Basic LaTeX

1 Introduction

LaTeX is not a word processor, in the conventional sense. It is a typesetting system, or document processing system, developed by Leslie Lamport [1]. LaTeX uses a set of special commands — or "macros" — based on Donald E. Knuth's TeX program [2, 3].

LaTeX is also not a WYSIWYG (What You See Is What You Get) system. It is a descriptive markup system. The user creates an *input* file (with any text editor) which consists only of ASCII characters. This input file contains the text of the document and the LaTeX formatting commands [3]. Then, the file is processed by the LaTeX software into a recognizable form which may be printed.

LaTeX is a powerful typesetting system, which can produce very complex documents. This manual, however, will be concerned with only the relatively simple commands needed to produce a 'mid-term paper' sized report. For a more complete documentation of LaTeX, refer to:

- Reference [3]
- Reference [4] (which can be purchased at the ISU Computation Center, Room 195 Durham, for about $5)
- An ISU Computation Center short course on LaTeX
- http://jasper.ora.com/texhelp/LaTeX.html
- http://www.cl.cam.ac.uk/CTAN/latex

2 Running LaTeX

2.1 Project Vincent

To run LaTeX on Project Vincent, first create a LaTeX input file. This input file must end in a `.tex` extension (for example, `project1.tex`).

In the Vincent window, add the appropriate locker:

```
% add tex
```

This must be done only once per login.

Run LaTeX with the command:
`% latex` *filename*`.tex`
While processing the LaTeX document, Vincent will print messages to the screen. If all goes well, the Vincent prompt will reappear. If not, an error message and a question mark prompt `(?)` will appear. Type `r` (for `run`) at the prompt, and LaTeX will complete the document processing. Any errors will be apparent while examining the document. Vincent will create files with the same *filename* as the input file, but with different extensions: `.aux`, `.log`, `.dvi`, and (sometimes) `.toc`. These files (except the `.dvi` file) contain information about page numbering, bibliography references, equation labels, plot labels, etc. Oftentimes, LaTeX must be rerun to obtain correct cross–references. If so, a warning will appear. LaTeX must also be rerun each time the input file is edited.

To view a processed document, enter the command:
`% xdvi` *filename*`.dvi &`
A window will appear on the screen which displays the processed document (excluding figures). After editing the `.tex` file and rerunning LaTeX the `xdvi` command need not be executed again. If the cursor is clicked in the `xdvi` window, the lastet version of the document will appear.

To convert a `.dvi` file to a Postscript file, enter the command:
`% dvips` *filename*`.dvi`
A file with the same *filename* as the input file will be created, but with the `.ps` extension. View the Postscript file with any Postscript previewer.

Note: In the very near future, the default version of LaTeX on Project Vincent will be LaTeX2e. The only major change from the current version is changing the command `\documentstyle` to `\documentclass`. This will be explained in Section 3.

2.2 SGI Workstations

To run LaTeX on an SGI workstation, use the same commands as above (except `% add tex`). LaTeX and its utilities are currently located in the `/usr/local/bin/` directory.

3 Getting Started

3.1 Creating a Document

The first line of your input file should be:

```
\documentstyle[12pt]{article}
```

If you are using LaTeX2e, the first line of your input file should be:

```
\documentclass[12pt]{article}
```

The input file must also contain the lines

```
\begin{document}
```

and

```
\end{document}
```

between which all other lines of text of your report must exist.

3.2 Special Characters

Much of the content of your reports will be typed into the input file in a straightforward way. However, the input file will also contain LaTeX commands which will show up differently in your input file. For example, *these words in italics* were created with the command `{\it these words in italics}`.

Most LaTeX commands will begin with the backslash. The exceptions include:

$	Starts and ends math mode
&	Separates columns in a table
%	Indicates a comment in an input file
{	Surround block of characters to be
}	treated as a unit

To print any of the above characters in your text, rather than have it execute a LaTeX command, precede it with a backslash. For example, this $ symbol was created with the command `\$`.

