An Introduction to LaTeX
Part I: Getting Starated

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LaTeX Part I

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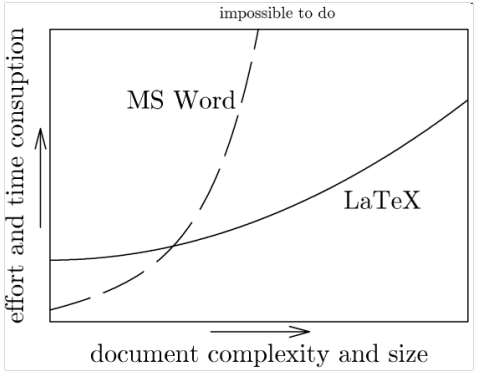
What is TeX, What is LaTeX and What is BiBTeX?

- TeX is a computer program for typesetting documents, created by D. E. Knuth.
- It converts a suitably prepared file into a .dvi, .ps, or .pdf file.
- Many publishers use TeX to typeset books and journals.
- LaTeX is an extension of TeX that consists of macro packages to make TeX easier to use (it is like assembly language versus C+).
- BiBTeX is a program associated with LaTeX that automatically creates, formats, and sorts your references.

LaTeX versus Word Processors

- LaTeX is a typesetting system (not a word processor).
- It is most suited to producing scientific and mathematical documents of high typeset quality.
- It is easy to include math formulas and equations.
- The source file format is not bounded to a particular OS or platform.
- LaTeX implementations exist for all platforms (DOS, Windows, Unix, Linux, ...)
- Latex is free.
- LaTeX is the de facto standard for scientific publishing, and probably not what you would use to write simple letters or memos.
- There are very few bugs.
- It is good for very large documents.

LaTeX versus Word Processors



Advantages of LaTeX over Word Processors

- Professionally crafted layouts are available.
- Typesetting of mathematical formulas and equations is supported in a convenient way.
- Only need to learn a few simple commands to specify the logical structure of a document.
- Complex structures such as footnotes, references, table of contents, and bibliographies can be generated easily.
- For many typographical tasks that are not directly supported by basic LaTeX, there are many free add-on packages.
- LaTeX is highly portable and there is a huge support group and many on-line resources (I would encourage you to form your own support group).
- If you can't figure out how to do something, Google-it.

Example Illustrating the Power of LaTeX with Equations

An Equation in Word

$$H_c(i,j) = \frac{\sum_{k\in\{O,N,U\}} I_c^k(i,j)W(Y_c^k(i,j))}{\sum_{k\in\{O,N,U\}} W(Y_c^k(i,j))}, \text{ for } c \in \{R,G,B\},$$

The Same Equation Reset Using LaTeX

$$H_c(i,j) = \frac{\sum_{k\in\{O,N,U\}} I_c^k(i,j)W(Y_c^k(i,j))}{\sum_{k\in\{O,N,U\}} W(Y_c^k(i,j))}, \text{ for } c \in \{R,G,B\}$$

Example Illustrating the Beauty of LaTeX Versus Word

It is convenient to use the matrix-vector representation as

$$\mathrm{y} = DHW\mathrm{x} + \eta, \tag{6}$$

where y and η represent the lexicographically ordered LR image and the additive noise of size M^2, respectively. x represents the HR image of size N^2. H and D denote $M^2 \times M^2$ matrix representing the PSF and $N^2 \times M^2$ matrix of decimation processes, respectively, and W the warping operator.

For solving (6), the regularized image restoration algorithm is used to estimate x , which satisfies the following optimization problem

$$\hat{\mathrm{x}} = \arg\min_{\mathrm{x}} f(\mathrm{x}), \tag{7}$$

where

$$f(\mathrm{x}) = \left\|y - DHW\mathrm{x}\right\|_2^2 + \lambda \left\|C\mathrm{x}\right\|_2^2, \tag{8}$$

where C represents the regularization operator. In (9), $\left\|C\mathrm{x}\right\|_2^2$ plays a role of the stabilizing function whose minimization suppresses high frequency components due to the noise amplification. λ represents the regularization parameter that controls the fidelity of the given data and the smoothness of the restored image.

