

# LaTeX Comprehensive Cheatsheet

Text Formatting, Math, Graphics, Document Features, and Advanced Layouts

January 11, 2026

# 1. DOCUMENT STRUCTURE

## Document Classes

### Basic Classes:

```
\documentclass{article} % Short papers
\documentclass{report} % Longer reports
\documentclass{book} % Books
\documentclass{letter} % Letters
\documentclass{beamer} % Presentations
\documentclass{extreport} % Extended report
\documentclass{memoir} % Extensive control
\documentclass{scrartcl} % KOMA-Script article
```

### With Options:

```
\documentclass[12pt]{article}
\documentclass[a4paper,twoside]{book}
\documentclass[8pt,landscape]{extreport}
\documentclass[oneside,openany]{report}
\documentclass[draft]{article} % Mark overfull
\documentclass[final]{article} % Production
\documentclass[fleqn]{article} % Flush left equations
% Options: 10pt/11pt/12pt, a4paper/letterpaper
% twoside/oneside, landscape/portrait
```

## Advanced Document Setup

```
\documentclass{article}
\usepackage[utf-8]{inputenc}
\usepackage[T1]{fontenc}
\usepackage[english]{babel}

\title{Document Title}
\author{Author Name \textbf{and} Co-author}
\date{\today}
\thanks{Funding}

% Draft mode watermark
\usepackage[draftwatermark]
\SetWatermarkText{DRAFT}
\SetWatermarkScale{3}

\begin{document}

\maketitle
\tableofcontents

\end{document}
```

## Section Hierarchy & Variants

```
\section{Main Section}
\subsection{Subsection}
\subsubsection{Sub-subsection}
\paragraph{Paragraph}
\subparagraph{Sub-paragraph}

% Unnumbered versions
\section{Unnumbered Section}
\subsection*{Unnumbered Subsection}

% Modify numbering depth
\setcounter{secnumdepth}{2}
\setcounter{tocdepth}{2}

% Chapter (book/report only)
\chapter{Chapter Title}
```

```
\chapter*{Unnumbered Chapter}
```

```
% Part divisions
\part{Part Title}
\part*{Unnumbered Part}

% Appendix
\appendix
\chapter{Appendix A}
\chapter{Appendix B}
```

```
\textsf{\textbf{Slant+Bold}}
```

```
% Tiny combinations
\fontsize{8pt}{10pt}\selectfont 8pt text
\begin{Large}
Large text block
\end{Large}
```

## Font Sizes

```
% Absolute sizes
\tiny tiny text
\scriptsize scriptsize
\footnotesize footnotesize
\small small
\normalsize normal
\large large
\Large Large
\LARGE LARGE
\huge huge
\Huge Huge
```

```
% Relative sizes
\smaller One size smaller
\larger One size larger
\fontsize{16pt}{18pt}\selectfont Custom size
```

```
% Environment syntax
\begin{tiny}
Tiny text block
\end{tiny}
```

```
% Local size change
\scalebox{0.8}{Scaled 80\%}
\resizebox{5cm}{!}{Fixed width}
```

## Colors and Highlighting

```
% Requires \usepackage{xcolor}
% Foreground color
\textcolor{red}{Red text}
\textcolor{blue}{Blue text}
\textcolor{green}{Green text}
```

```
% Background color
\colorbox{yellow}{Yellow background}
\fcolorbox{red}{white}{Red frame}
\hl{yellow}{Highlighted text} % ulem pkg
```

```
% Color from here
\color{red} Text and everything after
\textcolor{blue}{Only this text}
```

```
% Define custom colors
\definecolor{myblue}{rgb}{0, 1, 0.2, 0.7}
\definecolor{mygreen}{RGB}{0, 128, 0}
\definecolor{mygray}{gray}{0.5}
\definecolor{mycolor}{cmyk}{0.3, 0.1, 0, 0.2}
\textcolor{myblue}{Custom color}
```

```
% Predefined colors
% black, white, red, green, blue, cyan,
% magenta, yellow, brown, darkgray, etc.
```

```
% Transparent color
\usepackage{transparent}
\transparent{0.5} Semi-transparent
```

