Thesis GWU Example Dissertation

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The School of Engineering and Applied Science of The George Washington University certifies that Shankar Kulumani has passed the Final Examination for the degree of Doctor of Philosophy as of Dec 1, 2018. This is the final and approved form of the dissertation.

<div align="center">**Thesis GWU Example Dissertation**</div>

<div align="center">Shankar Kulumani</div>

Dissertation Research Committee:

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       Full Name, Title, Dissertation Director/Dissertation Co-Director/Committee Member

Include a fancy quote or dedication

Acknowledgments

Here you can acknowledge all of those people who have helped you to reach this point. It's rare that any work is done in a vacuum and your research is no exception. Feel free to be grateful for all those who've aided you along your way.

Abstract

Thesis GWU Example Dissertation

This is the abstract. It contains some random text from the `lipsum` package. You may safely remove the `lipsum` package once you write your thesis.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Ut purus elit, vestibulum ut, placerat ac, adipiscing vitae, felis. Curabitur dictum gravida mauris. Nam arcu libero, nonummy eget, consectetuer id, vulputate a, magna. Donec vehicula augue eu neque. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Mauris ut leo. Cras viverra metus rhoncus sem. Nulla et lectus vestibulum urna fringilla ultrices. Phasellus eu tellus sit amet tortor gravida placerat. Integer sapien est, iaculis in, pretium quis, viverra ac, nunc. Praesent eget sem vel leo ultrices bibendum. Aenean faucibus. Morbi dolor nulla, malesuada eu, pulvinar at, mollis ac, nulla. Curabitur auctor semper nulla. Donec varius orci eget risus. Duis nibh mi, congue eu, accumsan eleifend, sagittis quis, diam. Duis eget orci sit amet orci dignissim rutrum.

Table of Contents

List of Figures

List of Tables

Preface

This is the preface. It's another front matter page that offers additional detail into your work. Typically, only one (preface OR prologue OR foreword) is used. You can remove the other sections by deleting them inside `tex/frontmatter.tex` or using the appropriate show or hide commands.

Foreword

This is the forword. It's another front matter page that offers additional detail into your work. Typically, only one (preface OR prologue OR foreword) is used. You can remove the other sections by deleting them inside `tex/frontmatter.tex` or using the appropriate show or hide commands.

Prologue

This is the prologe. It's another front matter page that offers additional detail into your work. Typically, only one (preface OR prologue OR foreword) is used. You can remove the other sections by deleting them inside `tex/frontmatter.tex` or using the appropriate show or hide commands.

CHAPTER 1

Using this template

This chapter is stuck among the others as a brief users' manual for this template. The approach to this template is to result in LaTeX source code files (`.tex` files) that are as simple as possible. It also tries to do as much as possible automatically so that the user does not have to spend a lot of effort trying to match the poorly documented "guidelines" provided by GWU or SEAS. This is particularly useful for the first few pages, for example the title page, dedication, and abstract page, which are difficult to make in LaTeX and are supposed to go in a certain order.

In addition to the description in this chapter, anyone may, of course, also look at the source code for this file, `thesis-sample.tex`. That file contains all of the source for this `.pdf` in a single file, but it will work just as well with multiple input files combined with the `input` or `include` commands. Generally, it is a better idea to use `include` as this will allow for selective compiling of a specific portion of your thesis, i.e. only a single chapter at a time.

The final generic comment about this template is that it has been updated to take advantage of LaTeX's capabilities to create documents with links in them. Provided you are using a modern PDF viewer to view this document, you may have already noticed this. It creates a list of bookmarks, which can be used to quickly navigate what may be a long document. It also turns references within the text into links. The best examples in this file are the entries in the Table of Contents. Although the chapter and section names are shown in black (in accordance with the GWU guidelines), clicking on them does navigate to the start of the chapter, section, etc.

1.1   General Usage

The way to invoke usage of this template is to put

```
\documentclass{thesis-gwu.cls}
```

at the beginning of your preamble. This can also work if the `thesis-gwu.cls` file is not in the same directory as your `.tex` file. To do so, just give the relative path.

```
\documentclass{./tex/thesis-gwu.cls}
```

Much like a usual article or report in LaTeX, the user specifies the primary information about the document in the preamble with commands like

```
\author{Shankar Kulumani}
\chair{Taeyoung Lee}
```

At the beginning of the document, the title page will automatically be created and inserted at the beginning of the document. If you forget to declare any of the required fields, it will generate a title page with a message such as "Insert an author!"