It is convenient to use the matrix-vector representation as

$$y = DHWx + \eta \tag{6}$$

where y and η represent the lexicographically ordered LR image and the additive noise of size M^2, respectively, and x represents the HR image of size N^2. H and D denote $M^2 \times M^2$ matrix representing the PSF and $N^2 \times M^2$ matrix of decimation processes, respectively, and W the warping operator.

For solving (6), the regularized image restoration algorithm is used to estimate x, which satisfies the following optimization problem

$$\hat{x} = \arg\min_{x} f(x) \tag{7}$$

where

$$f(x) = \|y - DHWx\|_2^2 + \lambda \|Cx\|_2^2 \tag{8}$$

where C represents the regularization operator. In (9), $\|Cx\|_2^2$ plays a role of the stabilizing function whose minimization suppresses high frequency components due to the noise amplification. λ represents the regularization parameter that controls the fidelity of the given data and the smoothness of the restored image.

Disadvantages of LaTeX over WYSIWYG

- What you see is not what you get.
  - Is this really a disadvantage?
  - Why are you thinking about layout instead of content?
- The design of a whole new layout is difficult and takes a lot of time.
  - Here is where Templates come into play and do most everything for you.
- Warning! - LaTeX can become addicting.

TeXShowcase from TUG (TeX Users Group)

Take a look at the following link

`http://www.tug.org/texshowcase/`

to see some of the impressive things that you can do with TeX.

Here is an example for the TeX Showcase showing the creation of a
Computer Science Cheat Sheet
An example of the graphics that can be done using XY-pic

Another Example from the TeXShowcase

$$1/3 = 0.33333333333333333333333333333333\ldots$$

$$\sqrt{2} = 1.41421356237309504880168872420969\ldots$$

$$e = 2.71828182845904523536028747135266\ldots$$

$$\pi = 3.14159265358979323846264338327950\ldots$$

Getting Started - What you Need to Begin

- A program that will process your LaTeX commands and produce an output file for printing or viewing.
  1. The one that I use is MiKTeX.
  2. Another is EmTex for the Mac OS X platform.
- Editor
  1. WinEdt: This is the one I use, and find it to be very good.
  2. There is a free editor/viewer for the MAC OS called TeXShop.
  3. Texmaker (free): includes unicode support, spell checking, auto-completion, code folding and a built-in pdf viewer with synctex support and continuous view mode.
- MiKTeX and WinEdt are nicely integrated.

MiKTeX

please support the project:
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Welcome to the MiKTeX project page!

New here? Learn more about MiKTeX...

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Recent News

- MiKTeX on Windows 8 (*Thu, 15 Sep 2011 16:33:00 +0200*)
- LuaTeX 0.70.0 (*Wed, 11 May 2011 07:06:00 +0200*)
- Yap 2.4 render method (*Wed, 16 Feb 2011 17:13:00 +0200*)
- ConTeXt (*Sat, 16 Oct 2010 11:31:00 +0200*)
- MiKTeX 2.9 Beta is here (*Thu, 26 Aug 2010 15:43:00 +0200*)
- More...

MiKTeX Releases [compare]

2.9 [status] [download] [issues]
xetex 0.9997.4, pdftex 1.40.11, luatex 0.60.2, mpost 1.211
2.8 [status] [download] [issues]
xetex 0.9995.1, pdftex 1.40.10, mpost 1.005

MiKTeX Package Repository [status]

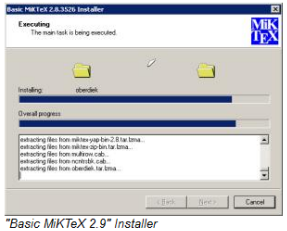
Version: 4317
Date: 2011-10-27
Packages: 2261
Recent Updates: ghab gauss crbox xepersian tram todonotes tikz-cd thuthesis suftesi pst-slpe pst-plot pst-func nicetext musixtex-fonts musixtex morehype csquotes bidi storebox thumbs

MiKTeX

Installing a basic MiKTeX system

To install a basic MiKTeX system, download and run the "Basic MiKTeX" installer. MiKTeX has the ability to install missing packages automatically, i.e., this installer is suitable for computers connected to the Internet.

