[THE TITLE OF YOUR THESIS GOES IN THIS SPACE TO LET US KNOW WHAT YOUR DOCUMENT IS ABOUT]

An Undergraduate Research Scholars Thesis

by

[INSERT NAME]

Submitted to the Undergraduate Research Scholars program at
Texas A&M University
in partial fulfillment of the requirements for the designation as an

UNDERGRADUATE RESEARCH SCHOLAR

Approved by Research Advisor: Dr. [Advisor Name]

May 2018

Major: [Insert Primary Major]

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ABSTRACT

[The Title of Your Thesis Goes Here Using Title Case Formatting]

[Insert Name]
Department of [Insert Primary Major]
Texas A&M University

Research Advisor: Dr. [Advisor Name]
Department of [Advisor Department]
Texas A&M University

This is the first numbered page Arabic numeral 1. Page numbers are outside the 1 inch margins (on all sides), 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. 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 the 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 accommodate with a variety of online database, images or complex equations should also be avoided.

The next pages are Dedication, Acknowledgments, and Nomenclature.

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.

ACKNOWLEDGMENTS

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.

NOMENCLATURE

B/CS	Bryan and College Station
TAMU	Texas A&M University
SDCC	San Diego Comic-Con
EVIL	Every Villain is Lemons
EPCC	Educator Preparation and Certification Center at Texas A&M University - San Antonio
FFT	Fast Fourier Transform
ARIMA	Autoregressive Integrated Moving Average

LIST OF FIGURES

FIGURE Page

LIST OF TABLES

TABLE Page

1. INTRODUCTION AND LITERATURE REVIEW

1.1 Read Me

This template is derived from Texas A&M University's Graduate LaTeXthesis template found on their website on December 7th 2016. This template is to be used for Undergraduate Research Scholars program at Texas A&M. This template shows the many features of LaTeX, with many more available to the user.

There are numerous guides, references, and tutorials available on the Internet to help you. If you are stuck, don't be afraid to conduct a Google search for your issue.

1.1.1 Changes

The changes made to the thesis template:

- Added appropriate commands for the title, program, advisor, and department. Commands needed for the graduate thesis were removed.
- Modified the introduction of the template to be more accurate.
- Reformatted the title page to follow URS formatting rules.
- Reformatted the abstract page to follow URS formatting rules.
- Condensed the appendices to one page.
- Changed the section file names to chapter to be more concise naming convention.
- Added a makefile to compile the document.
- Various updates made for URS 2018. These include title formatting, TOC location, spelling/grammar errors, and more.

1.1.2 Useful Resources and Websites

Here are some useful tutorials and references on LaTeX:

- http://www.latex-tutorial.com/tutorials/
- http://www.cs.princeton.edu/courses/archive/spr10/cos433/Latex/latex-guide.pdf
- https://www.sharelatex.com/learn/Main_Page
- https://tobi.oetiker.ch/lshort/lshort.pdf
- ftp://ftp.ams.org/pub/tex/doc/amsmath/short-math-guide.pdf

1.1.3 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 URS Thesis Manual. This template takes care of the margins, heading requirements, and front matter ordering for you.

1.1.4 Software to Install

TeXworks and **TeXstudio** for Windows, MaxOS, and Linux are free software for compiling your LaTeX document. To compile for this document, *pdflatex* or *xelatex* compiling engine should be used. Make sure you are using bibtex for generating references. Do not use *latex* compiling engine if you are using png images because it will not know the size of the image.

[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.

1.1.5 Procedure to Compile LaTeX Document

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

- In TeXstudio, go to the Tools menu, then select Commands, and click pdfLaTeX or XeLatex.
- In TeXworks, go to the Typeset menu and select pdfLaTeX or XeLatex.
- For other editors, consult the help files included with the editor.

If you are working in linux and want to use gnumake, make sure you have pdfLaTeX or XeLaTeX installed. To build on Linux, open a terminal, go to the thesis directory and type `make` and hit enter. The document will build and create a file called `thesis.pdf` that will be your thesis.

