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A Thesis

by

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MASTER OF SCIENCE

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Committee Members,	Committee Member 1
	Committee Member 2
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ABSTRACT

This is the first numbered page, lower case Roman numberal (ii). Page numbers are outside the prescribed margins, at the bottom of the page and centered; everything else is inside the margins.No bold on this page (Exception: heading ABSTRACT is bold if major headings are bold. *This LaTeX template applies to this exception*).

Text begins two double spaces below the major heading. Recommended length of text is no more than 350 words. Vertical spacing is double spaced or space-and-a-half. (*This LaTeX template applies double space for this ABSTRACT.*) The same margin settings and text alignment are followed else where in this thesis. There should be no numbered references or formal citations in ABSTRACT.

The content of this ABSTRACT provides a complete, succinct snapshot of the research, addressing the purpose, methods, results, and conclusions of the research. As a result, it should stand alone without any formal citations or references to chapters/sections of the work. To accomodate with a variety of online database, images or complex equations should also be avoided.

The next pages are Dedication, Acknowledgments, Contributors and Funding Sources, and Nomenclature. Of these, Contributors and Funding Sources is required. The rest are optional.

DEDICATION

To my mother, my father, my grandfather, and my grandmother. To see what happens with multiple lines, I extend this next part into a second line.

ACKNOWLEDGEMENTS

This section is also optional, limited to four pages. It must follow the Dedication Page (or Abstract, if no Dedication). If listing preliminary pages in Table of Contents, include Acknowledgments. Heading (ACKNOWLEDGMENTS) is bold if major headings are bold. It should be in same type size and style as text. So does vertical spacing, paragraph style, and margins. Also, ensure that the spelling of "acknowledgments" matches throughout the text and the table of contents.

I would like to thank the Texas A&M University Office of Graduate and Professional Studies to allow me to construct this LaTeX thesis template. Special thanks to JaeCee Crawford, Amy Motquin, Ashley Schmitt, Rachel Krolczyk, and Roberta Caton for carefully reviewing this material.

CONTRIBUTORS AND FUNDING SOURCES

Contributors

This work was supported by a thesis (or) dissertation committee consisting of Professor XXXX [advisor – also note if co-advisor] and XXX of the Department of [Home Department] and Professor(s) XXXX of the Department of [Outside Department].

The data analyzed for Chapter X was provided by Professor XXXX. The analyses depicted in Chapter X were conducted in part by Rebecca Jones of the Department of Biostatistics and were published in (year) in an article listed in the Biographical Sketch.

All other work conducted for the thesis (or) dissertation was completed by the student independently.

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NOMENCLATURE

ARIMA	Autoregressive Integrated Moving Average
B/CS	Bryan and College Station
DOS	Disk Operating System
EPCC	Educator Preparation and Certification Center at Texas A&M University - San Antonio
EVIL	Every Villain is Lemons
FFT	Fast Fourier Transform
GNU	GNU is Not Unix
GUI	Graphical User Interface
HDD	Hard Disk Drive
HDMI	High Definition Multimedia Interface
L^1	Space of absolutely Lebesgue integrable functions; i.e., $\int \lvert f \rvert < \infty$
L^2	Space of square-Lebesgue-integrable functions, i.e., $\int \lvert f \rvert^2 < \infty$
LP	Linear Program
MIP	Mixed Integer Program
O&M	Eller Oceanography and Meteorology Building
OGAPS	Office of Graduate and Professional Studies at Texas A&M University
$PC(S)$	Space of piecewise-continuous functions on S
PID	Principal Integral Domain
SDCC	San Diego Comic-Con

SSD	Solid State Drive
TAMU	Texas A&M University

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1. INTRODUCTION AND LITERATURE REVIEW

1.1 Author's Message to the Student Using This Template For Their Thesis or Dissertation

Howdy! This is the template for theses and dissertations written using LaTeXfor submission at Texas A&M University. While the Office of Graduate and Professional Studies (OGAPS) is here to guide you in submitting your thesis or dissertation. This template shows the many features of LaTeX, with many more available to the user.

Please note that this is NOT the official template supported by OGAPS. If you have issues, please submit an issues on the github page or email me at wodzicki [at] tamu [dot] edu.

1.1.1 Brief Usage of the Template

This template is intended for use by STEM[1] students. If you are not a STEM student, this template is likely not for you.

The advantage of using this template over the Microsoft Word templates are numerous. First, there is a lot of control granted to the user in how the document looks. Of course, you are expected to still follow the guidelines set forth in the TAMU Thesis Manual. This template takes care of the margins, heading requirements, and front matter ordering for you.

Software to Install

MikTeX or **ProTeXt** is the free software recommended for Windows PC users to compile their LaTeX document. **MikTeX** is also available for Mac OS X users. To compile for this document, XeLaTeX compiling engine is used. There is currently an issue in which the package xetex-def does not install; see the file README.txt for a solution. Another software called **JabRef** is also recommended for bibliography/reference management; its usage is similar with EndNote.

[1] Science, Technology, Engineering, and Mathematics. This is an example of a footnote. You can see that it is numbered and appended at the end of the page. Also, you can see the effect of having a multiline footnote.

Procedure to Compile LaTeX Document

This template (and consequently, your document) will be compiled using XeLaTeX. To compile your document, do the following[2]:

- In TeXstudio, go to the Tools menu, then select Commands, and click XeLaTeX.
- In Texmaker, go to the Tools menu and select XeLaTeX.
- For other editors, consult the help files included with the editor.

To view the output after the program is done compiling, press F7 in TeXstudio and TeXmaker or the appropriate hotkey for other editors. Be sure that the document is not open in another PDF reader, for your editor will not display it.

1.1.2 How to Fill This Document

The document structure is organized in the main .tex file, TAMU_Thesis_Main.tex, which has the same name as the output PDF file. Content in each section is in the Data folder. You can open the .tex files under the data folder to modify. Four sections are added initially. To add in more sections into the LaTeXdocument, open the TAMU_Thesis_Main.tex file and go to the section that says "Include all chapters/sections of the thesis" and include more .tex files.