"Basic MiKTeX 2.9" Installer Size: 163.89 MB	Download from: ftp.yz.yamagata-u.ac.jp (Japan)
"Basic MiKTeX 2.9 64-bit" Installer* (experimental) Size: 159.51 MB	Download from: ftp.yz.yamagata-u.ac.jp (Japan)


"Basic MiKTeX 2.9" Installer

*MiKTeX 2.9 64-bit requires a 64-bit Windows system.

When you have installed MiKTeX 2.9, it is recommended that you run the update wizard in order to get the latest updates.

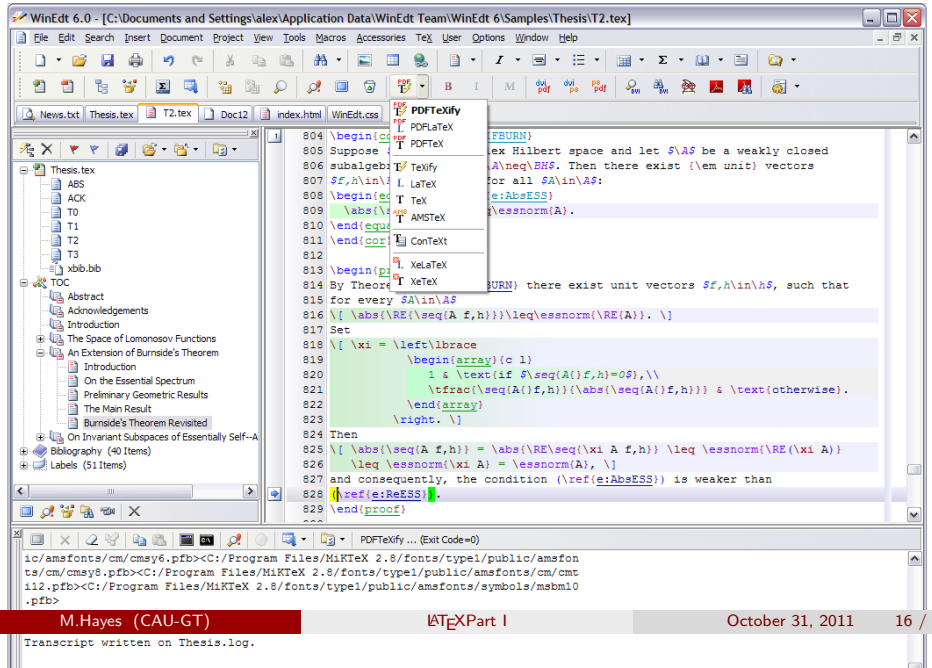
Installing the complete MiKTeX system

You use the MiKTeX Net Installer to download all MiKTeX packages and install a complete MiKTeX system. See the section Installing MiKTeX in the MiKTeX manual, for more information.

