LaTeX Class 2008

Berit Givens

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Chapter 1

Getting Started

1.1 Introduction to LaTeXclass

Welcome to the Introduction to LaTeXclass! This class should get you started on the basics of learning to type math using the program LaTeX(pronounced "Lay-tek" or "Lah-tek").

These notes are the only text for this class, but I also recommend that you download the file "A Not-so-Short Introduction to Latex" from the web at

`www.ctan.org/tex-archive/info/lshort/english/lshort.pdf`

Other recommended texts:

- Latex: A Document Preparation System, by Leslie Lamport [5].
- Math into Latex, by George Grätzer [3].
- The Internet!!

1.2 Downloading LaTeXto your personal computer

WinEdt is licensed software that is available at http://www.winedt.com. The student version costs $30. The MikTex package to make it fully operational is available at http://www.miktex.org/2.5/Setup.aspx and is free.

For Macs, TexShop is available for download at http://www.uoregon.edu/ koch/texshop/. It is free.

1.3 Source files vs output files

Every LaTeXdocument starts as a ".tex" file. This is the file you actually type, using either WinEdt, TexShop, or any other simple text editor. For example, this file I'm typing right now is called "QuarterNotes.tex."

Then you compile the tex file using MikTex, TexShop, or any other Latex program. When it is compiled it creates three new files: QuarterNotes.aux, QuarterNotes.log, and an output file. MikTex makes a dvi or a pdf file as its output. TexShop makes a pdf file. The aux and log files are not important to us right now. A printout of the pdf file "QuarterNotes.pdf" is the thing you are actually viewing right now.

So essentially, you create the tex file with a text editor, run it through the LaTeXprogram, and you get the pdf or the dvi file. Then you can print the pdf or dvi file, e-mail it to a journal, etc.

Each Latex file has a basic skeleton structure:

```
\documentclass[11pt]{article}
```

the preamble

```
\begin{document}
```

the body

```
\end{document}
```

The first line must always be the document class declaration. Anything between the document class declaration and the `\begin{document}` is called the *preamble*. You type the *body* of your file between the `\begin{document}` and `\end{document}`. Anything typed after the `\end{document}` will be completely ignored.

All special commands in Latex start with a \ (backslash). For example, in the above, the begin and end commands started with the backslash symbol. If you wish to write comments to yourself, begin the line with a % symbol. Everything on the line after the % will be ignored.

Try typing the above three lines into your editor and then texing it up. Type some words into the body of the file and tex it again. Try changing the 11pt to 12pt. Instead of the word article, try changing it to book, report, or slides.

1.4 Font Styles

It is easy to italicize or boldface your words. You may use the commands `\it` or `\bf` as follows:

```
Sometimes I want words in {\it italics} or in {\bf boldface}.
```

Command	Meaning	Example
`\it`	italics	*Example*
`\bf`	boldface	**Example**
`\sl`	slanted	*Example*
`\sf`	sans-serif	Example
`\tt`	monospaced	`Example`
`\sc`	small caps	EXAMPLE

Table 1.1: Some common font styles

Sometimes I want words in *italics* or in **boldface**.

Table 1.1 has a list of many font modifying commands.

1.5 Math Mode versus Text Mode

There are two modes in the body of a Latex file, math mode and text mode. Text mode is what you have been typing in. Any time you want to type an equation, a greek letter, or a mathematical symbol, you must switch to math mode. There are a couple of ways to do this.

In regular math mode, the equation appears within the paragraph like this: $a^2 + b^2 = c^2$. To use normal math mode, you enclose the mathematics within dollar signs:

```
$ a^2+b^2=c^2 $
```

In display math mode, the equation is set apart from the paragraph and centered. It is displayed more prominently.

$$a^2 + b^2 = c^2$$

To display your math, put it inside double dollar signs:

```
$$ a^2+b^2=c^2 $$
```

Finally, you can use the equation mode, which displays and numbers the equation, so you can refer to it later.

$$a^2 + b^2 = c^2 \tag{1.1}$$

```
\begin{equation}
a^2+b^2=c^2
\end{equation}
```

1.6 Fun Math Symbols

Now that you can type a simple file and use math mode, you can do lots of fun stuff. First of all, there are all the greek letters. Those must all be typed in math mode and the commands could not be simpler. Basically, to type a greek letter you use a backslash followed by the name of the letter. For example, to get a π you type `$\pi$` in the source file. Similarly for `$\alpha$` (α), `$\beta$` (β), etc. Note that if you are already in math mode, you do not need the dollar signs!

What about the letters that have two forms, a big and a small? Also very easy: just capitalize the first letter of the name. For example, `\Lambda` gives you a big Λ and `\lambda` gives you a little λ.

See the Table 1.2 for lots of other simple math mode commands. In Table 1.2, the fractions, integrals and summations are all a little crowded looking. That is because they are in normal math mode. This mode, also called *in-text* math mode, writes all equations to fit on a single line. My personal preference is to write integrals and other big symbols in *display math* mode. You can do this by adding a `\displaystyle` to the beginning of the equation. See Table 1.3 for the displaystyle versions of the math symbols.

There are many many more math symbols. You can find charts listing all the math symbols on pages 39-44 of the Lamport book or on pages 62-69 of the Not-So-Short Intro or in many many locations on the internet. Just google for "Math symbols Latex"

1.7 Exercises

Exercise 1.1: Reproduce the following paragraph on your own.