To use make on MaxOS, commandline tools must be installed from Xcode. If it is not already install I do not recommend using this because the Xcode is a large install and it might be advantageous to use one of the other mentioned methods.

1.1.6 How to Fill This Document

The document structure is organized in the main .tex file, thesis.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 thesis.tex file and go to **line 137** you can just delete the content in the data folder and fill your documents and then compile under thesis.tex.)

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

1.1.7 Reference Usage and Example

This subsection tests the usage of references. The book[2] is referred in this way. Actually, the option is available for you to change the default way how reference appears. The default and most commonly used option [3] is displayed here [4].

Unrelated citations are referred here for the test of reference section only. If you find that the reference has more items than you need [5], question marks will show up in place of a reference handle, like these [**?**].

1.1.8 Where to Start

Getting started in LaTeXcan be a daunting task. To get started I recommend getting your the information into the preliminary pages (abstract, acknowledgements, dedication, and nomenclature) as a way to learning how to move around the different files. The information in the preliminary pages is controlled by fields located in the files thesis.tex, and it allows you to enter the information into the template a single time. To modify the preliminary pages in this template, follow these steps:

1. Open the file thesis.tex in your LaTeX editor.

    (a) Locate the command `\title` and type your thesis title there.

    (b) Locate the command `\author` and type your name there.

    (c) Locate the command `\program`. Do not change this, it is already correct.

    (d) Locate the command `\ursadvisor` and type your research advisor's name there. Do not put "Dr." before their name; the template will do this for you.

    (e) Locate the command `\department` and type your primary department. If you have a secondary department, it isn't necessary for you to include it. You do not need to include the text "Department of" before the department names; the template will do this for you.

(f) Locate the command `\advisordepartment` and type your advisor's department there. Again, you do not need to add "Department of".

2. Save the file thesis.tex and open abstract.tex in the data directory

3. Type your abstract after the `\indent`. Remember that your abstract should be no longer than 350 words. Do not change anything else in the file. The rest of the file is formatting the abstract's header.

4. Save the file abstract.tex and open dedication.tex in the data directory

5. Type your dedication between the `\begin{center}` and `\end{center}` commands and between the `\vspace*` commands. This section is optional, and if you do not wish to include it, comment out the line `\{data/dedication}` on **line 124** of thesis.tex by placing a `%` character before the line. This will completely remove the dedication page.

6. Save the file dedication.tex and open acknowledgements.tex in the data directory

7. Type your acknowledgments after the `\indent` command. This section is optional, and if you do not wish to include it, comment out the line `\{data/acknowledgments}` on **line 125** of thesis.tex by placing a `%` character before the line. This will completely remove the acknowledgments page.

8. Save the file acknowledgments.tex and open nomenclature.tex in the data directory

9. Type your nomenclature between `\begin{tabular}` and `\end{tabular}`. Within the table the abbreviation will be to the left of the & and what it means will be the right. Use the examples already provided if you need more clarification. This section is optional, and if you do not wish to include it, comment out the line

`\{data/acknowledgments}` on **line 126** of thesis.tex by placing a `%` character before the line. This will completely remove the nomenclature page.

10. Save the file nomenclature.tex.

11. Compile the document from thesis.tex. This is considered the `main` file for your thesis document.

12. thesis.pdf should now contain the changes you made to the template. If you received any error messages use google or other resources provided to figure out what they mean and how to correct them.

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

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.

$$x \in A \cap \bigcup_j B_j \iff x \in A \ \wedge \ x \in \bigcup_j B_j$$

$$\iff x \in A \ \wedge \ x \in B_k \text{ for some k}$$

$$\iff x \in \bigcup_j A \cap B_j$$

There are many more commands and features available, but this document is too small to contain them.[3] Many guides are available on the Internet for your use.

1.1.10 A Test Subheading

This is just a test.