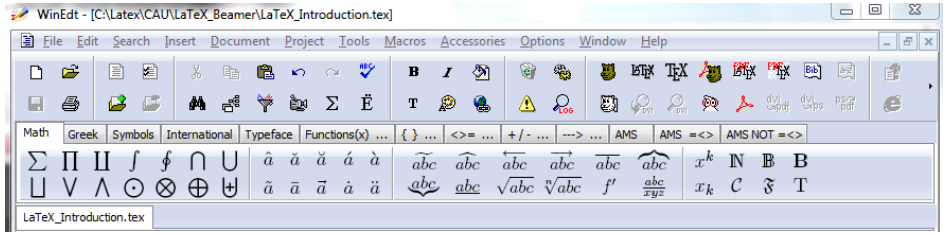
MiKTeX 2.9 Net Installer Size: 7.01 MB	Download
MiKTeX 2.9 64-bit Net Installer* (experimental) Size: 9.27 MB	Download

*MiKTeX 2.9 64-bit requires a 64-bit Windows system

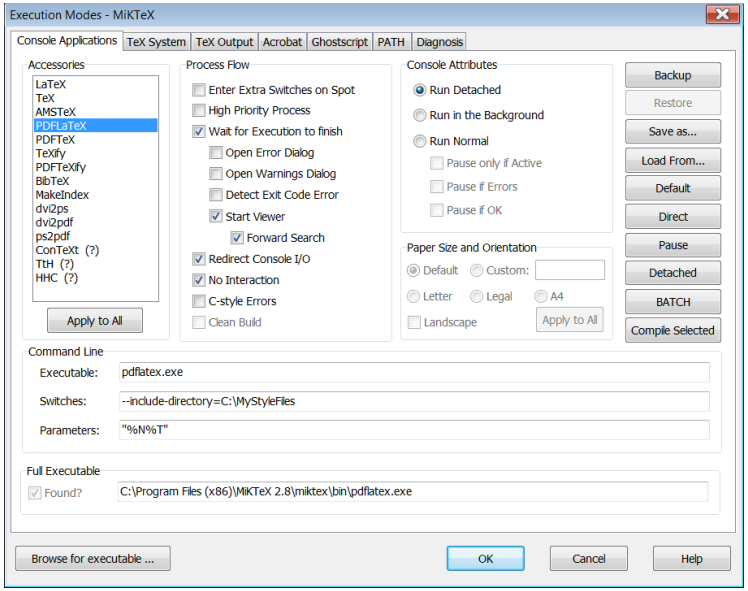
WinEdt: Nicely Integrated with TeX, LaTeX, and PDFLaTeX



WinEdt Toolbar



Setting Up WinEdt



Test Your Installation

LaTeX Input

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

\begin{document}

Some normal text.

\begin{equation}
    \sqrt{\pi} = 1.77245385\ldots
    \end{equation}

\end{document}
```

PDF Output

Some normal text.

$$\sqrt{\pi} = 1.77245385\ldots \quad (1)$$

Special Reserved Characters in LaTeX

- The following symbols are reserved characters that either have a special meaning under LaTeX or are unavailable in all the fonts.

```
# $ % & _ { } ~ \ and ^
```

- If you enter them directly in your text, they will normally not print, and they may make LaTeX do things you did not intend.
- All but the last three of these characters can be used in your document by adding a prefix backslash, such as \# for the number sign:

$ % & _ { } ~

Special Characters (continued)

- The backslash character \ cannot be entered by adding another backslash in front of it because \\ is reserved to indicate a line break.
- You may use `\textbackslash{}` or `\textblackslash\` to create \ and in math mode you can use `\backslash`.
- The commands `\~` and `\^` produce a tilde and a hat, respectively, over the next character. For example,
  - `\~n` gives ñ and
  - `\^o` gives ô.

  To produce the character ~ and ^ use `\~{}` or a `\^{}`, respectively, which puts a tilde or a hat above an empty space.
- To insert text that contains several particular symbols (such as URLs), you may use the `\verb` command (to be discussed later), such as

  `verb+http://www.ac.kr/~mhhgtx/+`

Input File Structure

When LaTeX processes an input file, it expects it to follow a certain flow. Every input file must start with the documentclass command where you specify the type of document you intend to write:

```
\documentclass[...]{...}
```

Next, you can include global style commands.

