# My Final College Paper

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A Thesis
Presented to
The Division of Mathematical and Natural Sciences
Reed College

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In Partial Fulfillment
of the Requirements for the Degree
Bachelor of Arts

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May 2024

Approved for the Division
(Computer Science)

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# Acknowledgements

I want to thank a few people.

# Preface

This is an example of a thesis setup to use the reed thesis document class.

# List of Abbreviations

You can always change the way your abbreviations are formatted. Play around with it yourself, use tables, or come to CUS if you'd like to change the way it looks. You can also completely remove this chapter if you have no need for a list of abbreviations. Here is an example of what this could look like:

| | |
|---|---|
| **ALU** | Arithmetic Logic Unit |
| **CPU** | Central Processing Unit |
| **ISA** | Instruction Set Architecture |
| **RISC-V** | Reduced Instruction Set Computer Five |

# Table of Contents

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# Abstract

The preface pretty much says it all.

# Dedication

You can have a dedication here if you wish.

# Introduction

Though there's countless pieces of hardware to study and delve into within this field, the CPU (Central Processing Unit) can be argued to be the most essential one. It is the heart of any computer, the piece that actually carries out the programs and computations that it was built for. It comes as no surprise, then, that most college-level Computer Systems courses begin by taking a close look at the inner workings of a simple CPU, so that they can then begin to understand how the other components of a computer support its functionality, and how it can produce computation out of just an assembly program, wires, and logic gates. Learning of this is all well and good, but getting hands-on experience with the topic is harder than one might expect: The powerful CPUs in the personal computers of students run on are all closed-source designs that obfuscate how they carry out their instructions; and even if they were transparent, the sheer breadth and depth of modifications they employ to get the performance they do would make their design completely indecipherable to a novice.

Therefore, the aim of this project is to develop a pedagogical simulator program, capable of running on modern computers, that simulates a simple RISC-V CPU at the hardware level, running assembly code and then transparently displaying how the code and computed information traverse the inside of the processor. While simple, the simulated CPU implements a 5-stage pipeline design similar to the ones that are mandatory for modern CPUs. The project also seeks to include some user-facing features, like a graphical interface and the ability to step through and rewind through the execution of a program, to make the simulator more intuitive to use.

## 0.1 Bibliographies

Of course you will need to cite things, and you will probably accumulate an armful of sources. This is why BibTeX was created. For more information about BibTeX and bibliographies, see our CUS site (`web.reed.edu/cis/help/latex/index.html`)[1]. There are three pages on this topic: *bibtex* (which talks about using BibTeX, at `/latex/bibtex.html`), *bibtexstyles* (about how to find and use the bibliography style that best suits your needs, at `/latex/bibtexstyles.html`) and *bibman* (which covers how to make and maintain a bibliography by hand, without BibTeX, at at `/latex/bibman.html`). The last page will not be useful unless you have only a few sources. There used to be APA stuff here, but we don't need it since I've fixed this

[1] Reed College (2007)

with my apa-good natbib style file.

### 0.1.1 Tips for Bibliographies

1. Like with thesis formatting, the sooner you start compiling your bibliography for something as large as thesis, the better. Typing in source after source is mind-numbing enough; do you really want to do it for hours on end in late April? Think of it as procrastination.

2. The cite key (a citation's label) needs to be unique from the other entries.

3. When you have more than one author or editor, you need to separate each author's name by the word "and" e.g.
   `Author = {Noble, Sam and Youngberg, Jessica},`.

4. Bibliographies made using BibTeX (whether manually or using a manager) accept LaTeX markup, so you can italicize and add symbols as necessary.

5. To force capitalization in an article title or where all lowercase is generally used, bracket the capital letter in curly braces.

6. You can add a Reed Thesis citation[2] option. The best way to do this is to use the phdthesis type of citation, and use the optional "type" field to enter "Reed thesis" or "Undergraduate thesis". Here's a test of Chicago, showing the second cite in a row[3] being different. Also the second time not in a row[4] should be different. Of course in other styles they'll all look the same.

## 0.2 Anything else?

If you'd like to see examples of other things in this template, please contact CUS (email cus@reed.edu) with your suggestions. We love to see people using LaTeX for their theses, and are happy to help.

