FLORIDA STATE UNIVERSITY

COLLEGE OF ARTY SCIENCE

OF CABBAGES AND KINGS:

AN ANALYSIS OF THE USE OF THE COLON IN DISSERTATION TITLES

By

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To my parents, who always suspected I'd end up here

ACKNOWLEDGMENTS

Many thanks are due to many people. My major professor didn't know what she was getting herself into when she took me on as a student, and I will always be grateful for her support and guidance. The other members of my committee deserve hazard pay, and this paper would not be the same without their diligence: many thanks.

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LIST OF SYMBOLS

The following short list of symbols are used throughout the document. The symbols represent quantities that I tried to use consistently.

π	$3.1415926\ldots$
E	mc^2
F	ma
R_e	Mean Radius of the Earth $\approx 6367.65\,\mathrm{km}$
e	Base of Natural Logarithms $\approx 2.71828\ldots$
P	The principal borrowed
N	The number of payments
i	The fractional (periodic) interest rate
P_j	The principal part of payment j
I_j	The interest part of payment j
B	A final balloon payment
x	The regular payment
R	The principal remaining after r payments
r	Some number of payments such that $0 < r < N$
R_j	The principal remaining after j payments
A_j	The total interest paid out after j payments

ABSTRACT

The FSU Thesis Class is a LaTeX document class useful for writing Theses, Dissertations, and Treatises. It has several custom macros and environments which are intended to ease the burden of formatting for writers of these documents so that they may focus more on the research and presentation rather than on the page layout. This sample document is intended to provide a few examples of how most of the class features may be used.

The main source file for this document is `thesis.tex`, and this is where you should start reading. The document's source is spread over several files. Many of the files contain helpful LaTeX comments which are not printed out here. It may be instructive to look at the source files as you read this "output" to see how the document was created.

CHAPTER 1

A DERIVATION OF A FORMULA FOR AMORTIZATION

This chapter contains several examples of the equation environment and equation references. There are also examples of every level of heading, from `\chapter` to `\subparagraph` (though these headings are somewhat artificial). The `amsmath` package is required to process this chapter, and so the `thesis.tex` file in this directory contains the package line `\usepackage{amsmath}`. The text of this file is located in the file `math.tex`. If you're new to LaTeX, you may find it instructive to look at the source text (which contains some extra documentation written as LaTeX comments) while reviewing this printed output.

The text and mathematics in this document are my own work, written in the mid-1980s when I was trying to figure out how long it would take to pay off my credit card debt after I had graduated. (This work is the basis of my on-line amortization calculator at the following web address: `http://bretwhissel.net/amortization/amortize.html`.) This material became a convenient test bed as I developed the FSU thesis macros.

1.1 Definitions

This is my derivation of the formula for amortization. The goal is to find a payment amount, x, which pays off the loan principal, P, after a specified number of payments, N. Variable definitions are listed in table 1.1.

1.1.1 Payment Schedule

Assuming that all payments (excluding an optional final balloon payment) are the same amount, a payment x consists of its interest part and its principal part:

$$x = I_j + P_j \tag{1.1}$$

Table 1.1: The List of Variables

P	The principal borrowed
N	The number of payments
i	The fractional (periodic) interest rate
P_j	The principal part of payment j
I_j	The interest part of payment j
B	A final balloon payment
x	The regular payment

$$
\begin{aligned}
I_1 &= iP & P_1 &= x - I_1 \\
I_2 &= i(P - P_1) & P_2 &= x - I_2 \\
I_3 &= i(P - P_1 - P_2) & P_3 &= x - I_3, \text{ etc.}
\end{aligned}
$$

This schedule states that the payment x includes interest on all of the remaining principal, including that which is part of the current payment. The first payment, therefore, includes an interest payment on the total borrowed, which defines the minimum payment. (If we are to make any progress toward paying off the loan, we must pay more than the amount iP.)

The P_j's may be rewritten into a recurrence relation:

$$
\begin{aligned}
P_1 &= x - iP \\
P_2 &= x - i(P - P_1) \\
&= x - i\left[P - (x - iP)\right] \\
&= x - iP + ix - i^2 P \\
&= (x - iP)(1 + i) \\
P_3 &= x - i(P - P_1 - P_2) \\
&= x - i\left[P - (x - iP) - (x - iP + ix - i^2 P)\right] \\
&= x + 2ix + i^2 x - iP - 2i^2 P - i^3 P \\
&= x(1 + i)^2 - iP(1 + i)^2 \\
&= (x - iP)(1 + i)^2
\end{aligned}
$$

In general, we will find that

$$P_j = (x - iP)(1 + i)^{j-1}. \tag{1.2}$$

1.2 Balloon Payment

If there is to be a balloon payment, then the final payment will consist of the final principal payment P_f and interest on that principal iP_f so that $B = P_f + iP_f$. Rewriting P_f in terms of B gives $P_f = B/(1+i)$.