However, the template does a lot more in the preamble than just create a title page. The preamble (that is, whatever comes before `begin{document}` in the primary `.tex` file) is also the place for the user to specify a dedication, any acknowledgments, a foreword, *etc.* This is done in a manner very similar manner to declaring the author, title, and so on. Suppose that someone wants to have a simple dedication "To Mom", the following command is all that is needed.

```
\dedication{To Mom}
```

This will cause the document to have a dedication page with the corresponding text. If the `dedication` command is not present, there will not be a dedication page. All the work of either having or not having a dedication has been compressed into a single command! Things other than simple text *are* allowed in the dedication, so feel free to put equations or whatever inside there. There are a few more commands that can be used to customize the appearance of the dedication page, and also for the other preamble text pages, but that is left to Section 1.2.3.

1.2 Front Matter

The LaTeX term "frontmatter" refers to all of the pages that occur before the beginning of the first chapter. It is usually made clear to the reader because the pages in the front matter are numbered with lower-case Roman numerals instead of Arabic numerals.

The present template, `thesis-gwu.cls` attempts to remove as much work associated with the front matter as possible. The template inserts all of the front

Table 1.1: List of all identifier commands

ITEM	USAGE	COMMENT
Author	\author{...}	Works as in standard LaTeX
Chair	\chair{...}	Name of chair *without* any title or affiliation. This appears only on the abstract page, and only if there is no co-chair.
Co-chair	\cochair{...}	Names of all co-chairs *without* any titles or affiliations. This appears only on the abstract page. Note that by convention, it is not chair *and* co-chair, but just two co-chairs.
Committee	\committee{...}	Formatted names of committee members *with* the appropriate titles and university names. This will appear only on the title page.
Department	\department{...}	Title of department of student
Title	\title{...}	Works as in standard LaTeX
Year	\year=2012	Year that dissertation will be *completed*

matter pages automatically, so that there is not even a need to use a command like \maketitle. The first thing after \begin{document} should be the start of the first chapter.

1.2.1 Identifiers

The template is not able to read minds, of course, so there needs to be some way of inputting the relevant information. This section covers how to specify the author, title, and so on. For the most part, this works just like any other LaTeX document, but a dissertation has a few more identifiers than most documents (How many books or reports have a committee?). So there are a few extra commands provided by this template, and they work *almost* exactly like the standard commands.

A full list of the identifiers is given in Table Table 1.1. You're free to adjust/delete these commands as desired.

1.2.2 Frontispiece and Copyright

By default, the template assumes that there should be a copyright page, and the copyright holder is the author. To prevent the copyright page from appearing, use

the command `\hidecopyright`. To assign the copyright to someone other than the author, use the following command.

`\copyrightholder{Someone Else}`

1.2.3   Text Pages

The handling of the first few pages after the title page is one of the best features of this template. The pages that occur between the copyright page and the abstract page all consist of short pieces of text that are usually a single paragraph. The text for each of these pages is set up using a command of the same name. Generally, only one of the front matter pages is used.

`\foreword{This is going to be the best dissertation ever.}`

Usually the contents of each of these pages will be longer than a single sentence, and thus it should be noted that each of these commands allows most types of LaTeX input. For example, the following is perfectly acceptable input–at least as far as the template is concerned.

`\foreword{This is going to be the \emph{best}. \\`
 `\begin{center} Really, really. \end{center}}`

As I mentioned before, a given page will appear in the document if and only if the corresponding command is used. The order in which the pages appear does not depend on the order the commands are used in the preamble. You can also prevent the pages from appearing by using commands like `\hideforeword`.

The style of each page can also be set by the user. By default, each page will appear with a bold, italic heading corresponding to the name of the page. However, there are five other formats, which can be controlled using an optional argument. For example, the following command creates a dedication page with no heading (*i.e.* it does not say "Dedication" on the page) but with lines above and below the dedication text.

`\dedication[4]{To Mom}`

A complete list of the available styles is given in Table 1.2. The style of each page can be set independently, but it is also possible to change which style is used by default.