[2] Noble (2002)
[3] Noble (2002)
[4] Reed College (2007)

# Chapter 1

# Mathematics and Science

## 1.1 Math

TEX is the best way to typeset mathematics. Donald Knuth designed TEX when he got frustrated at how long it was taking the typesetters to finish his book, which contained a lot of mathematics.

If you are doing a thesis that will involve lots of math, you will want to read the following section which has been commented out. If you're not going to use math, skip over this next big red section. (It's red in the .tex file but does not show up in the .pdf.)

## 1.2 Chemistry 101: Symbols

Chemical formulas will look best if they are not italicized. Get around math mode's automatic italicizing by using the argument `$\mathrm{formula here}$`, with your formula inside the curly brackets.

So, $Fe_2^{2+}Cr_2O_4$ is written `$\mathrm{Fe_2^{2+}Cr_2O_4}$`
Exponent or Superscript: $O^-$
Subscript: $CH_4$

To stack numbers or letters as in $Fe_2^{2+}$, the subscript is defined first, and then the superscript is defined.
Angstrom: Å
Bullet: $CuCl \bullet 7H_2O$
Double Dagger: ‡
Delta: $\Delta$
Reaction Arrows: $\longrightarrow$ or $\xrightarrow{solution}$
Resonance Arrows: $\leftrightarrow$
Reversible Reaction Arrows: $\rightleftharpoons$ or $\xrightleftharpoons{solution}$ (the latter requires the chemarr package)

### 1.2.1 Typesetting reactions

You may wish to put your reaction in a figure environment, which means that LaTeX will place the reaction where it fits and you can have a figure legend if desired:

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O$$

Figure 1.1: Combustion of glucose

### 1.2.2 Other examples of reactions

$NH_4Cl_{(s)} \rightleftharpoons NH_{3(g)} + HCl_{(g)}$
$MeCH_2Br + Mg \xrightarrow[below]{above} MeCH_2 \bullet Mg \bullet Br$

## 1.3 Physics

Many of the symbols you will need can be found on the math page (`http://web.reed.edu/cis/help/latex/math.html`) and the Comprehensive LaTeX Symbol Guide (enclosed in this template download). You may wish to create custom commands for commonly used symbols, phrases or equations, as described in Chapter **??**.

## 1.4 Biology

You will probably find the resources at `http://www.lecb.ncifcrf.gov/~toms/latex.html` helpful, particularly the links to bsts for various journals. You may also be interested in TeXShade for nucleotide typesetting (`http://homepages.uni-tuebingen.de/beitz/txe.html`). Be sure to read the proceeding chapter on graphics and tables, and remember that the thesis template has versions of Ecology and Science bsts which support webpage citation formats.

# Chapter 2

# Tables and Graphics

## 2.1 Tables

The following section contains examples of tables, most of which have been commented out for brevity. (They will show up in the .tex document in red, but not at all in the .pdf). For more help in constructing a table (or anything else in this document), please see the LaTeX pages on the CUS site.

Table 2.1: Correlation of Inheritance Factors between Parents and Child

| Factors | Correlation between Parents & Child | Inherited |
|---|---|---|
| Education | -0.49 | Yes |
| Socio-Economic Status | 0.28 | Slight |
| Income | 0.08 | No |
| Family Size | 0.19 | Slight |
| Occupational Prestige | 0.21 | Slight |

If you want to make a table that is longer than a page, you will want to use the longtable environment. Uncomment the table below to see an example, or see our online documentation.