The definite integral of $f(x)$ over $[a, b]$ is the limit of Riemann sums and is denoted by the integral sign:

$$\int_a^b f(x)dx = \lim_{||P||\to 0} \sum_{i=1}^{N} f(c_i)\Delta x_i.$$

When this limit exists, we say that $f(x)$ is integrable over $[a, b]$.

Type of command	Form	Example Input	Output
Subscripts	`Base_{Subscript}`	`x_1, I_{j,k}, \theta_{\alpha}`	$x_1, I_{j,k}, \theta_\alpha$
Superscripts	`Base^{Superscript}`	`x^2, A^*, \lambda^{n(n-1)}`	$x^2, A^*, \lambda^{n(n-1)}$
Fractions	`\frac{numerator}{denominator}`	`\frac{1}{x}, \frac{dx}{dt}, \frac{x+1}{(y-1)^2}`	$\frac{1}{x}, \frac{dx}{dt}, \frac{x+1}{(y-1)^2}$
Integrals	`\int_{lower}^{upper} eqn dx`	`\int_0^1 \sin x dx` `\int (\ln(y))^2 dy`	$\int_0^1 \sin x dx$ $\int (\ln(y))^2 dy$
Summations	`\sum_{lower}^{upper} equation`	`\sum_{i=1}^{3} i^2`	$\sum_{i=1}^{3} i^2$

Table 1.2: Some commonly used math commands

`\displaystyle\frac{1}{x},`	$\displaystyle\frac{1}{x},$
`\displaystyle\frac{dx}{dt},`	$\displaystyle\frac{dx}{dt},$
`\displaystyle\frac{x+1}{(y-1)^2}`	$\displaystyle\frac{x+1}{(y-1)^2}$
`\displaystyle\int_0^1 \sin x dx`	$\displaystyle\int_0^1 \sin x dx$
`\displaystyle\int (\ln(y))^2 dy`	$\displaystyle\int (\ln(y))^2 dy$
`\displaystyle\sum_{i=1}^{3} i^2`	$\displaystyle\sum_{i=1}^{3} i^2$

Table 1.3: Math commands in displaystyle – much nicer looking!

Chapter 2

Writing a Quiz in LaTeX

To write a quiz, you usually need two things. First of all, you want to number the questions on the quiz. Second, you want to leave space between the questions for students to write the answers.

2.1 Lists

To make a list of things, you can use the commands `enumerate` or `itemize`. The `itemize` command makes an unnumbered list, with bullet points. The `enumerate` command makes a numbered list. The format is

```
\begin{enumerate}
\item Type list item number 1 here.
\item Type list item number 2 here.
...
\end{enumerate}
```

You can nest enumerated lists. For example, one of the items in an enumerated list can itself be an enumerated list. (Or an itemized list). See the example below:

```
\begin{enumerate}
    \item Breakfast is my favorite meal.
    \item Lunch is okay too.
    \item For dinner, I like to have three things:
          \begin{enumerate}
          \item A vegetable
          \item Some rice
```

```
        \item Ice cream
        \end{enumerate}
    \item For dessert, maybe I will have more ice cream
\end{enumerate}
```

1. Breakfast is my favorite meal.
2. Lunch is okay too.
3. For dinner, I like to have three things:
   (a) A vegetable
   (b) Some rice
   (c) Ice cream
4. For dessert, maybe I will have more ice cream

The tabs and spaces in the LaTeXare not necessary. You could actually write the whole string of commands on one line, never hitting return or tab. However, if you made a mistake, you would never never find it and you would hate yourself. So use tabs and carriage returns to make your LaTeXfiles more readable and clear.

`Enumerate` will automatically default to numbering as 1., 2., 3., etc. Numbering differently is covered in the Extras section for this chapter.

2.2 Vertical Spaces

You can leave a space for students to write their answers by putting in a `\vspace` command. For example, try adding `\vspace{1.3in}` or `\vspace{3cm}` in between two of the items in a list.

```
\begin{itemize}
      \item Write your name in the space below:
\vspace{0.6in}
     \item What is $\displaystyle \int_3^4 \theta^2 d\theta$?
\vspace{2cm}
\end{itemize}
```

- Write your name in the space below:

- What is $\int_3^4 \theta^2 d\theta$?

Another nice way to add space is to use the `\vfill` command. This command will space out several things so that they are evenly spaced and fill the whole page. For example:

```
\begin{enumerate}
    \item $2+2=?$
    \vfill
    \item $7-8=?$
    \vfill
    \item $8\times 7=?$
    \vfill
    \item $63\div 9=?$
    \vfill
 \end{enumerate}
```

1. $2 + 2 =?$

2. $7 - 8 =?$

3. $8 \times 7 =?$

4. $63 \div 9 =?$

2.3 Labelling and Referring to Numbered items

If you have numbered equations (or anything) in your document, you may wish to refer to those equations later. To do this you use `\label` to name the equation and `\ref` to refer to it later.

Example:

```
A very important equation due to Pythagoras and his followers is:
\begin{equation}\label{pythag}
a^2+b^2=c^2
\end{equation}

Everybody's favorite trig identity is
\begin{equation}\label{trig}
\sin^2 \theta + \cos^2 \theta =1
\end{equation}

You may not realize that Equation \ref{pythag} and Equation \ref{trig} are
 actually equivalent.
```

A very important equation due to Pythagoras and his followers is:

$$a^2 + b^2 = c^2 \tag{2.1}$$

Everybody's favorite trig identity is

$$\sin^2 \theta + \cos^2 \theta = 1 \tag{2.2}$$

You may not realize that Equation 2.1 and Equation 2.2 are actually equivalent.