3.3 Spacing

LaTeX does not recognize extra spaces, extra blank lines, or the placement of carriage returns in your input file. One or more spaces between words is recognized as just one space. To create extra blank space between words use the command `\hspace{1.0in}` (for one inch). One or more blank lines in your input file is interpreted as a new paragraph. To create extra blank space between lines use the command `\vspace{2.5in}` (for 2.5 inches). A hard line break is created with a double backslash.

4 Environments

You can create special "environments" in LaTeX by surrounding text in your input file with the commands `\begin{ }` and `\end{ }`. Place the name of the appropriate environment inside the curly braces.

The `center` environment created the following:

This text is centered.

by using the commands:

```
\begin{center}
This text is centered.
\end{center}
```

The `itemize` environment created the following:

- Here's the first item in a list...
- ...and here's the second

by using the commands:

```
\begin{itemize}
  \item Here's the first item in a list...
  \item ...and here's the second
\end{itemize}
```

If you want the above list to be numbered use the `enumerate` environment.

The `verbatim` environment can be used to exactly replicate an area of text in an input file. LaTeX commands are not executed in the verbatim environment. Instead, they are printed as they appear in the input file.

Other LaTeX environments exist which will be described later.

5 Typefaces

You can change the typefaces (fonts) in your LaTeX document with the following commands:

`\rm`	Roman (default) type
`\bf`	**Boldface type**
`\it`	*Italic type*
`\sc`	SMALL CAPS TYPE
`\sf`	Sans serif type
`\sl`	*Slanted type*
`\tt`	`Typewriter style type`
`\em`	*Emphasized type*

For example, the command `{\bf this boldface type}` created **this boldface type**.

6 Equations

6.1 In-text Equations

Equations which are embedded in a line of text are created with the `math` environment. This environment is created by typing math text between `$` symbols, between `\(` and `\)` commands, or between `\begin{math}` and `\end{math}`. For example, the expression $x^2 = y^2 + z^2$ was created with the command `$x^2 = y^2 + z^2$`.

6.2 Unnumbered Equations

The `displaymath` environment creates equations which are centered on the page following normal text, and are not numbered. This environment is begun by typing `$$`, `\[`, or `\begin{displaymath}`. It is ended by typing `$$`, `\]`, or `\end{displaymath}`. The following equation:

$$x^2 = \frac{y^2 + z^2}{\sqrt{a+b+c}}$$

was created by typing

```
\[
x^2 = \frac{y^2 + z^2}{\sqrt{a+b+c}}
\]
```

6.3 Numbered Equations

The `equation` environment creates equations which are centered on the page following normal text, and are numbered. LaTeX keeps track of the equation numbers. The `equation` environment is created with the commands `\begin{equation}` and `\end{equation}`. The following equation:

$$x^2 = \frac{y^2 + z^2}{\sqrt{a+b+c}} \tag{1}$$

was created by typing

```
\begin{equation}
x^2 = \frac{y^2 + z^2}{\sqrt{a+b+c}}
\end{equation}
```

6.4 Superscripts and Subscripts

Superscripts and subscripts are created with the symbols `^` and `_`. They may be used in combination to produce multi-levels of superscripting and subscripting. For example, $e^{x^{\left(a+b\right)}}_{1,2}$ was created with `$e^{x^{\left(a+b\right)}}_{1,2}$`.

6.5 Fractions

Fractions can be created with the commands `/` and `\frac`. Typing `$3/4$` gives $3/4$, and typing `$\frac{x+1}{x-1}$` gives $\frac{x+1}{x-1}$.

6.6 Roots

Roots are created with `\sqrt`. Some examples include: typing `$\sqrt{x+5}$` gives $\sqrt{x+5}$, the command `$\sqrt[3]{y}$` gives $\sqrt[3]{y}$, and `$\sqrt{x+\sqrt{y}}$` gives $\sqrt{x+\sqrt{y}}$.