1.2 Reference Usage and Example

As previously mentioned, one program that can be used to organize references is **JabRef**. While a tutorial of how to use **JabRef** is beyond the scope of this template, a brief discussion of how to use **BibTeX** follows.

1.2.1 BibTeX

After you have installed **JabRef**, or any citation manager of your choosing that is compatible with **BibTeX**, you must create a **BibTeX** database. This database file will contain all the information

[2]Notice here that I also show off the itemize environment for unordered lists. Ordered lists use the enumerate environment.

BibTeX requires to generate your bibliography. An example .bib file named 'myReference.bib' is included in this template. The first entry of that file is shown below.[3]

```
@Article{Barn-JORVQ,
  author  = {Christopher F. Barnes and Richard L. Frost},
  title   = {Residual Vector Quantizers with Jointly Optimized Code Books},
  journal = {Advances in Electronics and Electron Physics},
  year    = {1992},
  volume  = {84},
  pages   = {1--59},
}
```

All of the keys in the bibtex entry are very self-explanatory, such as author and title, however, arguably the most important part of the entry is the key. The key is the first value after @Article, which is Barn-JORVQ in this example. This is the key you will use in any cite commands for references, e.g.,

```
\cite{Barn-JORVQ}
```

which will give you the following when used in text [4]. If you used a different key you will get the number, or author/year depending of citation style, that corresponds to that citation [2]. You can also use multiple keys in one cite command, just separate them using commas [1, 5, 3]. If you happen to use an undefined key, or just simply spell it wrong by mistake, you will get a question mark as follows [**?**].

Depending on the citation style that is used, there may be different cite commands for different types of in-text citations. It is important to know which commands must be used with the citation style you are using.

[3] The example of a BibTeX entry also shows the 'verbatim' environment, where text is displayed in monospaced font in the exact format that it is typed in the .tex document.

1.2.2 Compiling with BibTeX

When compiling your LaTeX document with **BibTeX** citations, four different compiles must be done to ensure that all references are updated correctly. This entails running XeLaTeX, then BibTeX, then XeLaTeX twice. This will ensure that all the citations and cross-references are updated correctly. If you are using a program such as **MikTeX** or **ProTeXt**, this may be the default compilation method. However, if you use **TeXShop** on a Mac, you must change the compiler manually. If compiling from command line, the sequence would be:

```
xelatex TAMU_Thesis_Main.tex
bibtex TAMU_Thesis_Main.aux
xelatex TAMU_Thesis_Main.tex
xelatex TAMU_Thesis_Main.tex
```

Note that **BibTeX** must be run on the .aux file, not the main .tex file. Be sure to check the output for any errors. If question marks (?) appear in any location where a reference should be, there was an issue with the compilation. Make certain that the key used in the cite command matches the corresponding references in the .bib file.

1.2.3 References at the end of chapters

If you would like references at the end of each chapter, first make sure you are using the 'chapref' options in the documentclass command at the top of the main LaTeXdocument. Once that option is set, compilation is similar to the method discussed above.

First, compile the main file use XeLaTeX. When it is done compiling, check the directory your document is saved in. There should be a bunch of files named 'bu*.aux', where the asterisk represents any number. You will now want to run **BibTeX** on all of these .aux files as well as the .aux file from the main document. After **BibTeX** is run on all the .aux files, run XeLaTeX two more times and your document should be good to go! If you are on a Mac, open up a Terminal window, cd into the directory your document is in and run the following commands (should work on any Linux machine as well):

```
xelatex TAMU_Thesis_Main.tex
find ./ -name '*.aux' -exec bibtex '{}' \;
xelatex TAMU_Thesis_Main.tex
xelatex TAMU_Thesis_Main.tex
```

The second command simply finds all the .aux files in the current working directory and executes (exec) the command bibtex on each of them.

Be sure to check the output for any errors. If question marks (?) appear in any location where a reference should be, there was an issue with the compilation. Make certain that the key used in the cite command matches the corresponding references in the .bib file.

1.3 Acronyms, Equations, Formulas, and Other Really Cool Math Things That LaTeX Can Do

1.3.1 Acronyms

Using acronyms (or nomenclature) in LaTeX is great because it keeps track of which acronyms have been used throughout the document. In the case of the template, that is done through the nomenclature package[4]. By default, the nomenclature package is loaded in the *TAMU_Thesis_Main.tex* file just after the documentclass command with the *all* option enabled. With the *all* option set, all acronyms/nomenclature defined in the *nomenclature.tex* file will appear in the Nomenclature section of the document. If you want only those acronyms used in the document to appear in the Nomenclature section, remove the *all* option from the package loading. If you would like the long form of acronyms/nomenclature to appear when hovering over the short version in text, add the *hover* option when loading the nomenclature package.

To edit the acronyms and nomenclature for the document, open up the *nomenclature.tex* file in the the Data directory. Below is the entry for the OGAPS acronym

[4]The nomenclature package in this distribution uses the acro package to handle the acronyms and the longtable and tabu packages for formatting the nomenclature section of the document.

```
\DeclareAcronym{OGAPS}{
short   = OGAPS,
long    = Office of Graduate and Professional Studies,
list    = Office of Graduate and Professional Studies at Texas A\&M University,
tooltip = Office of Graduate and Professional Studies
}
```

The *DeclareAcronym* command sets up a new acronym, with the first argument (in this case OGAPS) being the key used to access the acronym. After this, we define some attributes of the acronym. The *short* key defines the short version of the acronym. In this case, it is the same as the acronym key, OGAPS. The *long* key defines the full definition of the acronym that will appear in text, in this case Office of Graduate and Professional Studies. The *list* key defines how the acronym will be defined on the Nomenclature page. As you can see, this is different from the long version that will appear in the text. The last key is *tooltip*. This sets the definition that will appear when hovering over the short version of the acronym in the text if the hover option is set when loading the nomenclature package. Let's show some examples.