Table 2.2: Chromium Hexacarbonyl Data Collected in 1998–1999

| Chromium Hexacarbonyl | | | |
|---|---|---|---|
| State | Laser wavelength | Buffer gas | Ratio of $\frac{\text{Intensity at vapor pressure}}{\text{Intensity at 240 Torr}}$ |
| $z^7P_4^\circ$ | 266 nm | Argon | 1.5 |
| $z^7P_2^\circ$ | 355 nm | Argon | 0.57 |
| $y^7P_3^\circ$ | 266 nm | Argon | 1 |
| $y^7P_3^\circ$ | 355 nm | Argon | 0.14 |
| $y^7P_2^\circ$ | 355 nm | Argon | 0.14 |
| $z^5P_3^\circ$ | 266 nm | Argon | 1.2 |
| $z^5P_3^\circ$ | 355 nm | Argon | 0.04 |
| $z^5P_3^\circ$ | 355 nm | Helium | 0.02 |
| $z^5P_2^\circ$ | 355 nm | Argon | 0.07 |
| $z^5P_1^\circ$ | 355 nm | Argon | 0.05 |
| $y^5P_3^\circ$ | 355 nm | Argon | 0.05, 0.4 |
| $y^5P_3^\circ$ | 355 nm | Helium | 0.25 |
| $z^5F_4^\circ$ | 266 nm | Argon | 1.4 |
| $z^5F_4^\circ$ | 355 nm | Argon | 0.29 |
| $z^5F_4^\circ$ | 355 nm | Helium | 1.02 |
| $z^5D_4^\circ$ | 355 nm | Argon | 0.3 |
| $z^5D_4^\circ$ | 355 nm | Helium | 0.65 |
| $y^5H_7^\circ$ | 266 nm | Argon | 0.17 |
| $y^5H_7^\circ$ | 355 nm | Argon | 0.13 |
| $y^5H_7^\circ$ | 355 nm | Helium | 0.11 |
| $a^5D_3$ | 266 nm | Argon | 0.71 |
| $a^5D_2$ | 266 nm | Argon | 0.77 |
| $a^5D_2$ | 355 nm | Argon | 0.63 |
| $a^3D_3$ | 355 nm | Argon | 0.05 |
| $a^5S_2$ | 266 nm | Argon | 2 |
| $a^5S_2$ | 355 nm | Argon | 1.5 |
| $a^5G_6$ | 355 nm | Argon | 0.91 |
| $a^3G_4$ | 355 nm | Argon | 0.08 |
| $e^7D_5$ | 355 nm | Helium | 3.5 |
| $e^7D_3$ | 355 nm | Helium | 3 |
| $f^7D_5$ | 355 nm | Helium | 0.25 |
| $f^7D_5$ | 355 nm | Argon | 0.25 |
| $f^7D_4$ | 355 nm | Argon | 0.2 |
| $f^7D_4$ | 355 nm | Helium | 0.3 |
| Propyl-ACT | | | |

| State | Laser wavelength | Buffer gas | Ratio of $\frac{\text{Intensity at vapor pressure}}{\text{Intensity at 240 Torr}}$ |
|---|---|---|---|
| $z^7P_4^\circ$ | 355 nm | Argon | 1.5 |
| $z^7P_3^\circ$ | 355 nm | Argon | 1.5 |
| $z^7P_2^\circ$ | 355 nm | Argon | 1.25 |
| $z^7F_5^\circ$ | 355 nm | Argon | 2.85 |
| $y^7P_4^\circ$ | 355 nm | Argon | 0.07 |
| $y^7P_3^\circ$ | 355 nm | Argon | 0.06 |
| $z^5P_3^\circ$ | 355 nm | Argon | 0.12 |
| $z^5P_2^\circ$ | 355 nm | Argon | 0.13 |
| $z^5P_1^\circ$ | 355 nm | Argon | 0.14 |
| Methyl-ACT | | | |
| $z^7P_4^\circ$ | 355 nm | Argon | 1.6, 2.5 |
| $z^7P_4^\circ$ | 355 nm | Helium | 3 |
| $z^7P_4^\circ$ | 266 nm | Argon | 1.33 |
| $z^7P_3^\circ$ | 355 nm | Argon | 1.5 |
| $z^7P_2^\circ$ | 355 nm | Argon | 1.25, 1.3 |
| $z^7F_5^\circ$ | 355 nm | Argon | 3 |
| $y^7P_4^\circ$ | 355 nm | Argon | 0.07, 0.08 |
| $y^7P_4^\circ$ | 355 nm | Helium | 0.2 |
| $y^7P_3^\circ$ | 266 nm | Argon | 1.22 |
| $y^7P_3^\circ$ | 355 nm | Argon | 0.08 |
| $y^7P_2^\circ$ | 355 nm | Argon | 0.1 |
| $z^5P_3^\circ$ | 266 nm | Argon | 0.67 |
| $z^5P_3^\circ$ | 355 nm | Argon | 0.08, 0.17 |
| $z^5P_3^\circ$ | 355 nm | Helium | 0.12 |
| $z^5P_2^\circ$ | 355 nm | Argon | 0.13 |
| $z^5P_1^\circ$ | 355 nm | Argon | 0.09 |
| $y^5H_7^\circ$ | 355 nm | Argon | 0.06, 0.05 |
| $a^5D_3$ | 266 nm | Argon | 2.5 |
| $a^5D_2$ | 266 nm | Argon | 1.9 |
| $a^5D_2$ | 355 nm | Argon | 1.17 |
| $a^5S_2$ | 266 nm | Argon | 2.3 |
| $a^5S_2$ | 355 nm | Argon | 1.11 |
| $a^5G_6$ | 355 nm | Argon | 1.6 |
| $e^7D_5$ | 355 nm | Argon | 1 |