When you have added or changed labels and references, you must hit the LaTeXbutton twice to make sure the references come up correctly.

2.4 Exercises

Exercise 2.1: Type a quiz with two questions. Leave space for your students to show their work.

2.5 Extra – Numbering Lists

If you do not like the way that Latex automatically numbers lists, you can modify it in a couple of ways.

One choice is to manually type whatever you want the items to be labelled by. For example, you can write

```
\begin{itemize}
     \item[(A)] this is the first item
     \item[(bee)] this is the second item
     \item[(see)] this is the third item
 \end{itemize}
```

This method will give you

(A) this is the first item

(bee) this is the second item

(see) this is the third item

The advantages are that you can put anything you want to head the items. The disadvantage is that LaTeXwill not automatically update the numbering for you.

A second choice is to use the following command before your enumerated list

```
\renewcommand{\theenumi}{\Roman{enumi}}

\begin{enumerate}
\item chocolate
\item peanut butter
\end{enumerate}

\renewcommand{\theenumi}{\arabic{enumi}}
```

I. chocolate

II. peanut butter

The renewcommand will set the enumerate counter to display as a Roman numeral. After I finished my list, I reset the counter to display in the

usual way on later lists. Of course, you could always leave it in Roman numerals if you preferred.

The advantages are that LaTeXwill automatically make sure the items are numbered in order. Instead of `\Roman`, you can also use `\arabic, \roman`, `\Alph, \alph`. For the first level of a list, use `enumi`. For the next level, use `enumii`, and for the third use `enumiii`.

Chapter 3

Theorems, Definitions, Remarks, Propositions, etc.

3.1 The newtheorem command

Most mathematics papers have theorems, lemmas, propositions, definitions, etc. and most papers would like to number those things in some way. LaTeXhas a method for declaring these called `\newtheorem`.

In the preamble you put the command:

```
\newtheorem{theorem}{Theorem}
```

Here `theorem` is your name that you'd like to use in the document to refer to the thing by and `Theorem` is the name that LaTeXwill display in the output file. Then in the body you can type

```
\begin{theorem}........

\end{theorem}
```

An example preamble might include the following commands:

```
\newtheorem{theorem}{Theorem}
\newtheorem{cor}[theorem]{Corollary}
\newtheorem{defn}[theorem]{Definition}
```

The `[theorem]` in the lines declaring the corollaries and definitions affects the way the numbering is handled. This will make it so that everything is numbered in one long list. In other words, if you have a Theorem,

Corollary, Theorem and Definition, then they will be numbered Theorem 1, Corollary 2, Theorem 3, and Definition 4. If you leave out the `[theorem]` option, then they will be numbered Theorem 1, Corollary 1, Theorem 2, and Definition 1.

3.2 The newenvironment command

Most people like their proofs to have a certain format. Maybe they should all start with the word "Proof" in boldface and end with a square symbol (□). Or maybe you want to have the entire proof in italics (probably not!). Whatever it is, you can use the `\newenvironment` command to set up the format and it will be applied the same way throughout your document. Put the following line in your preamble:

```
\newenvironment{proof}{\textbf{Proof:}}{\hfill $\square$}
```

Then in the body, after a theorem, you can write

```
\begin{proof}  la la la here is my proof.
\end{proof}
```

Proof: la la la here is my proof. □

3.3 More on Labelling and Referring to Numbered items

If you have numbered equations, theorems, list items, etc. in your document, you may wish to refer to those equations later. To do this you use `\label` to name the item and `\ref` to refer to it later.

Example:

```
\begin{theorem}\label{fundamental}
The integral $\int_a^b f(x) dx = F(b)-F(a)$, where $F$ is an
anti-derivative of $f(x)$.
\end{theorem}

Theorem \ref{fundamental} is called the Fundamental Theorem of Calculus.
It has the following uses:
```

```
\begin{enumerate}
\item\label{area} We use it to find the area under a curve.
\item We also use it to take the derivative of an integral.
\end{enumerate}

The use in part (\ref{area}) is extremely common.
```

Theorem 1 *The integral* $\int_a^b f(x)dx = F(b) - F(a)$*, where* F *is an antiderivative of* $f(x)$*.*

Theorem 1 is called the Fundamental Theorem of Calculus. It has the following uses:

I. We use it to find the area under a curve.

II. We also use it to take the derivative of an integral.

The use in part (I) is extremely common.

When you have added or changed labels and references, you must hit the LaTeXbutton twice to make sure the references come up correctly.

When you label a thing, you type the command `\label{name}` just to the right of the `\begin{thing}` without any spaces. For example,

```
\begin{equation}\label{goodequation} ....\end{equation}

\begin{theorem}\label{greatthm}.....\end{theorem}

\begin{enumerate}
     \item\label{superproblem} .....
     \item\label{anotherproblem}.....
\end{enumerate}
```

Then you can refer to these things by the names that you gave them anywhere in the document (including before the things actually appear). Remember to hit the LaTeXbutton twice!!! When you use `ref` and `label`, LaTeXrequires two passes through the document to make sure all the cross-references are correct.