To use an acronym, is the *ac* command, or the *acp* command for a plural form (adds 's' to end). For example: *ac*: OGAPS, *acp*: OGAPSs. Notice that OGAPS was not defined in the text. That is because it was already defined at the beginning of the document. This means, you do not have to remember which acronyms you have already defined, just use the *ac* command whenever calling an acronym. You can also explicit access the long and short forms of the acronym: *acs*: Texas A&M University, *acl*: TAMU. Note that these commands change the 'used' state of the acronym, so future calls of *ac* produce only the short form: TAMU. If you would like to reprint the definition, you can use *acf*: Texas A&M University (TAMU). A final useful command is *acresetall*. This resets the 'used' state for all acronyms to unused. This might be useful to use at the beginning of a new chapter so that all acronyms will be redefined in the new chapter. For more acronym definition and use options see the documentation for the acro package[5].

[5] `http://mirror.hmc.edu/ctan/macros/latex/contrib/acro/acro_en.pdf`

1.3.2 Equations

Equations can be written in LaTeX in one of two ways. First, you can have material displayed inline by enclosing the desired statement in dollar signs. For example, $e^{i\pi} + 1 = 0$ is an inline math expression. Some longer expressions, especially those including sums, integrals, or large operators and objects can be displayed centered on their own line. In this **math mode**, you enclose the desired material in square brackets. For example,

$$\sum_{j=1}^{n} \int f_j \, dx = \int \sum_{j=1}^{n} f_j \, dx$$

is a math mode expression. We can also have a series of expressions aligned at a symbol. This is particularly useful when you are showing details in solving an equation or evaluating an integral. The next block shows off the *align** environment. We use it here to show a distributive property of set intersections over unions. Observe how each line is aligned to the biconditional symbol. This makes reading steps easier, since a reader can go line by line and determine why each step is justified.

$$\begin{aligned} x \in A \cap \bigcup_j B_j &\iff x \in A \ \wedge \ x \in \bigcup_j B_j \\ &\iff x \in A \ \wedge \ x \in B_k \ \text{ for some k} \\ &\iff x \in \bigcup_j A \cap B_j \end{aligned}$$

Some more information about equations appears in Section 2.3[6].

[6]This is an example of a cross-reference to a section. You can use the **label** command to label just about any point in the document; in this case I labeled the 'Equation' section in Chapter 2 with the label 'sec:more_equations'. You can then use the **ref** command with the label to get the exact chatper.section.subsection.etc, with all the information updating automatically as chapters/sections are added removed.

1.4 Specifications in This TAMU LaTeX Template

All requirements for theses can be found in the most recent version of the Thesis Manual, available at the OGAPS website. The Thesis Office will be happy to assist you if you have questions about formatting[7].

A common question students ask is the placement of a copyright statement at the beginning of a section with reprinted material from a previously printed source. The screenshot below describes how to achieve this. Check the instruction files for more details.

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%                          SECTION II
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

\renewcommand*{\thefootnote}{\fnsymbol{footnote}}

\chapter[PAGES WITH A FIGURE, A TABLE AND AN EQUATION]{PAGES WITH A FIGURE, A TABLE AND AN EQUATION
\footnote{I am allowed to do this}}

\renewcommand*{\thefootnote}{\arabic{footnote}}
```

Figure 1.1: The inclusion of a copyright statement as a footnote. The lines in yellow help to change to footnote marking scheme.

[7] Remember that this is NOT the official OGAPS LaTeXtemplate

2. PAGES WITH A FIGURE, A TABLE, AND AN EQUATION

2.1 Inserting Figures

Figure (and table) titles should be consistent through the document. All captions should be placed either above or below the object it describes. This is done by placing the *caption* in the correct place, i.e., before the *includegraphics* command for caption above or after for caption below).

Below is an example of a figure with the caption under the figure.

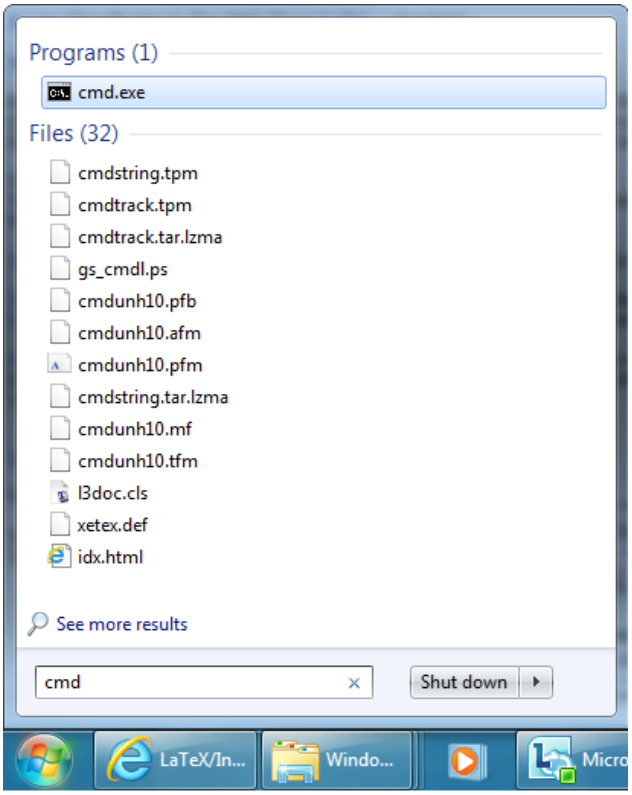

Figure 2.1: The command line compiler in Windows. It is not suggested that you compile using this method. See compilation instructions in the README.

2.1.1 Figure placement

When including a figure (or a table) it is important to specify where it should appear on the page. Note that when the *figure* environment is started of the above figure, [ht] appears after the begin statement. This tells LaTeX to place the figure here in the text, or at the top of the page if it does not fit here. While LaTeX will try its best to put the figure here, if the figure is too tall (i.e., it would run off the page if it were placed here), your figure will likely be pushed to the top of the next page. When using the h option, it is recommended that you specify your second preference for if the figure does not fit. If you want the figure exactly here, use the H option.

There are three other options that can be used when tell LaTeX where to place figures and tables

- t - top of the page
- b - bottom of the page
- p - give the figure/table its own page

It will likely take some trial and error to get your figures where you want them, but once you understand how LaTeX thinks when placing figures/tables, it is very easy to get them where you want. If you are having issues with LaTeX following your commands, you can try adding an exclamation mark (!) to the position (i.e., !t). I would recommend waiting until most of your text is written to start placing your figures exactly where you want them, as they will move if text is add/removed.

2.1.2 Figure width/height

If you have generate all your images to be the exact size that you want them and know they will fit within the margins of the page, then you can skip this section. If your figures are smaller/larger than you would like them to appear, continue reading see how to scale your images.

It is recommended that when specifying the width/height of images, the *width* or *height* option be used in the **includegraphics** command, where *width* sets the width of the image and *height* sets the height. It is also recommend that the lengths *textwidth* and *textheight* be used when specifying the width and height of images, respectively. Factional values of these lengths can be used by

simply placing a decimal number in front of the length. For example, the width of Figure 2.1 is defined as