```
\setlength{\parindent}{0pt}
\setlength{\parskip}{1ex plus 0.5ex minus 0.2ex}
```

You can also load packages that add new features to the LaTeX system as follows

```
\usepackage{...}
```

When the setup is finished, the body of the text begins with the command

```
\begin{document}
```

Then enter text and useful LaTeX commands, and end your document with:

```
\end{document}
```


The Document Class

- The Document Class command has the following format:

```
\documentclass[options]{class}
```

The class specifies what type of document you intend to write,
- Classes Include: article, letter, report, book, thesis, beamer, ...

The options allow you to specify what style files to use
- Options Include: a4paper, 11pt, 12pt, 10pt, twocolumn, landscape, ieee, ...

Global Style Commands

There is infinite flexibility in modifying the layout/style of your document, such as

- Line spacing

```
\linespread{factor}
```

- Paragraph formatting

```
\setlength{\parindent}{0pt}
\setlength{\parskip}{1ex plus 0.5ex minus 0.2ex}
```

Packages

- To load other packages you use the `\usepackage{\ldots }` command,

```
\usepackage[options]{package name}
```

There are many useful packages that all you to do just about anything you can imagine. Some of these include:

- `amsmath` and `amssymb`: Highly recommended for all documents.
- `mathtools`: To enhance the appearance of mathematics.
- `graphicx`: Required for importing graphics (.jpg, .png, .pdf, .eps)
- `subfigure`: For easily making subfigures.
- `fancybox`: Helps you create some fancy framed, shadowed, and rotated boxes.
- `fancyhdr`: For easy definition of footers and headers
- `colortbl`: A package that allows you to put colored panels behind specific columns in tables
- `ifthen`: Useful package for conditional inclusion/exclusion of text.
- `geometry`: Provides a flexible interface to page dimensions.
- `babel`: a language-specific package to take care of hyphenations.

Defining Your Own Special Little Things

- You may wish to insert a lot of your own special definitions and formatting instructions, and a nice way to do this is with the `\input` command:

```
\input{filename}
```

- The `\input` command inserts the contents of another file, named filename.tex. Note that the .tex extension is omitted.
- For all practical purposes, `\input` is no more than a simple, automated cut-and-paste of the source code in filename.tex.
- In my LaTeX files, I insert two files,

```
\input{symbols}
\input{myformat}
```


An Except from my symbols.tex File

```
%-----------------------------------------------
% BOXED EQUATION - No Number
%
\def\boxeqno#1{
        \[ \fbox{
        \rule[-0.2in]{0in}{0.1in}
        ${\displaystyle #1 }$
        \rule[0.2in]{0in}{0.1in} } \] }
%-----------------------------------------------
% SQUARE BOX AT END OF PROOF
%
\def\qed {\hfill $\rule{0.5em}{0.5em} $}
%-----------------------------------------------
% COMPLEX EXPONENTIAL
%
%       H(\om )
%
\def\om {e^{j\omega }}
%-----------------------------------------------
% Complement of a set
%
\newcommand{\comp}[1]{#1 ^c}
%\newcommand{\comp}[1]{\bar #1}   %Commented out
%
```


Example

```
\boxeqno{
    X(\om ) = \sum _{n=-\infty} ^{\infty} x(n) e^{-jn\omega}
    }
```

$$X(e^{j\omega}) = \sum_{n=-\infty}^{\infty} x(n)e^{-jn\omega}$$

Examples of Commands in myformat.tex

```
\newfont{\bsf}{cmssbx10}
\newfont{\twbsf}{cmssbx10 scaled \magstep1}
\definecolor{lepblue}{rgb}{0.75,0.25,0.0}
\newcommand{\bitblu}[1]{\textcolor{lepblue}{\boldmath\bfseries\textit{#1}}}
```

This is the normal font, but if I switch to `\bsf` **it looks like this.** A good font for the header on a problem set is `\twbsf` which looks like this:

Problem Set #8

A nice look for a section label in a textbook can be created using `\bitblu`, which is a nice burnt orange color:

4.1 Introduction to the DTFT

Example: My Standard "Basic" Setup