## 2.2 Figures

If your thesis has a lot of figures, LaTeX might behave better for you than that other word processor. One thing that may be annoying is the way it handles "floats" like tables and figures. LaTeX will try to find the best place to put your object based on the text around it and until you're really, truly done writing you should just leave it where it lies. There are some optional arguments to the figure and table environments

to specify where you want it to appear; see the comments in the first figure.

If you need a graphic or tabular material to be part of the text, you can just put it inline. If you need it to appear in the list of figures or tables, it should be placed in the floating environment.

To get a figure from StatView, JMP, SPSS or other statistics program into a figure, you can print to pdf or save the image as a jpg or png. Precisely how you will do this depends on the program: you may need to copy-paste figures into Photoshop or other graphic program, then save in the appropriate format.

Below we have put a few examples of figures. For more help using graphics and the float environment, see our online documentation.

And this is how you add a figure with a graphic:

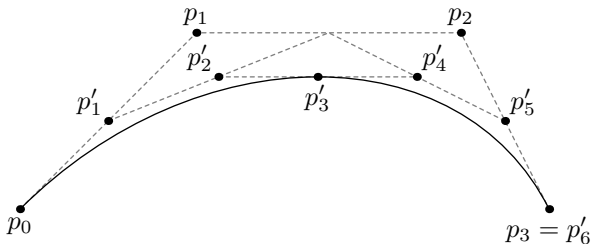


Figure 2.1: A Figure

## 2.3 More Figure Stuff

You can also scale and rotate figures.

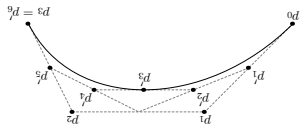

Figure 2.2: A Smaller Figure, Flipped Upside Down

## 2.4 Even More Figure Stuff

With some clever work you can crop a figure, which is handy if (for instance) your EPS or PDF is a little graphic on a whole sheet of paper. The viewport arguments are the lower-left and upper-right coordinates for the area you want to crop.

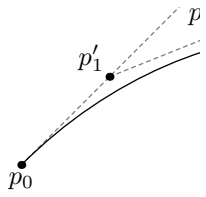


Figure 2.3: A Cropped Figure

### 2.4.1 Common Modifications

The following figure features the more popular changes thesis students want to their figures. This information is also on the web at `web.reed.edu/cis/help/latex/graphics.html`.

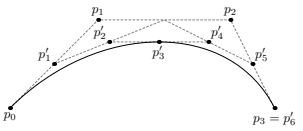


Figure 2.4: Subdivision of arc segments. You can see that $p_3 = p'_6$.

# Conclusion

Here's a conclusion, demonstrating the use of all that manual incrementing and table of contents adding that has to happen if you use the starred form of the chapter command. The deal is, the chapter command in LaTeX does a lot of things: it increments the chapter counter, it resets the section counter to zero, it puts the name of the chapter into the table of contents and the running headers, and probably some other stuff.

So, if you remove all that stuff because you don't like it to say "Chapter 4: Conclusion", then you have to manually add all the things LaTeX would normally do for you. Maybe someday we'll write a new chapter macro that doesn't add "Chapter X" to the beginning of every chapter title.

## 4.1 More info

And here's some other random info: the first paragraph after a chapter title or section head *shouldn't be* indented, because indents are to tell the reader that you're starting a new paragraph. Since that's obvious after a chapter or section title, proper typesetting doesn't add an indent there.

# Appendix A

# The First Appendix

# Appendix B

# The Second Appendix, for Fun

# References


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