<table>
<tr><td>$($</td><td><code>(</code></td><td>$)$</td><td><code>)</code></td></tr>
<tr><td>$[$</td><td><code>[</code></td><td>$]$</td><td><code>]</code></td></tr>
<tr><td>$\{$</td><td><code>\{</code></td><td>$\}$</td><td><code>\}</code></td></tr>
<tr><td>$\vert$</td><td><code>|</code></td><td>$\Vert$</td><td><code>\|</code></td></tr>
</table>

Table 1: Delimiters

$\hat{a}$	`\hat{a}`	$\check{a}$	`\check{a}`	$\breve{a}$	`\breve{a}`
$\acute{a}$	`\acute{a}`	$\grave{a}$	`\grave{a}`	$\tilde{a}$	`\tilde{a}`
$\bar{a}$	`\bar{a}`	$\vec{a}$	`\vec{a}`	$\dot{a}$	`\dot{a}`
$\ddot{a}$	`\ddot{a}`				

Table 2: Accents

6.7 Delimiters

Delimiters are characters which act like parenthesis. Table 1 lists some of the more common delimiters used in math mode and the commands needed to create them. LaTeX will automatically adjust the size of delimiters to the correct size if you use the `\left` and `\right` commands. This equation:

$$x = \left\{ \frac{(a+b)\times y}{c+d} \right\}$$

was produced with the commands:

```
$$
x = \left\{ \frac{(a+b)\times y}{c+d} \right\}
$$
```

6.8 Other Symbols

Tables 2–5 list other math symbols used in LaTeX

6.9 Multi-Line Equations

Equations with more than one line are procuded with the `eqnarray` environment. This is a special case of the `array` environment (see Subsection 6.10). It has only three columns—left, center, and right justified. End a line with the `\nonumber` command to prevent numbering that specific line. Specify `eqnarray*` to prevent numbering *any* lines. The equaion

$$\begin{aligned} x &= a+b+c+d \qquad (2) \\ &\quad +e+f+g \end{aligned}$$

α	\alpha	θ	\theta	o	o	τ	\tau
β	\beta	ϑ	\vartheta	π	\pi	υ	\upsilon
γ	\gamma	ι	\iota	ϖ	\varpi	ϕ	\phi
δ	\delta	κ	\kappa	ρ	\rho	φ	\varphi
ϵ	\epsilon	λ	\lambda	ϱ	\varrho	χ	\chi
ε	\varepsilon	μ	\mu	σ	\sigma	ψ	\psi
ζ	\zeta	ν	\nu	ς	\varsigma	ω	\omega
η	\eta	ξ	\xi				
Γ	\Gamma	Λ	\Lambda	Σ	\Sigma	Ψ	\Psi
Δ	\Delta	Ξ	\Xi	Υ	\Upsilon	Ω	\Omega
Θ	\Theta	Π	\Pi	Φ	\Phi		

Table 3: Greek Letters

\arccos	\cos	\csc	\exp	\ker	\limsup	\min	\sinh
\arcsin	\cosh	\deg	\gcd	\lg	\ln	\Pr	\sup
\arctan	\cot	\det	\hom	\lim	\log	\sec	\tan
\arg	\coth	\dim	\inf	\liminf	\max	\sin	\tanh

Table 4: Roman Math Commands

$\pm$	\pm	$\cdot$	\cdot	$\ast$	\ast	$\bullet$	\bullet
$\mp$	\mp	$\times$	\times	$\star$	\star	$\div$	\div
$\leq$	\leq	$\geq$	\geq	$\ll$	\ll	$\gg$	\gg
$\equiv$	\equiv	$\approx$	\approx	$\cong$	\cong	$\neq$	\neq
$\propto$	\propto	$\doteq$	\doteq	$\imath$	\imath	$\jmath$	\jmath
ℓ	\ell	∂	\partial	∞	\infty	$\prime$	\prime
∇	\nabla	$\backslash$	\backslash				