```
width = 0.5\textwidth
```

which means the figure will have a width half the length of a line of text. If the figure is much taller than it is wide, you may want to specify the height.

If you would prefer to provide a scaling factor for images, you can use the *scale* options and specify a decimal number, e.g., scale=0.5 to make the image half its original size. Just be careful when using scaling, as images may go outside of the margins. This is why it's recommended to specify a size and allow LaTeX to determine the scaling.

2.1.3 Captions for figures/tables

When adding a caption to a figure or table, the *caption* command is used. For Figure 2.1, the caption command is

```
\caption[The command line compiler in Windows.]{The command line
compiler in Windows.It is not suggested that you compile using
this method. See compilation instructions in the README.}
```

The text in the square brackets [] is the text that will appear in the list of figures in the table of contents, while the text in the curly brackets {} will appear in the caption under the figure. If the square brackets [] are not used, the text in the curly brackets {} will be placed in the list of figures. The same rules apply to tables using the *caption* command.

2.1.4 Labeling figures/tables

One of the features of LaTeX is its ability to cross-reference things very easily; e.g. Figure 2.1. When inserting a figure, table, or even an equation, it is highly recommended that you give the object a label using the *label* command inside the figure, table, etc. environment. For example, Figure 2.1 is given the label 'fig:CMD_1'[1]. The label can be anything you want, so long as you

[1] I recommend prefixing figure labels with fig:, tables with tab:, and equations with eq:. You can also label chapters, sections, etc.

remember what it is. Use the label whenever referencing the figure in the document and if figures are added before the figure, or the figure is moved around, the in-text reference to the figure will update to the new figure number.

To reference the figure in-text, you can use either the *ref* or *figref* command. The *ref* command will give you just the figure number, while the *figref* command will insert the figure label as well. For example, *ref* gives: 2.1, while *figref* gives: Figure 2.1.

2.1.5 Figure Cropping

If you have some figures that have large margins and you do not want to remake the figures, you can crop them from the *includegraphics* command. Just look at Figure 2.2.

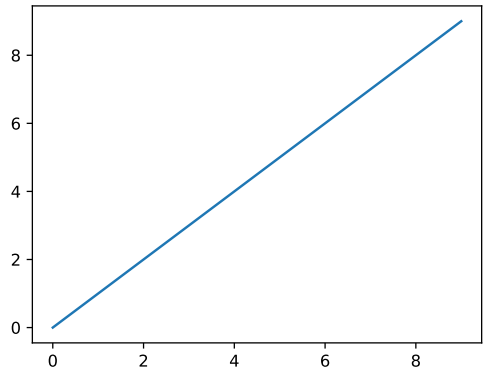

Figure 2.2: A figure that has large margins.

Notice that there is a good deal of white space between the bottom of the figure and the figure caption. This can be removed using the *trim* option in includgraphics. The option is as follows:

```
trim=0mm 0mm 0mm 0mm,clip
```

where trim specifies how much of the image is to be cropped, with the four 0mm values specify

how much to crop off the left, bottom, right, and top of the image (in milimeters), and clip tells includegraphics to crop the image. Figure 2.3 shows the cropped version of Figure 2.2 with trim set to '0mm 15mm 0mm 15mm'; as I am only worried about the bottom (and top) margins, I did not trim the left (first value) and right (third value) sides of the image. While I used milimeters (mm) as the unit in this case, any LaTeX unit of measure can be used: cm, in, pt, etc.

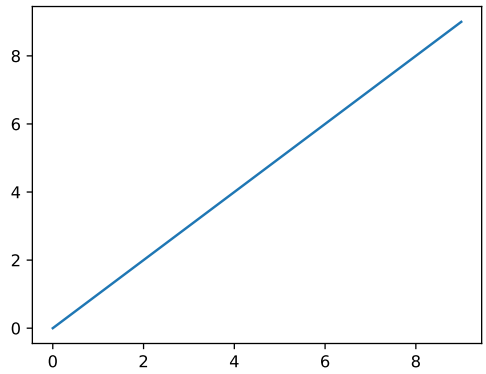

Figure 2.3: As in Figure 2.2, but with the margins cropped off.

Figure 2.3 is also an example of how the *ht* option for placement works, with the image being placed at the top of the page that it appears on.

2.1.6 Continued Figures

If you must use a continued figure, Figure 4.5 shows and example of how to do this. All that is required is adding the *ContinuedFloat* command to the continued portion of the figure and ensuring that the caption command is as follows