`\frontpagestyle{6}`

This would make all of the commands that were called without optional inputs to create pages using style 6.

Table 1.2: List of styles for frontmatter text pages

STYLE	DESCRIPTION
1	Justified text with no header or lines
2	Justified text with bold italic header and no lines
3	Justified text, capitalized header, no lines
4	Justified text with lines and no header
5	Justified text with bold italic header and lines
6	Justified text with capitalized header and lines
other	Centered text with no header or lines

1.2.4 Lists of Things

Suffice it to say that this template handles the Table of Contents appropriately, but this section is also meant to address the List of Figures, List of Tables, *etc.* According to the guidelines, a corresponding list must appear if there is more than one figure, table, map, program, illustration, or appendix. The template assumes that the dissertation will contain at least two figures and tables. If, for example, there is only one figure,

```
\hidelistoffigures
```

must be put in the preamble.

The other type of list that can occur is for abbreviations of various types. This is a somewhat convenient feature, particularly there are a lot of acronyms in the dissertation. This template utilizes the `acronym` package, but eventually I would like to migrate to the use of `glossaries` which is continuing to be supported. In the preamble put a command like the following.

```
\abbreviations{
 \acro{CFD}{Computational Fluid Dynamics}
 \acro{LOA}{List of Abbreviations}
 \acro{H2O}[$\mathrm{H_2O}$]{water}}
```

This will define a bunch of abbreviations that can be used. When you want to use one of the acronyms within the text, simply use the `\ac` command to refer to the abbreviation you want. This will automatically spell out what the abbreviation stands for on the first use and only print out the abbreviation on subsequent uses. Here's an acronym **CRTBP!** (**CRTBP!**). And if we use it a second time, such as **CRTBP!**, only the abbreviation will appear.

Figure 1.1: Glad to have a thesis class

1.3 Float environments

There are many possible float enviornments, and this section will serve as an introduction and demonstration of some of them. In addition, it offers the ability to ensure that this template actually follows the guidelines.

1.3.1 Figures

Here is a figure as shown in Figure 1.1. Notice how we're using the fancy referencing offered by the `cleveref` package. Instead of using the normal `\ref` command we instead use `\cref`. The magic of LaTeX automatically figures out that the previous reference points to a figure while Section 1.3.1 points to a section.

1.3.2 Tables

Here's a table in Table 1.3

1.4 References and Citation

Finally, we'll add a subfigure to demonstrate it's proper use. Many people use the package `subfigure` but this is in fact, quite wrong. To begin, the `subfigure` package has been deprecated, which one can check by going to `https://www.ctan.org/pkg/`

Day	Min Temp	Max Temp	Summary
Monday	11C	22C	A clear day with lots of sunshine. However, the strong breeze will bring down the temperatures.
Tuesday	9C	19C	Cloudy with rain, across many northern regions. Clear spells across most of Scotland and Northern Ireland, but rain reaching the far northwest.
Wednesday	10C	21C	Rain will still linger for the morning. Conditions will improve by early afternoon and continue throughout the evening.

Table 1.3: Long caption for text

`subfigure`CTAN. Instead, everyone should be using `subcaption`, just as this class file is already doing. Here, in Figure 1.2, we see two subfigures encapsulated in a larger figure environment. Luckily, with our fancy referencing we have access to both Figures 1.2a and 1.2b using the same commands. The key thing to note from Figure 1.2a is that trustworthiness reaches a maximum for those using `.tex`.