Table 5: Miscellaneous Symbols

was produced by the commands

```
\begin{eqnarray}
 x & = & a + b + c + d \\
   &   & + e + f + g \nonumber
\end{eqnarray}
```

and the equation

$$\begin{array}{rcl} x & = & a(b+c) \\ & = & ab+ac \end{array}$$

was produced by

```
\begin{eqnarray*}
 x & = & a (b + c) \\
   & = & ab + ac   \\
\end{eqnarray*}
```

6.10 Arrays

The `array` environment is similar to the `tabular` environment (see Section 7). The commands

```
\begin{equation}
  \left[
    \begin{array}{rlc}
      x+y^2      &   e^{2x}   &   \alpha \\
      y^2+2y+4   &   \beta    &   x+5    \\
    \end{array}
  \right] \\
\end{equation}
```

were used to create the following

$$\left[\begin{array}{rlc} x+y^2 & e^{2x} & \alpha \\ y^2+2y+4 & \beta & x+5 \end{array} \right] \tag{3}$$

The symbols `{rlc}` after the `\begin{array}` command represent three columns, each right, left, and center justified, respectively. You may have as many columns or rows as you wish.

Name	Score	Grade
Bob	84	B
Sue	94	A
John	92	A$-$
Mary	88	B$+$

Table 6: Example Table

7 Tables

For the purposes of writing only simple reports, an example table and the text used to produce it will be shown, without a detailed explanation. Table 6 was created with the commands

```
\begin{table}
\begin{center}
\begin{tabular}{|l|rc|} \hline
    Name   &   Score   &   Grade \\ \hline
    Bob    &    84     &    B    \\
    Sue    &    94     &    A    \\
    John   &    92     &    A$-$ \\
    Mary   &    88     &    B$+$ \\ \hline
\end{tabular}
\end{center}
\caption{Example Table}
\label{ta:ex_table}
\end{table}
```

Columns are separated with the & symbol. The command `{|l|rc|}` after the `\begin{tabular}` command has the meaning "vertical line, left-justified column, vertical line, right-justified column, center-justified column, vertical line". The `\hline` command creates a horizontal line. The caption may be placed before or after the table.

8 Figures

Figure 1 was created by importing a Postscript file named `ex_figure.ps` with the commands

```
\begin{figure}
 \special{psfile=ex_figure.ps angle=-90 hscale=65 vscale=65
          hoffset=-20 voffset=50}
 \vspace{4.5in}
```

