your auto-complete options for inserting citations until you recompile your entire document from the main TeX file. As with everything else, if you are having issues with achieving a certain effect you can typically find it answered easily via google.

VI. Conclusion

Overall, this is just a very simple document to get you going in LaTeX. There is a bit of a learning curve, but in my experience it is incredibly worthwhile for every graduate student to learn how to use this tool. There are still some times where I use Microsoft Word because it will be easier, but this is often very infrequent. At this point, I cannot imagine trying to write a journal paper within anything but LaTeX because of how much easier it is to control formatting, produce great looking equations, automatically handle cross-referencing and reference lists, etc.

References

[1] J.-M. Jin, *Theory and Computation of Electromagnetic Fields*. John Wiley & Sons, 2011.
[2] D. M. Pozar, *Microwave Engineering*. John Wiley & Sons, 2011.
[3] J.-M. Jin, *The Finite Element Method in Electromagnetics*. John Wiley & Sons, 2015.