## Advanced Font Control

```
% Font families
\textrm{Roman font} % Serif
\textsf{Sans-serif font} % Sans
\texttt{Typewriter}
```

```
% Boldface variants
\textbf{Bold}
\textmd{Medium weight}
\bfseries % Bold from here
\mdseries % Medium from here
```

```
% Font switching (declarations)
\rmfamily Roman font
\sffamily Sans-serif
\sfamily Monospace
\itshape Italic from here
```

```
% Series and shape
\textbf{\textit{Bold+Italic}}
\textit{\bfseries Bold+Italic}
```

## Text Alignment & Justification

```
% Environment syntax
\begin{center}
Centered text
\end{center}

\begin{flushleft}
Left-aligned text
\end{flushleft}

\begin{flushright}
Right-aligned text
\end{flushright}

% Declaration syntax
\centering % Center following
\raggedright % Ragged right
\raggedleft % Ragged left
\justifying % Justified (default)

% Inline center
{\centering This paragraph is centered.\par}

% Microtype for better justification
\usepackage{microtype}

% Right-to-left text
\usepackage{bidi}
\textRL{Arabic or Hebrew}
```

## Text Effects and Styling

```
% Lettrine (drop caps)
\usepackage{lettrine}
\lettrine{l}{his} is the first word...

% Small caps with proper sizing
\scshape Small capitals

% All caps
\MakeUppercase{uppercase text}
\MakeTextUppercase{text}

% All lowercase
\MakeLowercase{TEXT}

% Tracking (letter spacing)
\usepackage{microtype}
\textls[100]{Tracked text}
\textls*[150]{Tracked text}

% Shadow text
\usepackage{shadow}
\shadowtext{Shadow effect}

% Outline/hollow text
\usepackage{contour}
\contour{black}{Outline Text}

% Wavy text baseline
\usepackage{tikz}
\tikz[baseline=(word.base)]
\node[wave,inner xsep=0pt] (word) {Wavy};
```

## Spacing and Line Breaks

```
% Line breaks
\\ % Line break
\\[6pt] % Line break + space
\newline % New line
\linebreak % Break without penalty
\linebreak[4] % Force break (0-4)
```

```
% Horizontal space
\hspace{2cm} % Horizontal space
\hspace*(2cm) % Non-breakable
\quad % Width of letter 'm'
\quad*2 % 2 quads
\thinspace % Thin space (,)
\hphantom{ } % Non-breaking space
```

```
% Stretchy space
\hfill % Fill remaining
\dotfill % Dots filling
\hrulefill % Rule filling
```

```
% Vertical space
\vspace{1cm} % Vertical space
\vspace*[1cm] % Non-breakable
\smallskip, \medskip, \bigskip
```

```
% Line spacing
\usepackage{setspace}
\singlespacing % 1.0 spacing
\onehalfspacing % 1.5 spacing
\doublespacing % 2.0 spacing
\setstretch{1.3} % Custom
```

```
% Paragraph spacing
\setlength{\parindent}{1.5em}
\setlength{\parskip}{6pt}
\usepackage{parskip} % Auto skip between
```

```
% Quotes (typographic)
‘Double quotes’ % Correct
‘Single quote’ % Single
“Double quotes” % Using babel
```

```
% Dashes and hyphens
hyphen-like % Hyphen (-)
en---dash % En-dash (--)
em---dash % Em-dash (---)
```

```
% Special symbols
\usepackage{famssymb}
\checkmark, \maltese, \yen, \euro
\ddiameter, \ohm, \degree Celsius
```

```
% Degrees and angles
30\textdegree % Degree symbol
30\textdegree{} (if UTF-8) % Direct Unicode
\usepackage{gensymb}
90\degree % Using gensymb
```

```
% Micro and other
\usepackage{textcomp}
\textmu, \texttrademark, \textregistered
```

## 3. PARAGRAPHS AND PAGES

### Paragraph Control

```
% Indentation control
\noindent This paragraph has no indent
\indent This paragraph forced indent
\setlength{\parindent}{1.5em}
\setlength{\parindent}{0pt} % No indent
```

```
% Hanging indent (first line out)
\usepackage{hanging}
\begin{hangparas}{1.5em}
Paragraph with hanging indent
\end{hangparas}
```

```
% Paragraph spacing
\setlength{\parskip}{1em}
\setlength{\parskip}{Opt plus 1pt}
\usepackage{parskip}
```

```
% Text justification
\raggedright % Ragged right
\raggedleft % Ragged left
\justifying % Justified (default)
```

```
% Widow/orphan control
\widowpenalty=10000
\clubpenalty=10000
\brokenpenalty=10000
```

```
% Page breaks
\newpage % New page
\clearpage % Clear floats then new
\pagebreak % Soft break
\clearpage % Page + floats
```

```
% Keep content together
\begin{samepage}
Content stays on same page
\end{samepage}
```