1.1.11 Another Test Subheading

Hello, is it me you're looking for?

1.1.12 Yet Another One

She called me late last night to say she loved me so.

1.1.13 No Surprises Here

Insert another song lyric here.

[3] Yes, I pulled a Fermat. But really, a Google search will likely help you find what you need to do.

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

2.1 Figures: Placement, Size, and Captions

This is a figure template.

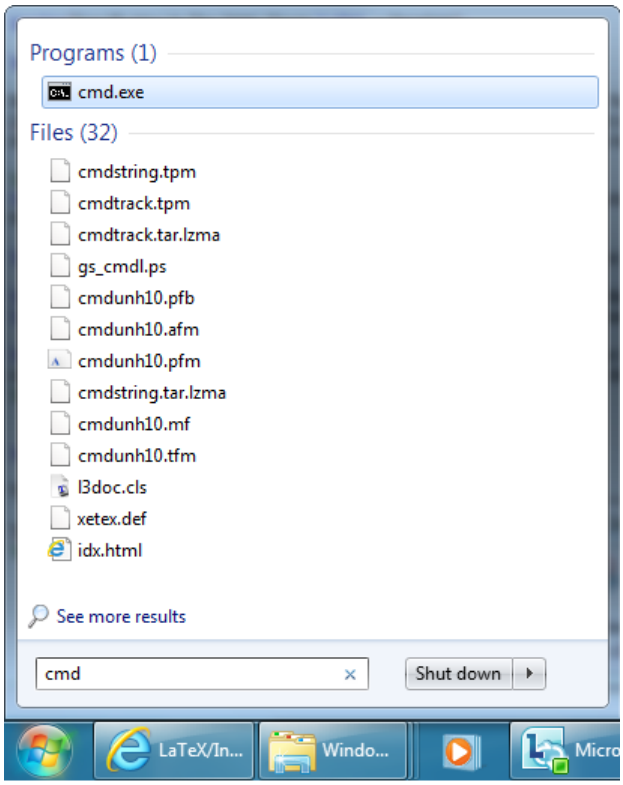

Figure 2.1: The command line compiler in Windows. It is not suggested that you compile using this method. See compilation instructions in the README.

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. While continued figures are allowed by the URS Thesis

Manual with proper continuation headings, it is not suggested that any continued figures be included in a LaTeX document.

The figure below is taken from R. While there are packages available to import graphics from R, MATLAB, and similar software, it is probably best to export plots generated by these programs as a PNG file, and then import it via the *includegraphics* command. Figures must also be referenced in the body text within 1 page of where the figure actually appears in the document.