3.4 Exercises

Exercise 3.1: Reproduce the following without typing the numbers of the theorems yourself (your numbers may not be exactly the same, that's ok):

Theorem 2 *Berit is a Norwegian name.*

Theorem 3 *Norway is part of Scandinavia*

Corollary 4 *Berit is a Scandinavian name*

Exercise 3.2: Change the proof environment in your preamble so that the "la la la" proof of Section 1.2 starts with the word Proof in italics and ends with a capital Delta. (Δ)

Exercise 3.3: Reproduce the following[1]. It's not important that the equation numbers are (1) and (2), just that you use `\ref` and `\label` to match the equation numbers with the references:

> This is the most important function in mathematics. It is defined, for every complex number z, by the formula
>
> $$\exp(z) = \sum_{n=0}^{\infty} \frac{z^n}{n!}. \tag{3.1}$$
>
> The series (3.1) converges absolutely for every z and converges uniformly on every bounded subset of the complex plane. Thus exp is a continuous function. The absolute convergence of (3.1) shows that the computation
>
> $$\sum_{k=0}^{\infty} \frac{a^k}{k!} \sum_{m=0}^{\infty} \frac{b^m}{m!} = \sum_{n=0}^{\infty} \frac{1}{n!} \sum_{k=0}^{\infty} \frac{n!}{k!(n-k)!} a^k b^{n-k} = \sum_{n=0}^{\infty} \frac{(a+b)^n}{n!}$$
>
> is correct. It gives the important addition formula
>
> $$\exp(a)\exp(b) = \exp(a+b), \tag{3.2}$$
>
> valid for all complex numbers a and b.

[1] From Walter Rudin's *Real and Complex Analysis*

Chapter 4

The Preamble

4.1 Introduction

The preamble is is the place to make global settings that apply to the entire document. There are several types of commands in the preamble.

First of all, you can include special packages with specialized commands. Use the `\usepackage` command. For example, I start all of my LaTeX files with the following:

```
\documentclass[11pt]{article}

\usepackage{amssymb, amsmath, graphicx}
```

Those three packages are ones that I use frequently. There are literally hundreds of packages out there, many of which come automatically pre-installed with your LaTeX program.

The second thing you can do in the preamble is set margins and other parameters. You can include something like the following in the preamble of your LaTeXfiles:

```
\textwidth = 6.0 in
\textheight = 9 in
\oddsidemargin = 0.0 in
\evensidemargin = 0.0 in
\topmargin = 0.0 in
\headheight = 0.0 in
\headsep = 0.0 in
\parskip = 0.2in
\parindent = 0.0in
```

Then, if I ever want to tweak the settings, I can go fiddle with the numbers. Notice that, for example, the topmargin on this file does will not be be literally 0 inches. No, LaTeX has predefined what it thinks are the best margin settings. Then the settings above can be used to adjust the preexisting settings. For example, if I change the topmargin to 0.3in, it will add 0.3 inches to the default margin setting. If I change topmargin to -0.3in, it will subtract 0.3 inches from the default margin setting. (I don't actually recommend these settings. Many people feel that it is wrong to make the textwidth and textheight so big.)

See page 119 of the Not So Short Introduction to LaTeX for more information on the page layout.

4.2 New Definitions in the Preamble

Sometimes there are certain LaTeX commands that one types over and over again in a certain article. If those commands are particular unwieldy or irritating to type, you can shorten them by making up your own abbreviation. The command is `\newcommand` and it goes in the preamble. The format is `\newcommand{\abbreviation}{\what it abbreviates}`. For example, the following are from my preamble in a document for a Number Theory class:

```
\newcommand{\ds}{\displaystyle}

\newcommand{\zzz}{\mathbb{Z}}    %writes the symbol for the integers
\newcommand{\nnn}{\mathbb{N}}  %writes the symbol for the naturals
\newcommand{\rrr}{\mathbb{R}}     %writes the symbol for the reals
\newcommand{\qqq}{\mathbb{Q}}   %writes the symbol for the rationals
```

Now, in the body, you can type the abbreviated command. When LaTeX processes the document, it will replace the abbreviated command by exactly what appears in the second brackets. So, whenever I type `\ds`, LaTeX just treats it as if it really said `\displaystyle`. Notice that all of the commands above are things that belong in math mode. That means I can use those abbreviations only in math mode. Now, in the body I could write

```
For all $p \in \nnn$, $\frac{p-1}{p}=n$.
Furthermore, $\ds\sum_{\theta \in \rrr} \theta = \infty$.
```

For all $p \in \mathbb{N}$, $\frac{p-1}{p} = n$. Furthermore, $\sum_{\theta \in \mathbb{R}} \theta = \infty$.

You can also write abbreviations for commands that have variables. You list the number of variables in square brackets and refer to them as `#1, #2, etc.`. For example,

```
\newcommand{\supersum}[3]{$#1+#2^2+#3^3+#1#2$}
```

If I type

```
\supersum{a}{b}{\pi}
```

I would get

$a + b^2 + \pi^3 + ab$

Here is a silly example:

```
\newcommand{\faves}[5]{I love \textbf{#1}, \textit{#2}, \textsf{#3},
\textsl{#4}, \textsc{#5}}
```

Then in the body I could type

```
\faves{Ice Cream}{Marzipan}{Peanut Butter}{Veronica Mars}{Kittens}
```

I love **Ice Cream**, *Marzipan*, Peanut Butter, *Veronica Mars*, KITTENS

4.3 Exercises

Exercise 4.1: Choose a symbol or expression that you use very frequently in either your thesis work or your classes. For example, I used the symbol $G^{\#}$ or $H^{\#}$ a lot. Make an abbreviation and a newcommand for your commonly used expression.