### Advanced Page Formatting

```
% Margins (geometry package)
\usepackage[margin=1in]{geometry}
\usepackage[top=1in, bottom=1in,
left=1.5in, right=1in]{geometry}
\usepackage[margin=1in,
includehead, includefoot]{geometry}
```

```
% Page size variants
\usepackage[a4paper]{geometry}
\usepackage[letterpaper]{geometry}
\usepackage[landscape]{geometry}
\usepackage[b5paper]{geometry}
```

```
% Conditional margins
\usepackage[top=1in,
twoside,
inner=1.5in, outer=1in]{geometry}
```

```
% Header and Footer
\usepackage{fancyhdr}
\fancystyle{fancy}
\fancyhead[L]{Left}
\fancyhead[C]{Center}
\fancyhead[R]{Right}
\fancyfoot[L]{Left}
\fancyfoot[C]{\thepage}
\fancyfoot[R]{Right}
```

```
% Page style variants
\pagestyle{plain} % Page number only
```

```
%pagestyle{headings} % Section titles
%pagestyle{empty} % No headers/footers

% Current page number
\thepage
\pagenumbering{roman} % i, ii, iii
\pagenumbering{arabic} % 1, 2, 3
\pagenumbering{alph} % a, b, c

% Multiple columns
\usepackage{multicol}

\begin{multicols}{2}
Two-column text...
\end{multicols}

% Three columns (no balance)
\begin{multicols*}{3}
Three columns
\end{multicols*}

% Column break
\columnbreak

% Rules between columns
\setlength{\columnsep}{1pt}
\setlength{\columnsep}{1.5cm}

% Document-wide twocolumn
\documentclass[twocolumn]{article}
\onecolumn % Switch to one
\twocolumn % Switch to two

% Parallel text (multicol alternative)
\usepackage{paracol}
\begin{paracol}{2}
Left column text
\switchcolumn
Right column text
\end{paracol}

% Fixed-width columns
\usepackage{tabularx}
\begin{tabularx}{\textwidth}{Xp{3cm}X}
\end{tabularx}
```

## 4. MATHEMATICAL EXPRESSIONS

### Inline Math Modes

```
% Dollar sign syntax (traditional)
\$x + y = z\$
```

```
% Modern syntax \(
\langle x + y = z \rangle
```

```
% Inline math styling
\$displaystyle \frac{a}{b}\$ % Large style
\$textstyle \frac{a}{b}\$ % Text style
\$scriptstyle x\$ % Smaller
```

```
% Fractions
\$frac{a}{b}\$ % Standard
\$tfrac{a}{b}\$ % Text-style
\$dfrac{a}{b}\$ % Display-style
\$cfrac{a}{b}\$ % Continued frac

% Superscript/Subscript
\$x^2 + y_{1\$}
\$x^{2n}\$ % Multi-char exponent
\$x_{(i,j)}\$ % Multi-char subscript
\$x_1^2\$ % Both

% Square root
\$sqrt{x}\$, \$sqrt[3]{x}\$, \$sqrt[n]{x^m}\$
```