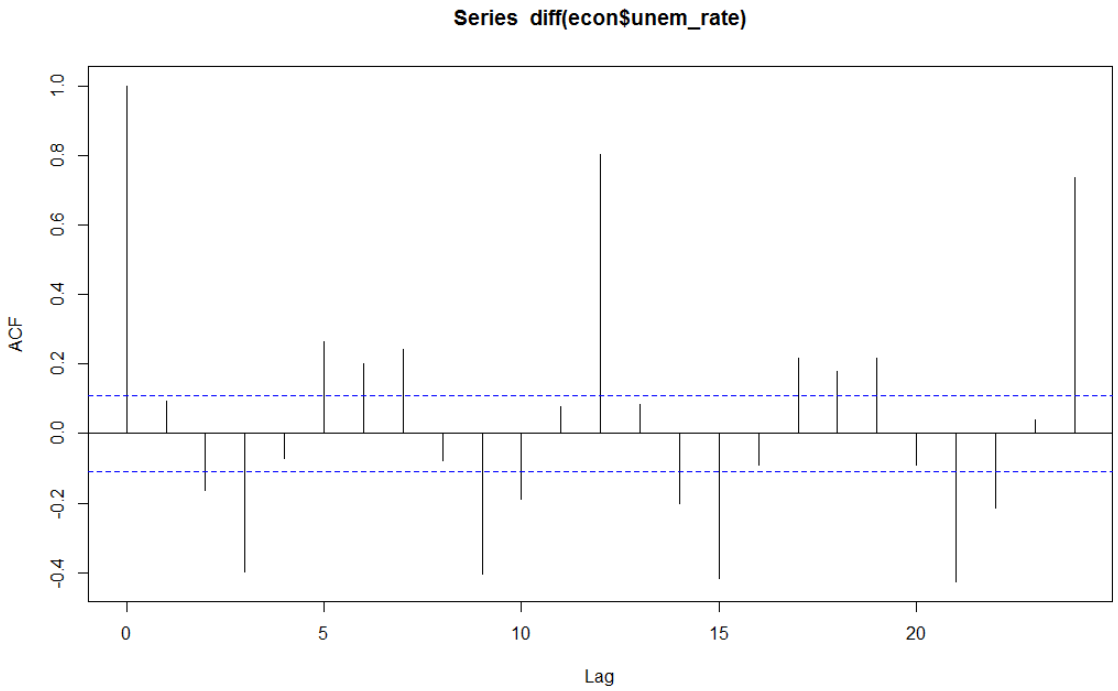

Figure 2.2: The autocorrelation function (ACF) of the differenced unemployment series. Seasonal adjustments may be needed.

2.2 Table Placement, Size and Table Title

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

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

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

The table is sorted by band score. There is more text here to demonstrate how the template handles spacing between tables and body text. 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* command 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 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[4])**.** *For any square matrix A with n rows and columns, the following are equivalent.*

[4]This is an incomplete list.

1. *A is invertible.*

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

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.

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

School	City and State	Fall 2015 Enrollment
Texas A&M University[5]	College Station, TX	64,376
Ohio State University[6]	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

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 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.

[5]Gig 'em!

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

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 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.

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.

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

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.

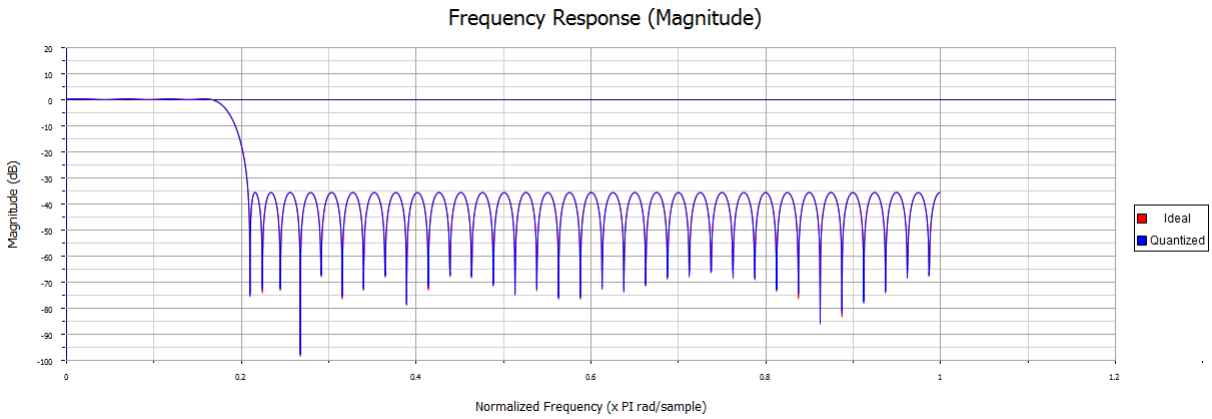

Figure 3.1: A low pass filter design.

4. SUMMARY AND CONCLUSIONS

Some text/figure here

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.

FIRST APPENDIX

Text for the Appendix follows.

Figure 4.1: TAMU figure

A SECOND APPENDIX WHOSE TITLE IS MUCH LONGER THAN THE FIRST

Text for the Appendix follows.

Figure 4.2: Another TAMU figure.