```
\caption[]{Continued.}
```

2.2 Inserting Tables

Here is a table, displaying band and auxiliary scores from the 2011 Arcadia Festival of Bands held in Arcadia, CA [6].

School Name	Band Score	Auxiliary Score
Rancho Bernardo	96.15	89.15
Mt. Carmel	95.30	83.55
Riverside King	93.85	91.75
Diamond Bar	93.20	88.60
El Dorado	92.80	95.45
Chino	92.65	91.45
Henry J. Kaiser	92.60	87.55
Glendora	92.60	89.15
Montebello	90.50	82.70
Mira Mesa	89.65	91.50

Table 2.1: Scores from the 2011 Arcadia Festival of Bands.

The table is sorted by band score. There is more text here to demonstrate how the template handles spacing between tables and body text. When referencing tables, you can use the *ref* or *tabref* commands. *tabref* is similar to *figref* discussed above, with *ref* giving: 2.1, and *tabref* giving: Table 2.1, for the above table. Also note how the table caption is in a smaller font size than the body text.

2.3 Equations

The following format is recommended to be used to display equations.

$$y = c_1 \cos(t) + c_2 \sin(t) \tag{2.1}$$

$$e^{it} = \cos(t) + i \sin(t) \tag{2.2}$$

Equation 2.1 is the general solution to the differential equation $y'' + y = 0$. In the source code,

the *ref* and *eqref* commands allows you to refer to an equation by a label you created. References must be made after the equation has been created; attempting to refer to an equation before it is defined results in a question mark placeholder. Some more sample equations are below. Notice the first set below is not numbered.

$$\begin{aligned}\log(x^n) &= \log(x \cdot x \cdot \ldots \cdot x) \\ &= \log x + \log x + \ldots + \log x \\ &= n \log x\end{aligned}$$

$$X^T X \mathbf{u} = X^T \mathbf{y} \tag{2.3}$$

$$u(x,t) = \int_{-\infty}^{\infty} G(x,\tau) \exp\left(-\frac{(t-\tau)^2}{4kt}\right)\, d\tau \tag{2.4}$$

$$\mathcal{L}(f) = \int_0^{\infty} e^{-st} f(t)\, dt \tag{2.5}$$

$$\mathcal{F}(f) = \frac{1}{2\pi} \int_{-\infty}^{\infty} e^{i\omega x} f(x)\, dx \tag{2.6}$$

You can use labels to refer to equations you create. 2.6 is the **Laplace transform** used extensively in differential equations. 2.3 is the matrix representation of the **normal equations** used in least-squares regression.

To have equations without labels appearing in the right margin, simply add an asterisk to the name of the environment (equation, align, etc.) when making the declaration.

2.4 Theorems and Proofs: Examples

This section will show an example usage of the theorem and proof environments, typically used for mathematics students. To use these environments, you must have the package **amsthm** declared in the preamble of your document. For this template, this is already declared in the main file. You may choose to remove this declaration if your document will not make use of theorems and proofs.

Theorems can be numbered, as the one below is, or you can force a different label to appear. For example, you can state the Bolzano-Weierstass theorem and have the names appear as the theorem label. See the examples below.

Sometimes you may have a theorem with multiple parts or multiple conditions. You can use other list environments, such as enumerate, inside the theorem environment declared to list these conditions. The final example at the end of this block shows this with the Invertible Matrix Theorem, which has several equivalent statements.

Theorem 1. *Suppose f is of class $\mathcal{C}^1$ and g is of class $\mathcal{C}^2$, and that the compact set D and its boundary satisfy the hypotheses of Green's Theorem. Then*

$$\iint_D f\nabla^2 g \, dA = \oint_{\partial D} f(\nabla g)\cdot \mathbf{n} \, ds - \iint_D \nabla f \cdot \nabla g \, dA.$$

Proof. Begin with the integral of $f\nabla g \cdot n$ taken over the boundary of D. By the second vector form of Green's Theorem,

$$\begin{aligned}\oint_{\partial D} f\nabla g \cdot n \, ds &= \iint_D \nabla\cdot(f\nabla g)\, dA \\ &= \iint_D f\nabla^2 g + \nabla f\cdot\nabla g \, dA.\end{aligned}$$

Rearranging yields the desired. □

Theorem 2 (Bolzano-Weierstrass)**.** *Every bounded real sequence has a convergent subsequence.*

Theorem 3 (Invertible Matrix Theorem[2])**.** *For any square matrix A with n rows and columns, the following are equivalent.*

1. *A is invertible.*

2. *The equation $A\mathbf{x} = \mathbf{0}$ has only the trivial solution $\mathbf{x} = \mathbf{0}$.*

[2]This is an incomplete list.

3. *For any nonzero* $\mathbf{b}$, $A\mathbf{x} = \mathbf{b}$ *has exactly one solution.*

4. *The columns of* A *form a linearly independent set.*

5. *Zero is not an eigenvalue of* A*.*

6. A *has full rank.*

7. *The determinant of* A *is not zero.*

There is currently no set format on how propositions and theorems should be laid out in the document. The idea is to remain consistent. It is best to not customize the appearance of theorems so that they can easily be distinguished from body text - just like figures, tables, and headings.

2.5 Another Table Example

For the sake of testing the appearance of the list of tables, a second table will be displayed here. This table displays a list of some major universities and their enrollments during fall 2015. This table is sorted in descending order of enrollment.

School	City and State	Fall 2015 Enrollment
Texas A&M University[3]	College Station, TX	64,376
Ohio State University[4]	Columbus, OH	58,322
Iowa State University	Ames, IA	36,001