### Display Math Environments

```
% Numbered equation
\begin{equation}
E = mc^2
\label{eq:einstein}
\end{equation}

% Unnumbered equation
\begin{equation*}
E = mc^2
\end{equation*}

% Multiple equations (numbered)
\begin{align}
x &= 1 \\
y &= 2
\end{align}

% Multiple equations (unnumbered)
\begin{align*}
x &= 1 \\
y &= 2
\end{align*}
```

```
% Split equations
\begin{equation}
\begin{aligned}
x &= 1 + 2 \\
&= 3
\end{aligned}
\end{equation}
```

```
% Multiline (long equations)
\begin{multiline}
f(x) = ax + b + \\
cx + d
\end{multiline}
```

```
% Gather (centered, no alignment)
\begin{gather}
x = 1 \\
y = 2
\end{gather}
```

```
% Fleqn (flush left equations)
\documentclass[fleqn]{article}
```

```
% Bold math
\$mathbf{A}\$, \$mathbf{x}\$
\$boldsymbol{x}\$ % Bold with symbols
\$bm{x}\$ % Using bm package
```

```
% Blackboard bold
\$mathbb{R}\$, \$mathbb{N}\$, \$mathbb{Z}\$
```

```
% Calligraphic
\$mathcal{L}\$, \$mathcal{F}\$
```

```
% Fraktur (German)
\$mathfrak{G}\$, \$mathfrak{A}\$
```

```
% Roman (upright)
\$mathrm{d}\$
```

```
% Italic (default)
\$mathit{xyz}\$
```

```
% Sans-serif
\$mathsf{A}\$
```

```
% Monospace
\$mathtt{code}\$
```

```
% Color in math
\$textcolor{red}{x} + \textcolor{blue}{y}\$
```

### Operators and Relations

```
% Basic operators
\$a \pm b\$, \$a \mp b\$, \$a \times b\$, \$a \div b\$
\$a \cdotdot b\$, \$\frac{a}{b}\$, \$a^{-b}\$, \$sqrt[n]{a}\$
```

```
% Relations
\$a = b\$, \$a \neq b\$, \$a < b\$, \$a > b\$
\$a \leq b\$, \$a \geq b\$, \$a \equiv b\$
\$a \approx b\$, \$a \sim b\$, \$a \propto b\$
```

```
% Set notation
\$a \in A\$, \$a \notin A\$, \$A \subset B\$
\$A \subsetset B\$, \$A \cap B\$, \$A \cup B\$
\$A \setminus B\$, \$A \times B\$, \$emptyset\$
\$mathbb{R}\$, \$mathbb{N}\$, \$mathbb{C}\$
```

```
% Logic
\$forall x\$, \$exists x\$, \$neg p\$, \$p \land q\$, \$p \lor q\$
\$rightarrow\$, \$Leftarrow\$, \$Leftrightarrow\$
```

```
% Calculus
\$frac{dy}{dx}\$, \$partial_x f\$, \$nabla f\$
\$int f(x) dx\$, \$int f ds\$, \$oint f ds\$
\$sum_{i=1}^n\$, \$prod_{i=1}^n\$
\$lim_{x \rightarrow infinity}\$
```

### Matrix and Advanced Structures

```
% Matrix environments
\begin{pmatrix}
a & b \\
c & d
\end{pmatrix} % Parentheses ()
\begin{bmatrix}
\end{bmatrix} % Brackets []
\begin{vmatrix}
\end{vmatrix} % Vertical bars ||
\begin{Vmatrix}
\end{Vmatrix} % Double bars |||
\begin{matrix}
\end{matrix} % No brackets
```

```
% Determinant shortcut
\det(A) = \begin{vmatrix}
a & b \\
c & d
\end{vmatrix}
```