Chapter 5

Features of WinEdt and TexShop

5.1 Features of WinEdt

I'm a Mac user, so I am not familiar with the features of WinEdt. Nevertheless, here are a few things that I have found.

5.1.1 Insert

Under the menu Insert, you can choose to insert an array, matrix, table, or equation. You can also insert an itemized list, enumerated list, or cases command. When you select any of these, WinEdt inserts the appropriate Latex command wherever your cursor is. There are red asterisks in the areas where you need to add information. Under the Font command, you can insert the Latex commands for boldface, italics, and so on. Under the Latex command you can insert the commands for `\ref` and `\label`

5.1.2 Document

When you have a new blank document, you can start by clicking on Document → New Document. Select Latex:AMS Article and it will start a file for you with the preamble typed already.

Under Document → Current Work (Samples), there is a skeleton file for several types of documents. Try looking at these. In my opinion, they have almost too much information, but you might delete some of the stuff and just keep the things you like.

5.1.3 The Toolbar

On the toolbar (where the Latex and magnifying glass buttons are), there are buttons for various Latex math symbols. If you click on the big Σ, you will get another toolbar with the majority of math symbols you need. Then if you click on any of these buttons, it will insert the command into your document. Note that it does not insert the $ dollar signs, you still need to type those. Experiment with the buttons here.

5.2 Features of TexShop

Again, I am not really an expert on these programs, but I can tell you about the commands that I use frequently.

5.2.1 Window

Under the Window menu option, click Show Toolbar or Hide Toolbar to view the toolbar at the top of the .tex file. I recommend showing the toolbar, as it has some useful features. Once the Toolbar is showing there are several useful things:

I. The Typeset button. Hit it with your mouse to run Latex.

II. The Tags menu. You can set tags in your document so that you can quickly find your way back to a particular spot. You set a tag by typing %: at the very beginning of a line. Anything after the tag is a comment and will be ignored by Latex.

III. The Templates menu. TexShop has a couple of predefined templates that can get you started. When you have a brand-new empty document, select the Template menu and choose one the templates. It will insert the `\documentclass` command along with a bunch of other stuff that you may or may not want. You can also write your own templates and save them in the Template folder so that they will appear under the Templates menu. (On my computer the templates folder is at Faculty/Library/TeXShop/Templates.)

Click Latex Panel or Matrix Panel for a panel that comes up with many commonly used commands. If you use your mouse to click on any of these, TexShop will insert the LaTeXcommand into your file wherever your cursor is. This is particularly useful when you have forgotten the command for something, or for arrays, in my opinion.

5.2.2 Preview

The commands here all have to do with how you want the PDF file to be displayed.

5.2.3 Macros

These are extremely useful. On the lower part of the menu are choices for things you might like to type. For example, under Text Styles, you can choose Typeface, Size, Style, and Underline.

5.3 Exercises

Exercise 5.1: Use the features of WinEdt or TexShop to find the following symbols: $\star, \otimes$, Ç.

Exercise 5.2: Use Google to find out how to type: ♪ and $\underbrace{a + b + c + \cdots z}_{26}$

Chapter 6

Arrays

There are several types of array-like things that you can do with LaTeX. Some of them can only be used in math mode and others can be used anywhere.

6.1 The array environment

In math mode, one can type

```
$\begin{array}{clr}
5    &    7     & 3 \\
\sin(\theta)   &    x+1-x^2 &  5y^2+14
\end{array}$
```

Notice that I put dollar signs before and after the array, so that every entry of the array is already in math mode. The `{clr}` tells me that there are 3 columns in my array and that the first column is centered, the second is left-justified, and the third is right-justified. The `&` is used to separate the items in each row, and the `\\` signals the end of the row. Here is the output:

$$\begin{array}{clr}
5 & 7 & 3 \\
\sin(\theta) & x+1-x^2 & 5y^2+14
\end{array}$$

If you want to put parentheses or brackets around your array, you use the commands `\left[....\right]` or `\left(....\right)`, etc. A list of delimiters is in Table 6.4 on page 30. The left and right command will automatically size the parentheses to be as tall as the array. For example,

```
$\left[
```

```
\begin{array}{clr}
5    &    7     & 3 \\
\sin(\theta)   &    x+1-x^2 &  5y^2+14
\end{array}
\right]$
```

$$\left[\begin{array}{clr}
5 & 7 & 3 \\
\sin(\theta) & x+1-x^2 & 5y^2+14
\end{array}\right]$$

6.2 The eqnarray environment

A sequence of equations or inequalities is typed with the `eqnarray` or the `eqnarray*` environment. When you type the `\begin{eqnarray}` command, it automatically goes into math mode, so you don't need the dollar sign. `eqnarray` basically sets up an array with 3 columns, with the idea being that the middle column is for the $=$ or $\leq$ or whatever relational symbol you are using.