1.3 Finding a Solution

1.3.1 Defining the Equation

Next, we define an equation which uses these ideas:

$$B + Nx = P + \sum_{j=1}^{N} I_j + i\left(\frac{B}{1+i}\right), \tag{1.3}$$

or in English, the sum of all the payments (left side) is equal to the principal borrowed plus all of the interest paid with regular payments plus interest paid on the balloon payment (right side). Note that if there will be no balloon payment ($B = 0$), then the B terms drop out.

1.3.2 Breaking It Down

Now we glue some more pieces together: replace I_j of equation (1.3) using the relationship given by eq. (1.1) and then substitute the recurrence identity of eq. (1.2):

$$B - \frac{iB}{1+i} + Nx = P + \sum_{j=1}^{N} \left[x - (x - iP)(1+i)^{j-1}\right]$$

$$B - \frac{iB}{1+i} + Nx = P + Nx - (x - iP)\sum_{j=1}^{N}(1+i)^{j-1}$$

$$P - B\left(1 - \frac{i}{1+i}\right) = (x - iP)\sum_{j=1}^{N}(1+i)^{j-1} \tag{1.4}$$

Initial Solution. Now we can see our way clear to solve for x:

$$x = \frac{P - B\left(1 - \frac{i}{1+i}\right)}{\sum_{j=1}^{N}(1+i)^{j-1}} + iP. \tag{1.5}$$

Finding a Closed Form. While a computer program could be written to solve the problem as it is, a closed-form solution (i.e., without the iteration) is preferable.

Isolation. The series form of eq. (1.5) can be rewritten without the series after a little transformation. First, we separate the summation and rewrite its limits:

$$x = \left[P - B\left(1 - \frac{i}{1+i}\right)\right] \frac{1}{\sum_{j=0}^{N-1}(1+i)^j} + iP. \tag{1.6}$$

Transformation. To simplify the transformation, we can substitute by letting $g = 1 + i$ so that the summation looks like $\sum_{j=0}^{N-1} g^j$. Next we multiply the series by $(1-g)/(1-g)$, which causes all but the first and last terms to drop out:

$$\frac{(1-g)\sum_{j=0}^{N-1} g^j}{1-g} = \frac{\sum_{j=0}^{N-1} g^j - \sum_{j=0}^{N-1} g^{j+1}}{1-g} = \frac{1-g^N}{1-g}. \tag{1.7}$$

Result. Since the series is originally in the denominator, we invert the transformed result, and then undo the substitution:

$$x = \left[P - B\left(1 - \frac{i}{1+i}\right)\right] \frac{1-(1+i)}{1-(1+i)^N} + iP. \tag{1.8}$$

Rearranged. Now we can expand and rearrange to taste:

$$x = i\left[\frac{P(1+i)^N}{(1+i)^N - 1} + \frac{B}{(1+i) - (1+i)^{N+1}}\right]. \tag{1.9}$$

Quod erat demonstrandum ("That which was to be shown"), recognized in most mathematical circles as the initials Q.E.D. □

1.4 Application

Two forms. Equations (1.8) and (1.9) solve for the payment amount, but either can be rearranged to solve for any of the other variables, with the exception of i, the periodic interest rate. To date I have been unable to find an analytic solution for this variable, so the program invokes an iterative method to find successive approximations to the solution.

Computation. To reduce the number of computations, $1 + i$ can be stored in single variable, as well as a single calculation of $(1 + i)^N$. Then the calculation of $(1 + i)^{N+1}$ merely requires multiplying the two previously-calculated values, i.e., $(1 + i)^{N+1} = (1 + i)^N \cdot (1 + i)$.