### Advanced Math Formatting

```
%\end{vmatrix}

% Cases/Piecewise
f(x) = \begin{cases} x < 0 \\ 1 & x \geq 0 \end{cases}
\end{cases}

% Binomial coefficient
\$ \binom{n}{k} \$, \$ \dbinom{n}{k} \$, \$ \tbinom{n}{k} \$

% Underbrace/Overbrace
\$ \underbrace{a+b}_{(2)} \$, \$ \overbrace{a+b}^{(2)} \$

% Delimiters
\left( \right), \left[ \right], \left\{ \right\}, \left\langle \right\rangle
\left| \right|, \left| \right| \left| \right|, \left\langle \right. \left. \right\rangle
\big(, \Big(, \bigg(, \Bigg( % Manual sizing

% Multi-line with alignment
\begin{aligned}
x &= 1 \\
y &= 2
\end{aligned}

% Standard enumerate
\begin{enumerate}
\item Nested
\end{enumerate}
\end{enumerate}

% Parentheses numbering
\begin{enumerate}[label=(a)]
\item First (a)
\item Second (b)
\end{enumerate}
\end{enumerate}

% Using enumitem package
\usepackage{enumitem}

% Roman numerals
\begin{enumerate}[label=\text{\textnormal{\textit{roman}}}.]
\item Roman numerals
\end{enumerate}
\end{enumerate}

% Custom formats
\begin{enumerate}[label=\text{\textnormal{\textit{arabic}}}.]
\item First
\end{enumerate}
\end{enumerate}

% Resumed numbering
\begin{enumerate}
\item First
\item Second
\end{enumerate}
\begin{enumerate}[resume]
\item Third (continued)
\end{enumerate}
\end{enumerate}

% Nested depth control
\begin{enumerate}[label=\text{\textnormal{\textit{Alph}}}\text{.}, ref=\text{\textnormal{\textit{Alph}}}\text{.}]
\item Item A
\end{enumerate}
\end{enumerate}

% Standard itemize
\begin{itemize}
\item First item
\item Second item
\begin{itemize}
\item Nested item
\end{itemize}
\end{itemize}
\end{itemize}

% Custom bullet markers
\begin{itemize}
\item[-] Dash bullet
\item[\star] Star bullet
\item[\rightarrow] Arrow bullet
\item[\textbullet] Standard bullet
\end{itemize}
\end{itemize}

% Using enumitem package
\usepackage{enumitem}
\begin{itemize}[label=\text{\textnormal{\textit{circ}}}]
\item Circle bullets
\end{itemize}
\end{itemize}

% Compact lists
\begin{itemize}[noitemsep]
\item Compact item
\item Compact item
\end{itemize}
\end{itemize}

% Custom label styles
\begin{itemize}[label=\text{\textnormal{\textit{textperiodcentered}}}]
\item Item with period center
\end{itemize}
\end{itemize}

% Standard tabular
\begin{tabular}{l|c|r}
& Standard &
\end{tabular}
\hline
Left & Center & Right \\
\hline
A & B & C \\
\hline
\end{tabular}

% Professional tables (booktabs)
\usepackage{booktabs}
\begin{tabular}{lcc}
\toprule
Header 1 & Header 2 & Header 3 \\
\midrule
Data & Data & Data \\
\bottomrule
\end{tabular}

% Column types
l - left aligned
c - center aligned
r - right aligned
p{width} - paragraph
m{width} - middle-aligned
b{width} - bottom-aligned
X - stretchy (tabularx)
S - siunitx aligned

% Multi-column (merge horizontal)
\multicolumn{2}{|c|}{Merged Cells}

% Multi-row (merge vertical)
\usepackage{multirow}
\multirow{2}{*}{Tall Cell}

% Table rotation
\usepackage{rotating}
\begin{sidewaystable}
\end{sidewaystable}
```

## 5. LISTS

### Unordered Lists

```
% Standard itemize
\begin{itemize}
\item First item
\item Second item
\begin{itemize}
\item Nested item
\end{itemize}
\end{itemize}
\end{itemize}

% Custom bullet markers
\begin{itemize}
\item[-] Dash bullet
\item[\star] Star bullet
\item[\rightarrow] Arrow bullet
\item[\textbullet] Standard bullet
\end{itemize}
\end{itemize}

% Using enumitem package
\usepackage{enumitem}
\begin{itemize}[label=\text{\textnormal{\textit{circ}}}]
\item Circle bullets
\end{itemize}
\end{itemize}

% Compact lists
\begin{itemize}[noitemsep]
\item Compact item
\item Compact item
\end{itemize}
\end{itemize}

% Custom label styles
\begin{itemize}[label=\text{\textnormal{\textit{textperiodcentered}}}]
\item Item with period center
\end{itemize}
\end{itemize}
```

### Ordered Lists

```
% Standard enumerate
\begin{enumerate}
\item First item
\item Second item
\end{enumerate}
```

### Description Lists

```
% Standard description
\begin{description}
\item[Term 1] Definition of term 1
\item[Term 2] Definition of term 2
\end{description}

% Using enumitem
\usepackage{enumitem}
\begin{description}[style=nextline]
\item[Term] Definition on next line
\end{description}

% Using enumitem with style
\begin{description}[style=multiline]
\item[Term] Definition
\end{description}

% Inline lists
\usepackage{paralist}
\begin{inparaenum}
\item Item one
\item Item two
\end{inparaenum}
```