University of California, San Diego	La Jolla, CA	33,735
University of West Florida	Pensacola, FL	12,798
Massachusetts Institute of Technology	Cambridge, MA	11,319

Table 2.2: Some major universities and their fall 2015 enrollments.

Naturally, tables and footnotes do not go together. If you attempted to write a footnote inside a table, there will be nothing at the bottom of the page, yet the footnote marker will still appear. To

[3] Gig 'em!

[4] This number describes enrollments at the Columbus campus; enrollments at regional campuses in Lima, Mansfield, Marion, Newark, and Wooster are not counted.

remedy this, the *footnote* package has been loaded from the *mdwtools* package. Check your TeX distribution to see if *mdwtools* is installed. See the source code for how this is implemented.

3. VERY, VERY, VERY LONG TITLE THAT FLOWS INTO A SECOND LINE FOR THE SAKE OF EXAMPLE

Notice that the title of this section is long - much longer than the others. When you have long section titles, this template takes care of double spacing the lines in the title. If the title is too long to fit in the table of contents, the template will single space the title.

3.1 Yet Another Table

Another table is placed here to show the effect of having tables in multiple sections. The list of tables should still double space between table titles, while single spacing long table titles.

Dates	Attendance
August 8-10, 2008	3,523
August 14-16, 2009	4,003
July 9-11, 2010	5,049
August 5-7, 2011	6,891
August 10-12, 2012	9,464
August 16-18, 2013	11,077
July 18-20, 2014	14,686
July 31-August 2, 2015	18,411

Table 3.1: San Japan attendance. Data is taken from [1]. I intentionally make the title of this table long so the single space effect is seen in the list of tables.

You may be wondering why San Japan was chosen. There are a few reasons as to why I did this:

1. It is one of the fastest-growing anime conventions in Texas.
2. Filler.
3. I wanted a good variety of table examples.

4. Because conventions are cool.

The *enumerate* environment was used to generated an ordered list above.

3.2 Section Test Example

We insert another figure here, just for kicks.

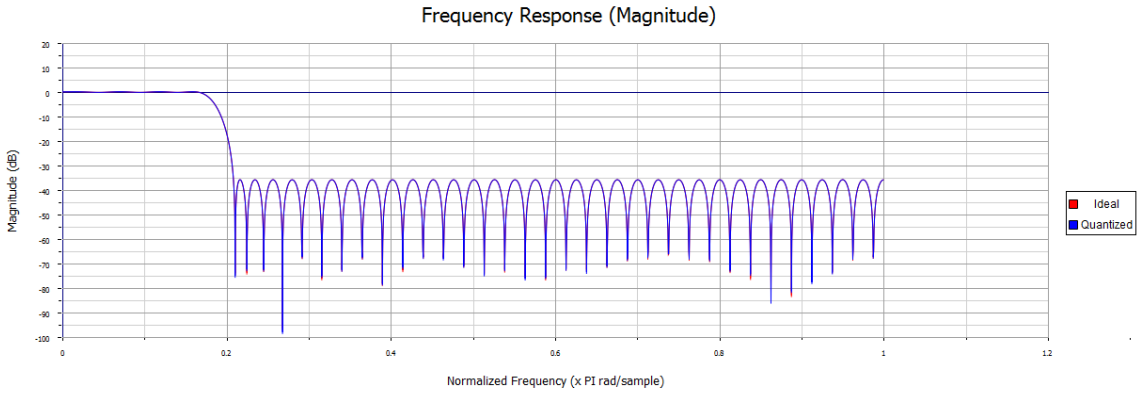

Figure 3.1: A low pass filter design.

3.2.1 Filler, Filler, Filler

This section has filler text. These words serve no meaning except to fill a few lines in the document. This section has filler text. These words serve no meaning except to fill a few lines in the document. This section has filler text. These words serve no meaning except to fill a few lines in the document.

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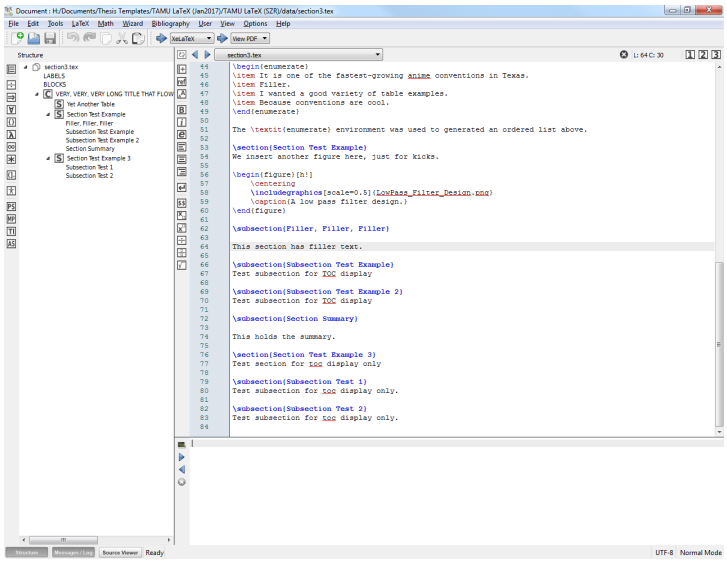

Figure 3.2: A typical Texmaker workspace in Windows 7. The right sidebar displays the current file's structure according to the subsections in place.

few lines in the document. This section has filler text. These words serve no meaning except to fill a few lines in the document.

3.2.2 Subsection Test Example

Test subsection for TOC display

3.2.3 Subsection Test Example 2

This section has filler text. These words serve no meaning except to fill a few lines in the document. This section has filler text. These words serve no meaning except to fill a few lines in the document. This section has filler text. These words serve no meaning except to fill a few lines in the document.

3.2.4 Section Summary

This holds the summary. Well, not really a summary - there was a lot of filler in this section.

3.3 Section Test Example 3

Test section for toc display only.

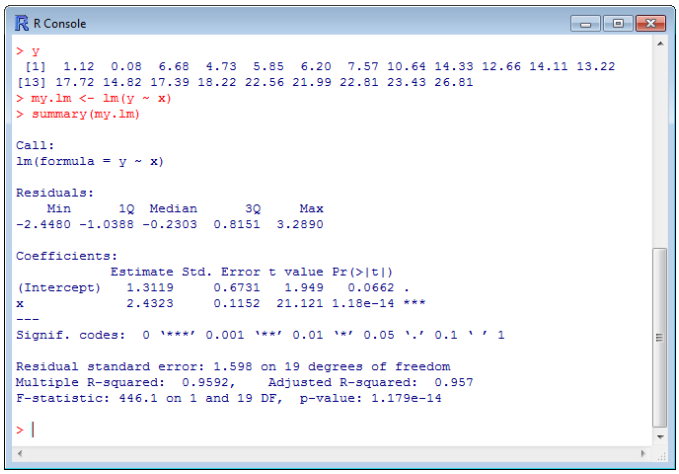

Figure 3.3: Some commands in R.

3.3.1 Subsection Test 1

Test subsection for toc display only.

3.3.2 Subsection Test 2

Test subsection for toc display only.

Figure 3.4: The logo of a familiar university.

Figure 3.5: Yet another blank float that has no purpose. This is only to test the appearance of the Lists of Figures and the List of Tables.

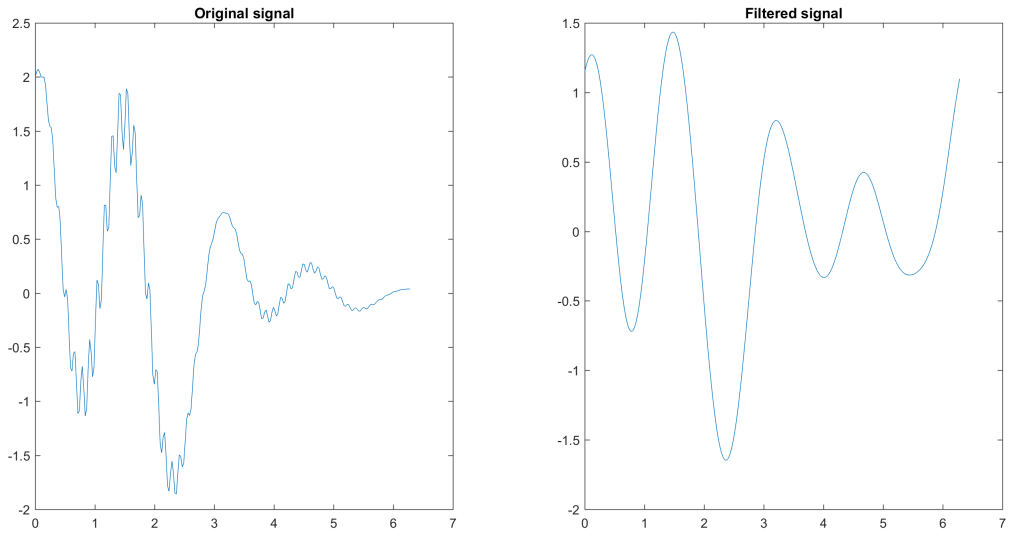

Figure 3.6: A signal and the result after a basic filter. The FFT was used to create the plot on the right.

Figure 3.7: There is nothing to see here.

Figure 3.8: There is another float here. I wonder what could be here? Guess what? Nothing! There is no material in this float.

4. SUMMARY AND CONCLUSIONS

The summary goes here, along with your conclusions. The title of this final chapter/section must contain the words "summary" or "conclusions."

Here, I attempt to fill the section with more figures, possibly more tables. The inclusion of these floats is to manipulate the list of figures and list of tables in order to see when the inconsistent spacing begins. It is important to remember that any images you wish to use are placed in the appropriate directory inside the folder in which the project is kept. In the original template, all the images used as figures here are placed in the subdirectory *graphics*, as declared in the preamble of *TAMU_Thesis_Main.tex*. If you wish to use any other directories, be sure to declare them in the preamble of *TAMU_Thesis_Main.tex*. See the figure below on how to declare directories.

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%  Set path to the figures and figure extensions %%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
\graphicspath{ {./graphic/},{./figures/}  } % Locations of figures
\DeclareGraphicsExtensions{.pdf,.png,.PNG,.jpg}  % Figure extensions
```