CHAPTER 2

TABULAR DATA AND TABLES

Most graduate students will come to a place in their career where they must create a table of some kind. Many simple layouts are a breeze with LaTeX. Here's a brief example:

1	a	3^1	3
2	abb	3×3^2	27
33	abbccc	$3^3 \times 3^3 \times 3^3$	19683

and the source text that created it:

```
\begin{tabular}{ r r || c | l }
  1  & a      & $3^1$                         &     3 \\
  2  & abb    & $3\times 3^2$                 &    27 \\ \hline
  33 & abbccc & $3^3 \times 3^3 \times 3^3$ & 19683 \\
\end{tabular}
```

When the `tabular` environment begins, the next required parameter specifies the layout of the table. In this case, the table layout specifies two right-justified columns (`r r`), a double-vertical separator (`||`), a centered column (`c`), a single-vertical separator (`|`), and a left-justified column (`l`). The next rows provide the data for the table, with columns separated by the ampersand (`&`) character. The end of the row is indicated by the double backslash (`\\`). As you can see, the columns may contain text, numeric data, and even some math. A horizontal line may be drawn between rows using the `\hline` command. As always with LaTeX, multiple spaces within columns are ignored. In addition, LaTeX also ignores spaces immediately following the `&` character.

For many people, this may be all the information on tables that's required (for now, anyway). But at some point, you may need even more options to create just the right layout. There are several additional packages that add functionality to LaTeX's table-formatting capability. A quick web search for `latex table` will turn up a wealth of usable information, samples, examples, packages, and tutorials.

The `tabular` environment provides the layout mechanism for placing text and data into row and column form. But it's the `table` environment that allows you to automatically number your table and to add a heading (caption). The `table` environment works just like the `figure` environment as far as floating placement is concerned. However, the FSU thesis guidelines state that table captions should appear *before* the table, while `figure` captions appear *after* the figure. The text in Figure 2.1 generates Table 2.1 as an example. (And I used `Table~\ref{sonnets}` in the previous sentence to retrieve the table number.) This demonstrates how one can create paragraphs of text as part of a table by using the `p{5cm}` format specifier. Additional space was inserted after each row by adding a dimension to the linebreak specification, i.e., `\\[5pt]`.

However, just because you put some text or data into a multi-column form, it doesn't necessarily mean that it's a table as far as your thesis or dissertation is concerned. If the tabular-form data is part of your text and flows in the order of your presentation, it may not be necessary to set it off as a table. The layout example at the beginning of this chapter is an example of tabular data which is not set off as a table.

Other than the unfortunately confusing similarity in their names, the `tabular` environment and the `table` environment have independent functionality: while the `tabular` environment is often used inside the `table` environment, either environment can be used without the other. And while we're at it, figures don't necessarily need to contain graphics. Figure 2.1 is an example of a figure which contains ordinary text, but the text has been wrapped within a `figure` environment so that it can be allowed to float outside the main flow of text.

If you have a particularly wide table, you may want to turn the table sideways on the page. To do this, add `\usepackage{rotating}` to the document preamble. When it is time to insert the rotated table, type `\begin{sidewaystable}` instead of `\begin{table}`. This also works for figures, by the way, so instead of `\begin{figure}`, you may use `\begin{sidewaysfigure}` for diagrams and images that you want rotated. Sideways figures and tables will always be floated to their own page.

```
\begin{table}
\caption{Shakespeare Sonnets, First Lines, IIX --- XII}
\label{sonnets}
\begin{center}
  \begin{tabular}{r p{5cm} }
    8 & Music to hear, why hear’st thou music sadly? \\[5pt]
    9 & Is it for fear to wet a widow’s eye \\[5pt]
   10 & For shame deny that thou bear’st love to any \\[5pt]
   11 & As fast as thou shalt wane, so fast thou grow’st \\[5pt]
   12 & When I do count the clock that tells the time \\
  \end{tabular}
\end{center}
\end{table}
```

Figure 2.1: LaTeX source that generates Table 2.1 on page 7.

Table 2.1: Shakespeare Sonnets, First Lines, IIX — XII

8	Music to hear, why hear’st thou music sadly?
9	Is it for fear to wet a widow’s eye
10	For shame deny that thou bear’st love to any
11	As fast as thou shalt wane, so fast thou grow’st
12	When I do count the clock that tells the time

APPENDIX A

GOOD TIME HAD BY ALL

This appendix is here merely to demonstrate how appendices may be included and formatted in your document. Look through the files `thesis.tex` and `appendix.tex` to see how these pieces work together.

REFERENCES

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BIOGRAPHICAL SKETCH

The author was born, and then the author was “educated,” at least to some degree. After finishing high school in Florida, the author completed a Bachelor of Arts degree at Florida State University. Following a decade in the work force in his discipline, the author returned to FSU to pursue graduate work.