## 6. TABLES EXTENDED

### Basic and Advanced Tables

```
% Headers
\rowcolor{gray}
\textbf{Header 1} & \textbf{Header 2} \\

% Footnotes in tables
\tablefootnote{Footnote text}

% Long tables (multi-page)
\usepackage{longtable}
\begin{longtable}{|l|c|l|}
\caption{Long Table} \\
\hline
...
\end{longtable}
```

```
% Line control
\hline % Horizontal line
\cline{2-3} % Partial line cols 2-3
\hhline{-|-|-} % Complex lines

% Cell formatting
\multicolumn{2}{c}{Center across 2}
\multirow{3}{*}{3 rows}

% Cell padding
\setlength{\tabcolsep}{10pt}
\renewcommand{\arraystretch}{1.5}
```

```
% Headers
\rowcolor{gray}
\textbf{Header 1} & \textbf{Header 2} \\

% Footnotes in tables
\tablefootnote{Footnote text}
```

```

\end{longtable}

% Fixed-width columns
\usepackage{tabularx}
\begin{tabularx}{\textwidth}{Xp{3cm}X}
\end{tabularx}

% Trim and clip
\includegraphics[trim=10 20 30 40,
                clip]{image.png}

% Flipped images
\scalebox{-1}[1]{\includegraphics{img}}


% Text and nodes
\node at (1,1) {Text};
\node[red] at (0,0) {};
\node[circle, draw] at (2,2) {B};

% Shapes
\draw (0,0) ellipse (2cm and 1cm);
\draw (0,0) -- (1,1) -- (2,0) -- (0,0);

% Arrow
\draw[->] (0,0) -- (2,2);
\draw[<->] (0,0) -- (2,2);

% Formats: PNG, JPG, PDF, EPS

% Floating table
\begin{table}[h]
\centering
\caption{Table Caption}
\label{tab:my_table}
\begin{tabular}{l|c|r}
\hline
Header 1 & Header 2 & Header 3 \\
\hline
Data 1 & Data 2 & Data 3 \\
\hline
\end{tabular}
\end{table}

% Reference table
See Table~\ref{tab:my_table}

% Placement options: h, t, b, p, !

% Landscape table
\usepackage{lscape}
\begin{landscape}
\begin{table}
...
\end{table}
\end{landscape}

% Subtables
\usepackage{subtable}
\begin{subtable}{0.45\textwidth}
\end{subtable}

% Subfigures
\usepackage{subcaption}
\begin{figure}[h]
\centering
\begin{subfigure}{0.45\textwidth}
\includegraphics[width=\textwidth]{fig1}
\caption{First figure}
\label{fig:first}
\end{subfigure}
\begin{subfigure}{0.45\textwidth}
\includegraphics[width=\textwidth]{fig2}
\caption{Second figure}
\label{fig:second}
\end{subfigure}
\caption{Main caption}
\label{fig:main}
\end{figure}

% Sideways figure (landscape)
\usepackage{rotating}
\begin{sidewaysfigure}
...
\end{sidewaysfigure}

```

## 7. FIGURES AND GRAPHICS

### Image Inclusion

```

% Basic inclusion
\includegraphics{image.png}

% With width
\includegraphics[width=5cm]{image.png}
\includegraphics[width=0.8\textwidth]{img}

% With height
\includegraphics[height=3cm]{image.png}

% Scaling
\includegraphics[scale=0.5]{image.png}
\includegraphics[scale=1.5]{image.png}

% Rotation
\includegraphics[angle=90]{image.png}
\includegraphics[angle=-45]{image.png}

% Aspect ratio
\includegraphics[width=5cm,
               keepaspectratio]{image.png}
\includegraphics[height=5cm,
               keepaspectratio]{image.png}

```

### Figure Environments

```

% Floating figure
\begin{figure}[h]
\centering
\includegraphics[width=0.6\textwidth]{img}
\caption{Figure Caption}
\label{fig:my_figure}
\end{figure}

% Reference
See Figure~\ref{fig:my_figure}
\autoref{fig:my_figure} % Auto-labeled

% Subfigures
\usepackage{subcaption}
\begin{figure}[h]
\centering
\begin{subfigure}{0.45\textwidth}
\includegraphics[width=\textwidth]{fig1}
\caption{First figure}
\label{fig:first}
\end{subfigure}
\begin{subfigure}{0.45\textwidth}
\includegraphics[width=\textwidth]{fig2}
\caption{Second figure}
\label{fig:second}
\end{subfigure}
\caption{Main caption}
\label{fig:main}
\end{figure}

% Sideways figure (landscape)
\usepackage{rotating}
\begin{sidewaysfigure}
...
\end{sidewaysfigure}