```
\documentclass[a4paper]{article}
\usepackage{fancybox,arydshln,subfigure}
\usepackage{graphicx}
\usepackage{ifthen}
\usepackage[top=1in, bottom=1in, left=1in, right=1in]{geometry}
\renewcommand{\floatpagefraction}{0.2}
\renewcommand{\textfraction}{0.0}
\renewcommand{\floatsep}{0.0in}
\setlength{\unitlength}{0.1in}
\input{symbols}
\input{myformat}
\newcounter{ctr}
\makeindex
```


Body of Text

The format of the main body of the LaTeX file is simple.

- Begin with `begin{document}`
- End with `end{document}`
- Put your text, equations, figures, and tables in-between.

```
\begin{document}
Here is my beautifully typeset document with some \textit{italics}, some
text in \textbf{bold font } and even some \underline{underlining}.
I even have a simple equation:
    \[ e = mc^2 \]
\end{document}
```

Here is my beautifully typeset document with some *italics*, some text in **bold font**, and even some underlining. I even have a simple equation:

$$e = mc^2$$

Font Size

You can change the size of a font with a single command, which stays in effect until you change it.

\tiny
\scriptsize
\footnotesize
\small
\normalsize
\large
\Large
\LARGE
\huge
\Huge

Simple LaTeX Rules

- A new paragraph is created with a blank line. A single <CR> is ignored.
  - I like to use <CR>s to break my text into separate lines for easy editing/deleting.
- The general form of a LaTeX command is

  `\commandname[option1,option2,...]{argument1}{argument2}...`
- Two examples of commands are
  - `\emph{Italics}` to produce *Italics* and
  - `\textbf{Bold Face}` to produce **Bold Face** text.
- All text in a line following a % is treated as a comment.

Numbered Lists Using Enumerate

- The enumerate command generates numbered lists,

```
\begin{enumerate}
    \item First item in my list
    \item Second and last item in my list
    \end{enumerate}
```

- You may change the appearance of the enumerator. The simplest way is to use the enumerate package that allows you to chose an enumerator.

```
\usepackage{enumerate}
...
\begin{enumerate}[I]%Capital roman numbers.
    \item
    \end{enumerate}
\begin{enumerate}[(a)]%Small letters within parentheses.
    \item
    \end{enumerate}
```


Lists Using Itemize

- The itemize list generated bulleted lists

```
\begin{itemize}
    \item First item in my list
    \item Second and last item in my list
    \end{itemize}
```

- Itemization is probably the mostly used list in LaTeX.
- It provides for up to four levels, and the bullets may be changed for each level using the following command:

```
\renewcommand{\labelitemi}{$\bullet$}
\renewcommand{\labelitemii}{$\cdot$}
\renewcommand{\labelitemiii}{$\diamond$}
\renewcommand{\labelitemiv}{$\ast$}
```


Lists Using List

```
%define "Lcount" as a counter
   \newcounter{Lcount}
%set the "default" label to print counter as a Roman numeral
   \begin{list}{Item-\Roman{Lcount}}
%The the List command to use this counter
   {\usecounter{Lcount}
%Set the leftmargin equal to one inch and begin the list
   \setlength{\leftmargin}{1in}}
   \item This is the first item
   \item And this is the second item
   \end{list}
```

Item-I This is the first item

Item-II And this is the second item

LaTeX Document Structure

- At the beginning of most documents there will be information about the document itself, such as the title and date, and also information about the authors, such as name, address, email etc.
- All of this information is collectively referred to as top matter.
- Here is an example:

```
\title{How to Structure a \LaTeX\ Document}
\author{M.H. Hayes \\
Graduate School of Advanced Imaging \\
Chung-Ang University \\
Seoul, South Korea \\
\texttt{mhh3@gatech.edu} \\
\texttt{http://cau.ac.kr/~mhhgtx/}}
\date{\today}
\maketitle
```

- Everything here should be self-explanatory.

The Abstract

- Most papers have an abstract, and there is a LaTeX command to generate an abstract. This command should appear after the top matter, but before the main sections of the paper.
- This command is available for document classes article and report.