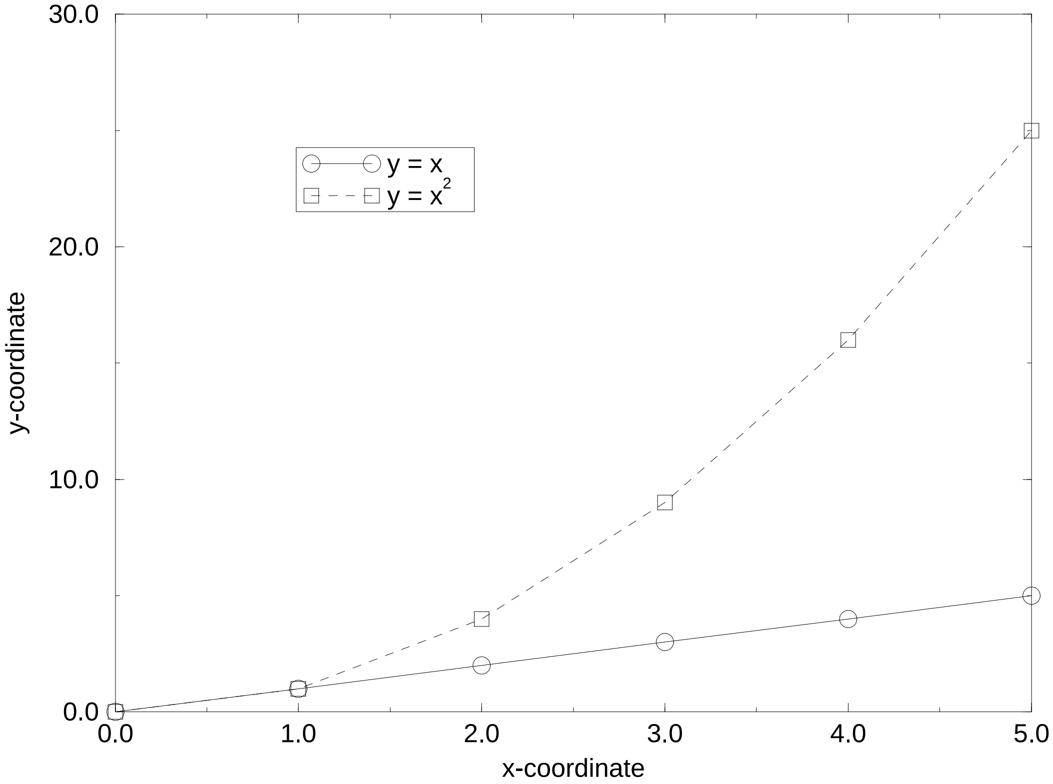

Figure 1: Example Figure

```
 \caption{Example Figure}
 \label{fig:ex_figure}
\end{figure}
```

The stuff after the `\special` command are the name of the file you wish to import, rotation angle, horizontal scaling, vertical scaling, horizontal offset, and vertical offset. If you have created the Postscript file to be imported with software other than `xmgr`, you will probably have to play around with these numbers to get your figure centered correctly. You must also provide enough vertical space with the `\vspace` command. The caption may be placed before or after the table. Figures are *not* visible when viewing text with `xdvi`—you must use a Postscript previewer.

9 Cross–References

To cross–reference a particular section of text, equation, table, etc., you must first label each area you wish to refer to. For example, notice that the commands used to create Table 6 contain the line `\label{ta:ex_table}`. To refer to that table anywhere in the text of your document, type `\ref{ta:ex_table}`. You can put anything you want to inside the curly braces. LaTeX will automatically keep track of the numbering, so you don't have to.

10 Organizing a Document

10.1 Sectioning

You can organize your document into logical sections with the commands

```
\section{...}
\subsection{...}
\subsubsection{...}
```

Place the appropriate section titles inside the curly braces. LaTeX will keep track of the section numbers.

10.2 Title

To create a title, use the commands   immediately after the `\begin{document}` command. Fill the curly braces with the appropriate information. For a separate title page, specify the `titlepage` option in the `\documentstyle` command. For example,

```
\documentstyle[titlepage,12pt]{article}
```

10.3 Creating a Bibliography

To create a bibliography, use the commands

```
\begin{thebibliography}{99}
```

and

```
\end{thebibliography}
```

Between these commands, place each bibliography item. For example, item [4] of the bibliography for this manual was created with the command

```
  \bibitem{isulatex} Harris, Erica M.S., Hutchison, Linda J.,
    Christensen, George A., {\it Local Guide for Using
    \LaTeX\ at the ISU Computation Center}.  Iowa State
    University Computation Center Document No. 123.,
    Ames, Ia., 1990.
```

Each item in the bibliography is created with the `\bibitem` command, followed by its own unique label (inside the curly braces), then text. To cite a bibliography item, use the `\cite` command. For example, item [4] is cited with the command `\cite{isulatex}`.

10.4 Appendices

The `\appendix` command causes section numbering to change from numbers to letters. Normal sectioning commands are still used.

References

[1] Lamport, Leslie. LaTeX*: a Document Preparation System.* Addison–Wesley Publishing Co., Reading Ma., 1986.

[2] Knuth, Donald E. *The TeXbook* Addison–Wesley Publishing Co., Reading Ma., 1986.

[3] Buerger, David J. LaTeX *for Engineers and Scientists.* McGraw–Hill, New York, 1990.

[4] Harris, Erica M.S., Hutchison, Linda J., Christensen, George A., *Local Guide for Using* LaTeX *at the ISU Computation Center.* Iowa State University Computation Center Document No. 123., Ames, Ia., 1990.