```

### TikZ Graphics

```

% Basic drawing
\usepackage{tikz}
\begin{tikzpicture}
% Circle
\draw (0,0) circle (1cm);

% Line
\draw (0,0) -- (2,2);

% Rectangle
\draw (0,0) rectangle (2,1);
\fill[blue] (0,0) rectangle (2,1);

% With options
\draw[red, thick] (0,0) -- (2,0);
\draw[blue, dashed] (0,0) -- (0,2);

% Fill/stroke
\fill[yellow] (0,0) circle (0.5);
\filldraw[black] (1,1) circle (0.3);

```

### PGFPlots Advanced

```

% Basic plot
\usepackage{pgfplots}
\begin{tikzpicture}
\begin{axis}[
 xlabel=X axis,
 ylabel=Y axis,
 title=Plot Title,
 legend pos=north west
]
\addplot[blue] {x^2};
\addplot[red] {sin(deg(x))};
\legend{$x^2$, $\sin(x)$}
\end{axis}
\end{tikzpicture}

% From data file
\addplot table {data.csv};
\addplot table[x=col1, y=col2] {data.csv};

% Parametric plot
\addplot[domain=0:2*pi] ({cos(x)}, {sin(x)});

% Error bars
\addplot[error bars/.cd,
         x dir=both, x explicit,
         y dir=both, y explicit
        ] table[x=X, y=Y, x error=XE,
                y error=YE] {data.csv};

% 3D plot
\begin{axis}[view={60}{30}]
\addplot3[surf] {x^2 + y^2};
\end{axis}

```

## 8. ADVANCED LAYOUTS AND BOXES

### Minipage Environment

```

% Basic minipage
\begin{minipage}{0.45\textwidth}
Content in fixed width column
\end{minipage}

% Side-by-side content
\begin{minipage}{0.45\textwidth}
Left column content
\end{minipage}

```

```

\hfill
\begin{minipage}{0.45\textwidth}
Right column content
\end{minipage}

% Vertical alignment options
[t] - top alignment
[c] - center alignment
[b] - bottom alignment
% Example:
\begin{minipage}[c]{0.45\textwidth}
Centered minipage
\end{minipage}

% Nested minipages
\begin{minipage}{\textwidth}
\begin{minipage}{0.3\textwidth}
Left
\end{minipage}
\begin{minipage}{0.3\textwidth}
Center
\end{minipage}
\begin{minipage}{0.3\textwidth}
Right
\end{minipage}
\end{minipage}

% Multiple columns with minipages
% (3-column layout)
\noindent\begin{minipage}{0.32\textwidth}
Column 1
\end{minipage}\hfill
\begin{minipage}{0.32\textwidth}
Column 2
\end{minipage}\hfill
\begin{minipage}{0.32\textwidth}
Column 3
\end{minipage}

% Minipage with rules
\begin{minipage}[t]{0.45\textwidth}
\rule{\textwidth}{1pt}
Content here
\rule{\textwidth}{1pt}
\end{minipage}

% Information box (4 minipages)
\noindent\begin{minipage}{0.48\textwidth}
\textrb{Box Title 1} \\
Info content
\end{minipage}\hfill
\begin{minipage}{0.48\textwidth}
\textrb{Box Title 2} \\
Info content
\end{minipage}

% Minipage with custom formatting
\begin{minipage}[b]{4cm}
\footnotesize
Small text in fixed width
minipage for notes
\end{minipage}

% Minipage with list
\begin{minipage}{\textwidth}
\begin{itemize}[label=\textbullet]
\item Item 1 \item Item 2
\end{itemize}
\end{minipage}