```
\documentclass{article}
\begin{document}
\begin{abstract}
This is the abstract of my wonderful paper.
it.
\end{abstract}
...
\end{document}
```

- By default, LaTeX uses the word "Abstract" as a title, but is may be changed by adding the following line in the preamble:

```
\renewcommand{\abstractname}{New Title For my Abstract}
```


Sectioning Commands

- The commands for inserting sections are fairly intuitive.
- Some commands are appropriate only for certain document classes. A book, for example, has chapters but an article does not.
- Here are the sectioning commands

```
\section{Introduction}
This section's content ...

\section{Background}
This section's content...

\subsection{History}
This subsection's content...

\subsubsection{Twenty-First Centruy}
This subsubsection's content...
```


Table of Contents

- All numbered section titles are added automatically to the table of contents (if one is generated).
- Section headings may have very long titles or some special line-breaks or unusual fonts and these will appear in the TOC.
- LaTeX allows you to give an optional extra version of the heading text that is used in the TOC and any running heads.
- The optional alternative heading is placed in square brackets.

```
\section[Heading for TOC]{Section Heading}
```

Appendices

- The appendix command can be used to indicate that following sections or chapters are to be numbered as appendices.
- In the report or book classes use

```
\appendix
\chapter{First Appendix}
```

- For the article class use

```
\appendix
\section{First Appendix}
```


Simple Text-Style Mathematics in LaTeX

- Mathematics inside a text line is formed by enclosing it between two $ symbols. For example,

```
\sqrt{\pi}
```

prints the square root of pi: $\sqrt{\pi}$.

- Greek characters and other special symbols are also printed by enclosing the proper text between two $ symbols.

```
Some letters of the Greek alphabet are $\gamma$, $\Gamma$,
$\sigma$ and $\Sigma$, and the four suits in a deck of
cards are $\clubsuit$, $\diamondsuit$, $\heartsuit$, and
$\spadesuit$.
```

Some letters of the Greek alphabet are γ, Γ, σ and Σ, and the four suits in a deck of cards are $\clubsuit$, $\diamondsuit$, $\heartsuit$, and $\spadesuit$.

A LaTeX Jumpstart for Equations

- Numbered equations are generated with \begin{equation} followed by the equation in LaTeX, and then ending with \end{equation}.

```
\begin{equation}
    x(n) = \frac{1}{\sqrt {2\pi}}
           \int _{-\pi} ^{\pi } X(e^{j\omega}) e^{jn\omega} d\omega
    \end{equation}
```

$$x(n) = \frac{1}{\sqrt{2\pi}} \int_{-\pi}^{\pi} X(e^{j\omega}) e^{jn\omega} d\omega \qquad (2)$$

- For equations without numbers, use a * in the equation command,

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

or use \[Equation \]

```
\[ a^2 + b^2 = c^2 \]
```


Develop a *Programming Style* for LaTeX

Formatting your Equations

```
This is an equation
\[
a^2 = b^2 + c^2
\]
and here is more text.
```

This is an equation

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

and here is more text.

```
This is an equation
    \[ a^2 = b^2 + c^2 \]
and here is more text.
```

This is an equation

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

and here is more text.

Develop a *Programming Style* for LaTeX

Numbered Equations

```
This is an equation
\begin{equation}
    a^2 = b^2 + c^2
    \label{eq:mylabel}
    \end{equation}
and here is more text.
```

This is an equation

$$a^2 = b^2 + c^2 \tag{3}$$

and here is more text.

Next Time ···

4. More Mathematic in LaTeX
   - Integrals and summations,
   - Equation arrays
   - Matrices
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