For example,

```
\begin{eqnarray}
5x+1 & \leq & 7x-3 \\
-2x + 1  & \leq & -3     \nonumber   \\
-2x & \leq & -4 \\
x & \geq & 2\label{answer}
\end{eqnarray}

Equation (\ref{answer}) is the answer to the exercise.
```

$$\begin{aligned}
5x+1 &\leq 7x-3 && (6.1)\\
-2x+1 &\leq -3 &&\\
-2x &\leq -4 && (6.2)\\
x &\geq 2 && (6.3)
\end{aligned}$$

Equation (6.3) is the answer to the exercise.

Since I wanted to refer to the last equation, I used `\label` to give it a name and then `\ref` to refer to it later.

The command `eqnarray` will number every equation in the array, unless you write `\nonumber` at the end of that line. If you don't want any of them to be numbered, you use the command `eqnarray*` instead.

The following example has no equation numbers, so we use `eqnarray*`. Also, we want to write some English text on the third line. Since the `eqnarray` automatically puts us in math mode, we can put `\textnormal{ }` around any English words:

```
\begin{eqnarray*}
|f(x)-f(a)|   & = &  |x^2-a^2| \\
    & = & |x-a||x+a| \\
    & < & \delta |x+a|, \textnormal{ since } |x-a|<\delta\\
    & < & 2a \delta\\
    & < & \varepsilon
\end{eqnarray*}
```

$$\begin{aligned} |f(x)-f(a)| &= |x^2-a^2| \\ &= |x-a||x+a| \\ &< \delta|x+a|, \text{ since } |x-a|<\delta \\ &< 2a\delta \\ &< \varepsilon \end{aligned}$$

6.3 The tabular environment

The tabular environment is used for making tables of data. The command is `\begin{tabular}...\end{tabular}` and the syntax is very similar to the `array` and `eqnarray` environments. You still use the & to separate columns and \\ to end rows. A key difference is that the tabular command is usually used for plain text, not math, so you do not go into math mode to use tabular.

For example,

```
\begin{tabular}{rll}
```

```
Item & Description  & Price\\
Sweater & Green and Warm & \$34.99\\
Notebook & Spiral Bound & \$1.49 \\
\end{tabular}
```

Item	Description	Price
Sweater	Green and Warm	$34.99
Notebook	Spiral Bound	$1.49

Now the table might look better with some lines around or between the columns and rows. To add vertical lines, you add the `|` symbol (just below the backspace key) between the column justification identifiers in the tabular declaration. To add horizontal lines, you add the command `\hline` between rows. With lines around it, the table above would look like:

```
\begin{tabular}{|r|ll|}
\hline
Item & Description  & Price\\
\hline
Sweater & Green and Warm & \$34.99\\
Notebook & Spiral Bound & \$1.49 \\
\hline
\end{tabular}
```

Item	Description	Price
Sweater	Green and Warm	$34.99
Notebook	Spiral Bound	$1.49

6.4 Exercises

Exercise 6.1: Type the following:

$$T = \left\{ \begin{bmatrix} a & b \\ c & d \end{bmatrix} : ad = bc \right\}$$

Exercise 6.2: Reproduce the following[1]:
We define the **absolute value** of a complex number $\alpha = a + bi$ to be

$$|\alpha| = \sqrt{a^2 + b^2}.$$

[1]From Serge Lang's *Undergraduate Analysis*

Name	Delimiter	How to type it in Latex
Parentheses	$(\ldots)$	`(...)`
Square Brackets	$[\ldots]$	`[...]`
Braces	$\{\ldots\}$	`\{...\}`
Angle Brackets	$\langle\ldots\rangle$	`\langle ... \rangle`
Bars	$\vert\ldots\vert$	`\vert...\vert`
Double Bars	$\Vert\ldots\Vert$	`\Vert...\Vert`

Table 6.1: Common delimiters in arrays

The absolute value satisfies properties analogous to those satisfied by the absolute value of real numbers:

$$\begin{aligned} |\alpha| &\geq 0 \text{ and } = 0 \text{ if and only if } \alpha = 0 \\ |\alpha\beta| &= |\alpha||\beta| \\ |\alpha + \beta| &\leq |\alpha| + |\beta|. \end{aligned}$$

Exercise 6.3: Make a multiplication table for the numbers 1 through 4.

Chapter 7

Citing your sources

7.1 The Bibliography

LaTeXhas a built-in system for making and referring to a bibliography. There are two main ways to make a bibliography.

I. One can create a "master" bibliography file that you use for all your papers. Then using BIBTeX, you can create an article specific bibliography that just lists the sources referred to in that paper.

II. Using the `\thebibliography` environment, which is just like an itemized list at the end of the paper.

The first option is beyond the scope of my knowledge, so I refer you to other sources to read about it. I will discuss the second option here.

Start by putting some sources in your bibliography.

At the **very end of your document**, before the phrase `\end{document}`, type

```
\begin{thebibliography}{99}

\bibitem{mainsource} Kunen, K.,  ``The complex Stone-Weierstrass
property,"  {\it Fund. Math.} 182  (2004),  no. 2, 151--167.

\bibitem{knots} Adams, Colin, ``Hyperbolic knots."
{\it Handbook of knot theory},  1--18, Elsevier B. V., Amsterdam, 2005.

\bibitem{erdos} Erd\"os, Paul, ``Some of my favourite unsolved problems."
```

```
{\it Math. Japon.}  46  (1997),  no. 3, 527--537.


\end{thebibliography}
```

The results of typing this can be seen at the end of this document.