1.4.1 References

Lots of famous people tend to write famous papers [2]. Were they famous because or in-spite of their papers? Regardless, they're famous now and we all should read them. Certain people are so famous and do such great work that they invent a whole new field of study with a single paper [1, 3]
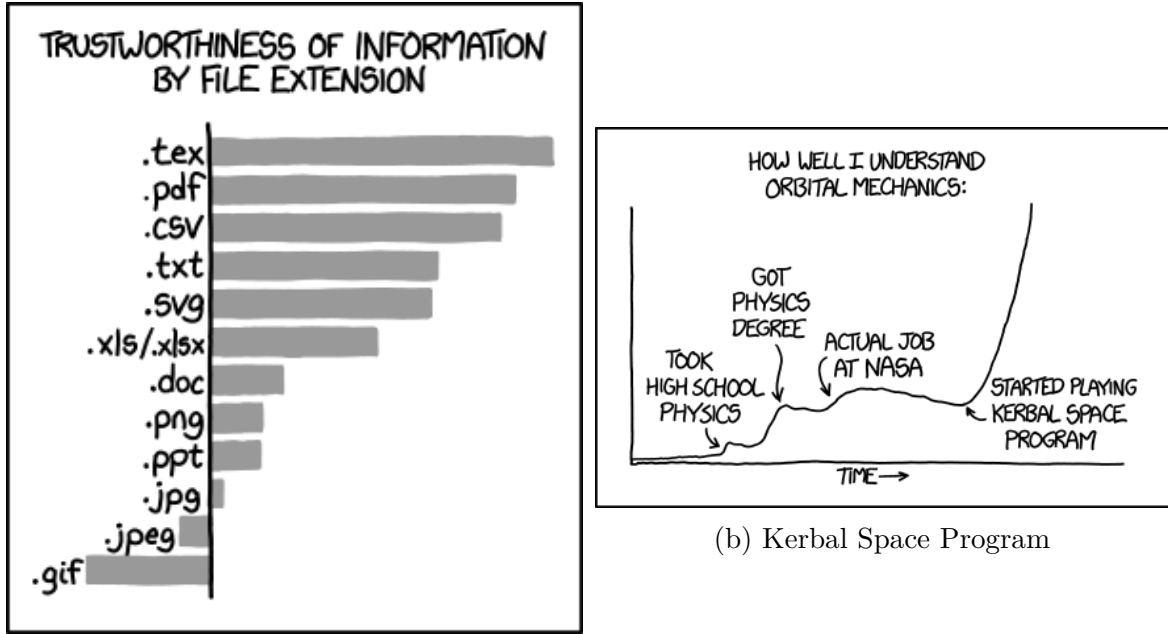
(a) File Extensions

(b) Kerbal Space Program

Figure 1.2: Some words of wisdom from Randall Munroe

1.5   Math

Here are some nice equations Equations (1.1) and (1.2)

$$\min_{s \subset W} \; J(s) = \sum_{i=1}^{l-1} H(s_j, s_{j+1}) \tag{1.1}$$

$$\max_{s \subset W} \; P_{tr}(s) = \prod_{i=1}^{l-1} P_{tr}(s_j, s_{j+1})$$

Here's another equation.

$$\min_{s \subset W} \; J(s) = \sum_{i=1}^{l-1} H(s_j, s_{j+1}) \tag{1.2}$$

$$\text{subject to } P_{tr}(s) > \epsilon_{tr}$$

CHAPTER 2

Another sample chapter

This chapter has several paragraphs of random text. This ensures our table of contents is correct and demonstrates how to use a multi-file LaTeXdocument.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Ut purus elit, vestibulum ut, placerat ac, adipiscing vitae, felis. Curabitur dictum gravida mauris. Nam arcu libero, nonummy eget, consectetuer id, vulputate a, magna. Donec vehicula augue eu neque. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Mauris ut leo. Cras viverra metus rhoncus sem. Nulla et lectus vestibulum urna fringilla ultrices. Phasellus eu tellus sit amet tortor gravida placerat. Integer sapien est, iaculis in, pretium quis, viverra ac, nunc. Praesent eget sem vel leo ultrices bibendum. Aenean faucibus. Morbi dolor nulla, malesuada eu, pulvinar at, mollis ac, nulla. Curabitur auctor semper nulla. Donec varius orci eget risus. Duis nibh mi, congue eu, accumsan eleifend, sagittis quis, diam. Duis eget orci sit amet orci dignissim rutrum.

2.1   A section

Suspendisse vitae elit. Aliquam arcu neque, ornare in, ullamcorper quis, commodo eu, libero. Fusce sagittis erat at erat tristique mollis. Maecenas sapien libero, molestie et, lobortis in, sodales eget, dui. Morbi ultrices rutrum lorem. Nam elementum ullamcorper leo. Morbi dui. Aliquam sagittis. Nunc placerat. Pellentesque tristique sodales est. Maecenas imperdiet lacinia velit. Cras non urna. Morbi eros pede, suscipit ac, varius vel, egestas non, eros. Praesent malesuada, diam id pretium elementum, eros sem dictum tortor, vel consectetuer odio sem sed wisi.