Figure 4.1: Declaring graphics directories and image extensions.

The template has a section to place any packages that you are using (Figure 4.2). By default, the hyperref, multirow, footnote, amsthm, and url packages are all loaded in this area. The hyperref package enables hyper references within the document, i.e., if you click on a section in the table of contents, or on a figure, table, equation number, you will be taken to the section's, figure's, table's, equation's location in the document. The multirow package provides commands to place table entries across multiple rows. And so on...

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%          Load extra packages here                    %%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
\usepackage[colorlinks=false]{hyperref} % hyperref with coloring and footnote d
\usepackage{multirow}                   % Multirow package for tables
\usepackage{footnote}                   % Package for the savenotes command
\usepackage{amsthm}                     % AMS package for theorems
\usepackage{url}                        % Load the url package
```

Figure 4.2: The place to declare any packages you require that I have not already declared. This simplifies debugging.

There is also a section in the *TAMU_Thesis_Main.tex* document that allows for custom commands (Figure 4.3). In this case the command *mmday* has been defined, which produces mm day^{-1}. Defining commands like this can be very useful when a certain string is used very often, or a complex equation format is needed many times. In the case of the units for millimeters per day, we no longer have to write

```
mm day$^{-1}$
```

every time we need the units. We only need to type

```
\mmday
```

Note that if there is a space required between the units and text, add a backslash to the end of the command for the space to appear. For example, there is no space with mm day^{-1}even when a space is present after the command. However, if we add a backslash after mm day^{-1} a space is added.

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Define custom  commands for easier typing          %%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
\newcommand{\mmday}{mm day$^{-1}$}  % Command for mm day^-1 units
```

Figure 4.3: The place to declare custom commands.