Now I can type in my document, before the bibliography. When I want to refer to something in my bibliography, I use the command `\cite{}`, as follows:

```
In this paper, I do not answer any questions of Erd\"os \cite{erdos}.
I also have not read the papers of Kunen \cite{mainsource} or
Adams \cite{knots}.
```

In this paper, I do not answer any questions of Erdös [2]. I also have not read the papers of Kunen [4] or Adams [1].

Notice that the bibliography items are not automatically alphabetized. You must enter the items in your bibliography in alphabetical order yourself. If you want LaTeXto alphabetize the bibliography, you will have to learn how to use BIBTeX, which you are free to do on your own.

As with any other cross-references, you must run the Latex button twice to be sure the numberings and references are accurate.

7.2 Footnotes

Anytime you want a footnote[1], you can just use the `\footnote{}` command.

`...want a footnote\footnote{like this!}, you can....`

Multiple[2] footnotes will be numbered automatically[3].

```
Multiple\footnote{more footnotes!} footnotes will be numbered
automatically\footnote{Hurray!}.
```

[1] like this!

[2] more footnotes!

[3] Hurray!

7.3 Exercises

Exercise 7.1: Use MathSciNet to find two articles that look interesting to you. Make a bibliography in your class file and insert these two articles. Then write a paragraph in which you reference the articles.

Exercise 7.2: Write a paragraph that has two footnotes.

Exercise 7.3: Type the following, including the References. Use the `\begin{definition}` command for the definition.

Definition 1 *[6] Given* $\mathbf{x} = (x_1, \ldots, x_n)$ *in* $\mathbb{R}^n$*, we define the* **norm** *of* $\mathbf{x}$ *by the equation*

$$||x|| = (x_1^2 + \cdots + x_n^2)^{1/2};$$

and we define the **euclidean metric** d *on* $\mathbb{R}^n$ *by the equation*

$$d(\mathbf{x}, \mathbf{y}) = ||\mathbf{x} - \mathbf{y}||.$$

In the book *Analysis* by Royden [7], he defines the characteristic function as

$$\chi_E(x) = \begin{cases} 1 & x \in E \\ 0 & x \notin E \end{cases}$$

Chapter 8

Tables, Figures, and Graphics

8.1 Including graphics

Using the package `graphicx` allows you to import graphics files into your LaTeXdocument. First you must include the package by typing

```
\usepackage{graphicx}
```

I have placed a file called UnitCircle.pdf on the lab computers, so we can use that file to experiment with. If you'd like to try your own files, you may use .jpg, .pdf, .png, and probably other file types.

Now in the body of the document, type

```
\includegraphics[width=3in]{UnitCircle.pdf}
```

By varying the width of the picture, you can vary the size. LaTeXwill automatically keep the aspect ratio the same. You can also change the aspect ratio by including two optional sizing arguments:

```
\includegraphics[width=3in,height=3in]{UnitCircle.pdf}
```

A third way to change the size is with the optional argument `scale`. The `scale` command will multiply the original picture by a factor. So to keep it the same size, use `scale=1`, to double it, use `scale=2`, or to make it twice as small, use `scale=0.5`.

```
\includegraphics[scale=0.6]{UnitCircle.pdf}
```

Finally, you may wish to include a picture file, but crop it. You can do this by using the optional arguments of viewport and clip. Inside the square brackets you type

`viewport=`*llx lly urx ury*`, clip=true,`

where *llx, lly, urx, ury* represent the x and y coordinates of the lower left and upper right corners of the box. The origin is considered to be the lower left corner of the page, and the coordinates must be given with units, like inches or cm.

For example,

```
\includegraphics[viewport=3in 7.2in 7in 10.3in,
                 clip=true, scale=0.5]{UnitCircle.pdf}
```

8.2 Tables and Figures

Now that you know how to include images and how to use tabular to make tables, you can use the `table` and `figure` commands to include numbered tables and figures with captions. Both environments work the same way.

```
\begin{figure}
\centering
\includegraphics[width=2in]{UnitCircle.pdf}
\caption{The Unit Circle}\label{circle}
\end{figure}
```

This creates a figure, which is automatically numbered by LaTeX, with the caption listed. By using `\label`, I can give it a nickname, so that I can refer to it later using `\ref`.

```
Figure \ref{circle} is the unit circle that all students should
memorize.
```

Figure 8.1 is the unit circle that all students should memorize.

Notice that the figure does not usually get placed wherever you typed it. Figures and tables are called *floats*. LaTeX decides on its own where the floats should go. You may give it suggestions, but it is difficult to entirely control what it does. The suggestions are given using an optional argument in square brackets, right after the `\begin{figure}` command. See Table 8.1

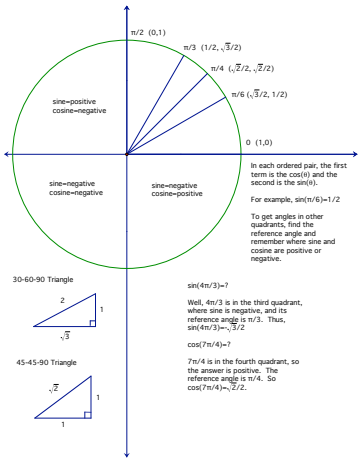

Figure 8.1: The Unit Circle

Optional argument	Meaning
h	place figure Here
t	place figure at Top of some page
b	place figure at Bottom of some page
p	place figure on a Page of just figures

Table 8.1: Optional arguments for placement of Figures and Tables

for a list of the arguments. The following example will first instruct LaTeX to put the table right at the location that you typed it. If LaTeX determines that you are wrong, and that it is not a good place for the table, it will then try to place it at the top of some page. Finally, if no top of a page is available, it will place it at the bottom of the page.

```
\begin{figure}[htb]
\centering...
...
\end{figure}
```

8.3 Exercises

Exercise 8.1: Include the UnitCircle.pdf file in your document, but crop it so that only the first quadrant appears.