2.1.1 A subsection

Morbi luctus, wisi viverra faucibus pretium, nibh est placerat odio, nec commodo wisi enim eget quam. Quisque libero justo, consectetuer a, feugiat vitae, porttitor eu, libero. Suspendisse sed mauris vitae elit sollicitudin malesuada. Maecenas ultricies eros sit amet ante. Ut venenatis velit. Maecenas sed mi eget dui varius euismod. Phasellus aliquet volutpat odio. Vestibulum ante ipsum primis in faucibus orci luctus et ultrices posuere cubilia Curae; Pellentesque sit amet pede ac sem eleifend consectetuer. Nullam elementum, urna vel imperdiet sodales, elit ipsum pharetra ligula, ac pretium ante justo a nulla. Curabitur tristique arcu eu metus. Vestibulum lectus. Proin mauris. Proin eu nunc eu urna hendrerit faucibus. Aliquam auctor, pede consequat laoreet varius, eros tellus scelerisque quam, pellentesque hendrerit ipsum dolor sed augue. Nulla nec lacus.

2.1.1.1 A subsubsection

Sed feugiat. Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Ut pellentesque augue sed urna. Vestibulum diam eros, fringilla et, consectetuer eu, nonummy id, sapien. Nullam at lectus. In sagittis ultrices mauris. Curabitur malesuada erat sit amet massa. Fusce blandit. Aliquam erat volutpat. Aliquam euismod. Aenean vel lectus. Nunc imperdiet justo nec dolor.

Bibliography

[1] R E Kalman. A New Approach to Linear Filtering and Prediction Problems. *Journal of Basic Engineering*, 82(1):35–45, 1960.

[2] Isaac Newton. *The principia: mathematical principles of natural philosophy.* Univ of California Press, 1999.

[3] C.E. Shannon. Communication in the presence of noise. *Proceedings of the IRE*, 37(1):10 – 21, jan. 1949.

Appendix

This is an example of an appendix. The only difference is the use of `\appendix` command at the start of this `tex` file. This automatically changes the chapter and section headings.

A.1 A section

The easiest method.

$$x_k = \frac{a_k + b_k}{2} \tag{A.1}$$

A.2 False Position

Nulla ac nisl. Nullam urna nulla, ullamcorper in, interdum sit amet, gravida ut, risus. Aenean ac enim. In luctus. Phasellus eu quam vitae turpis viverra pellentesque. Duis feugiat felis ut enim. Phasellus pharetra, sem id porttitor sodales, magna nunc aliquet nibh, nec blandit nisl mauris at pede. Suspendisse risus risus, lobortis eget, semper at, imperdiet sit amet, quam. Quisque scelerisque dapibus nibh. Nam enim. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Nunc ut metus. Ut metus justo, auctor at, ultrices eu, sagittis ut, purus. Aliquam aliquam.

A.3 Starting the Appendices

Actually, using appendices is quite simple. Immediately after the end of the last chapter and before the start of the first appendix, simply enter the command `\appendix`. This will tell LaTeX to change how it interprets the commands `\chapter`, `\section`, *etc.*

Each appendix is actually a chapter, so once the `\appendix` command has been called, start a new appendix by simply using the `\chapter` command.

Note that the `\appendix` command should be called only once–not before the start of each appendix.

All the fancy referencing and tools still work. You only need to add the appendix command and all will be as it should be.

Appendix B

Another Appendix

Maecenas non massa. Vestibulum pharetra nulla at lorem. Duis quis quam id lacus dapibus interdum. Nulla lorem. Donec ut ante quis dolor bibendum condimentum. Etiam egestas tortor vitae lacus. Praesent cursus. Mauris bibendum pede at elit. Morbi et felis a lectus interdum facilisis. Sed suscipit gravida turpis. Nulla at lectus. Vestibulum ante ipsum primis in faucibus orci luctus et ultrices posuere cubilia Curae; Praesent nonummy luctus nibh. Proin turpis nunc, congue eu, egestas ut, fringilla at, tellus. In hac habitasse platea dictumst.