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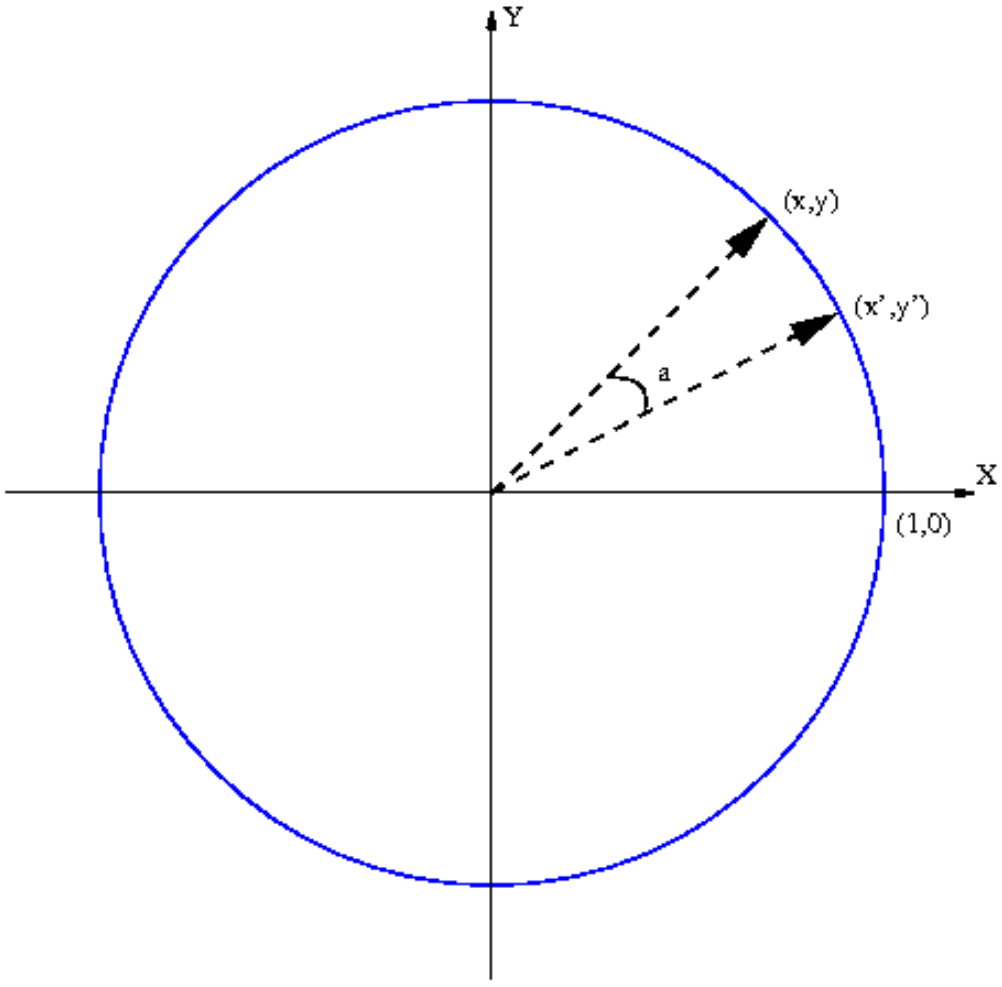

Figure 4.4: Two points on the unit circle and their corresponding position vectors. This figure should be at the bottom of the page

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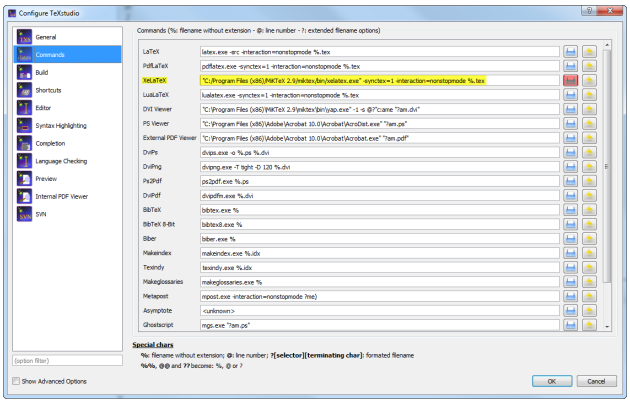

Figure 4.5: Changing the method of compilation for XeLaTeX in TeXstudio. Also at the bottom of the page.

words serve no meaning except to fill a few lines in the document. This section has filler text. These words serve no meaning except to fill a few lines in the document. This section has filler text. These words serve no meaning except to fill a few lines in the document. This section has filler text. These words serve no meaning except to fill a few lines in the document. This section has filler text. These words serve no meaning except to fill a few lines in the document. This section has filler text. These words serve no meaning except to fill a few lines in the document.

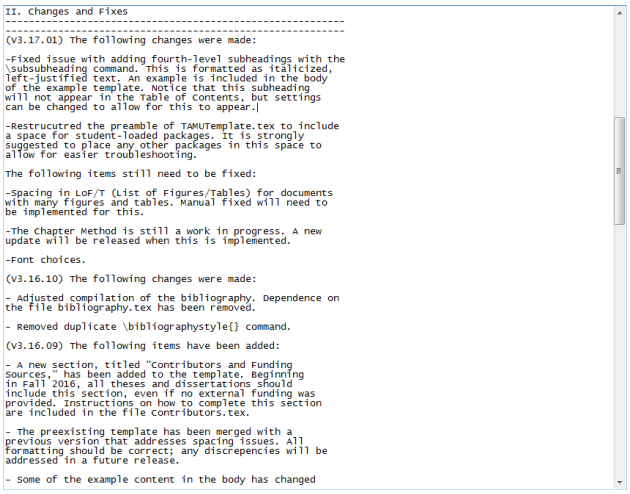

Figure 4.5: Continued.

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4.1 Challenges

Section here is to test toc display only.

4.2 Further Study

Section here is to test toc display only.

REFERENCES

[1] "Animecons.com - Anime Conventions and Guests." Web, 2015.

[2] N. Carothers, *Real Analysis*. Cambridge University Press, 2000.

[3] A. Einstein, "Zur Elektrodynamik bewegter Körper. (German) [On the electrodynamics of moving bodies]," *Annalen der Physik*, vol. 322, no. 10, pp. 891–921, 1905.

[4] C. F. Barnes and R. L. Frost, "Residual vector quantizers with jointly optimized code books," *Advances in Electronics and Electron Physics*, vol. 84, pp. 1–59, 1992.

[5] G. T. Gilbert and R. L. Hatcher, "Wagering in final jeopardy!," *Mathematics Magazine*, vol. 67, pp. 268–277, October 1994.

[6] "Results - Arcadia Festival of Bands." Web, November 2011.

APPENDIX A

FIRST APPENDIX

Text for the Appendix follows.

Figure A.1: TAMU figure

APPENDIX B

A SECOND APPENDIX WHOSE TITLE IS MUCH LONGER THAN THE FIRST

Text for the Appendix follows.

Figure B.1: Another TAMU figure.

B.1 Appendix Section

B.2 Second Appendix Section