Exercise 8.2: Make a table with a caption.

Chapter 9

Margins and Formatting

9.1 The Document Class command

We've already seen that by changing the document class to slides or report you can change the look of a file. Experiment by changing the word "article" to "report", "book", or "amsart". All four produce a paper, but they have different margins and different looks. To title a document, you can use the following in your preamble:

```
\title{Sample Title}
\author{Berit}
\date{December 1, 2008}
```

followed by `\maketitle` right after your `\begin{document}`. Each of the classes will handle the title and author differently.

You can also try changing some of the options. We've already changed 11pt to 12pt. You can also use the options

```
\documentclass[11pt, twoside]{article}
\documentclass[11pt,twocolumn]{article}
```

9.2 Packages

Another way to change the look of your document is to use a predefined package. A package is a style file, which should have the suffix *.sty*. We've already used style files for some of the math symbols by typing

```
\usepackage{amssymb, amsmath}
```

This command tells Latex to look in the files `amssymb.sty, amsmath.sty` for further instructions. The `\usepackage` commands must be in the preamble and traditionally are list first thing, right after the `\documentclass` declaration.

In your file, add the line `\usepackage{a4}` right after the other `\usepackage` commands. This changes the formatting to fit A4 size paper (used in Europe).

9.3 Page Styles

Page styles refers to the look of the head, the body, and foot, including any running headers along the top of each page and the numbering system for the pages. A sample of some commands:

```
\pagenumbering{arabic}
\pagenumbering{roman}
\pagenumbering{Roman}
\pagenumbering{alph}
\pagenumbering{Alph}
```

This command can be put in the preamble, where it will apply to the whole document. Or you can put a `\pagenumbering` command in the body and it will apply the new page numbering from that page on. It will also reset the page number back to one, so be sure this is what you want!

```
\pagestyle{plain}
\pagestyle{empty}
\pagestyle{headings}
\pagestyle{myheadings}
```

This command goes in the preamble and applies to the whole document. It affects the location and style of the numbering and headings. If you choose the `myheadings` option, you have to set the headings yourself. Right after the `\pagestyle{myheadings}`, type

```
\markright{Berit is the Greatest!}
```

Now try deleting the `\markright` command and replacing it with

```
\markboth{I love Latex}{Berit Givens}
```

You may or may not see both statements in the headers. This depends on what document class you are in. Try again changing between article, report, amsart, and book and using the options of twoside and twocolumn.

9.4 Setting the margins and lengths yourself

Look at the figure photocopied from Lamport's book, page 182. If you do not have the book or the figure, a similar figure is available at
`http://www.iam.ubc.ca/ newbury/tex/page-set-up.html#margins`

Each of those commands, like `\textheight` or `\oddsidemargin`, is basically set to a default number by Latex. You can change them by typing something like

```
\textwidth = 6.5in
```

in your preamble. I have standard margin setting commands in my preamble.

The lengths you can use are `in` for inches, `cm` for centimeters, `mm` for millimeters, `pt` for point, `em` for the width of a capital M, and `ex` for the height of a lower case x. You can also use the commands themselves to get their values. For example, I could use the graphics command

```
\includegraphics[width=\textwidth]{UnitCircle.pdf}
```

Instead of specifically telling it how many inches it should be, this command just sets it to whatever the current value of `\textwidth` is.

Some other useful lengths are `\parindent` and `\parskip`. Consult the Leslie Lamport book for other lengths. Some of these lengths can only be set in the preamble, while others can be modified at any time in the body of your document.

Chapter 10

Goodbye and Happy Typing!

In the flyer for this class I had fun writing Cal Poly Pomona with mathematical symbols:

$$\subset\alpha\int \quad P\circ\int\gamma \quad \mathcal{P}\emptyset\mathfrak{m}0\cap\alpha$$

What can you write?

Bibliography

[1] Adams, Colin, "Hyperbolic knots." *Handbook of knot theory*, 1–18, Elsevier B. V., Amsterdam, 2005.

[2] Erdös, Paul, "Some of my favourite unsolved problems." *Math. Japon.* 46 (1997), no. 3, 527–537.

[3] Grätzer, George, *Math into LaTeX*, 3rd ed., Birkhauser, 2000.

[4] Kunen, K., "The complex Stone-Weierstrass property," *Fund. Math.* 182 (2004), no. 2, 151–167.

[5] Lamport, Leslie, *LaTeX: A Document Preparation System: User's Guide and Reference Manual*, Addison-Wesley, 1994.

[6] Munkres, James R., *Topology*, 2nd ed. Prentice Hall, 2000.

[7] Royden, H.L., *Real Analysis*, 3rd ed., Macmillan, 1988.