```

**Text Boxes and Framing**

```

% Simple frame
\usepackage{fancybox}
\fbox{Simple box}
\framebox{Box with custom width}

% Wrap figure left
\begin{wrapfigure}{l}{5cm}
\includegraphics[width=5cm]{image.png}
\caption{Image caption}
\end{wrapfigure}
Text wraps around image...

% Fancy boxes with shadows
\usepackage{shadow}
\shadowbox{Shadow effect box}

% Oval box
\ovalbox{Oval shaped box}
\doublebox[Double border box]

% Wrap figure right
\begin{wrapfigure}{r}{4cm}
\includegraphics[width=4cm]{image.png}
\caption{Right wrapped}
\end{wrapfigure}
Text flows around right side...

% Wrapped table
\begin{wraptable}{l}{4cm}
\centering
\begin{tabular}{|c|c|}
\hline
A & B \\
\hline
\end{tabular}
\caption{Wrapped table}
\end{wraptable}
Text wraps around table...

% Wrap with clearance
\begin{wrapfigure}{3}{4cm}
\includegraphics[width=4cm]{image.png}
\end{wrapfigure}
Short wrap for 3 lines only

% Suppress indentation after wrap
\begin{wrapfigure}{l}{3cm}
\includegraphics[width=3cm]{img}
\end{wrapfigure}
Text starts immediately...
\noindent continued text

% Multiple wrapped figures
\begin{wrapfigure}{l}{3cm}
\includegraphics[width=3cm]{img1}
\end{wrapfigure}
\begin{wrapfigure}{r}{3cm}
\includegraphics[width=3cm]{img2}
\end{wrapfigure}
Text between two wrapped images

% Wrap with colored background
\begin{wrapfigure}{l}{4cm}
\colorbox{lightgray}{%
\includegraphics[width=3.8cm]{image}}
\end{wrapfigure}
Text wraps around colored image

```

## Text Wrapping and Image Wrapping

```

% Text wrapping (wrapfig package)
\usepackage{wrapfig}

```

```

% Wrap figure left
\begin{wrapfigure}{l}{5cm}
\includegraphics[width=5cm]{image.png}
\caption{Image caption}
\end{wrapfigure}
Text wraps around image...

% Custom page format with fancyhdr
\usepackage{fancyhdr}
\pagestyle{fancy}
\fancyhead[R]{Page \thepage}
\fancyhead[L]{Chapter \thechapter}
\fancyfoot[C]{\thepage}

```

## 9. PAGE NUMBERING AND ADVANCED FORMATTING

### Page Numbering Styles

```

% Basic page numbering
\pagenumbering{arabic} % 1, 2, 3...
\pagenumbering{roman} % i, ii, iii...
\pagenumbering{Roman} % I, II, III...
\pagenumbering{alph} % a, b, c...
\pagenumbering{Alpha} % A, B, C...

```

```

% Reset page counter
\setcounter{page}{1}
\pagenumbering{arabic}

```

```
% Different styles per section
\pagestyle{headings} % Section names
\pagestyle{plain} % Number only
\pagestyle{empty} % No headers/footers

% Suppress page number on first page
\thispagestyle{empty}

% Custom page counter format
\renewcommand{\thepage}{\Roman{page}}

% Page number in corners
\fancyfoot[LE,RO]{\thepage} % Outer corners
\fancyfoot[LO,RE]{\thepage} % Inner corners

% Conditional page styling
% Front matter (roman) vs main (arabic)
\frontmatter % Uses roman numerals
\mainmatter % Uses arabic numerals
\backmatter % Uses roman numerals

% Page number relative to chapter
\renewcommand{\thepage}{(\thechapter-\arabic{page})}
```

## Advanced Horizontal Rules and Dividers

```
% Horizontal rules
\hrule % Full width line
\rule{\textwidth}{1pt} % Customizable

% Filled rules
\rule{2cm}{0.5pt} % Width x Height
{\color{red}\rule{\textwidth}{2pt}}
```

```
% Partial rules
\noindent\rule{0.5\textwidth}{1pt}
```

```
% Decorative dividers
\hrulefill % Fill space with line
\dotfill % Fill with dots
\hfill % Space
```

```
% Custom dividers
\begin{center}
* * *
\end{center}
```

```
% Line with text
\noindent\rule{0.4\textwidth}{1pt}
\hspace{0.1\textwidth}\centering Text
\hspace{0.1\textwidth}\rule{0.4\textwidth}{1pt}
```

```
% Colored rule
{\color{blue}\rule{\textwidth}{1pt}}
```

```
% Using TikZ for custom lines
\usepackage{tikz}
\tikz\draw[red,thick](0,0) -- (\textwidth,0);
```

```
% Multiple lines
\noindent
\rule{\textwidth}{0.5pt}\vrule[2pt]
\rule{\textwidth}{1pt}\vrule[2pt]
\rule{\textwidth}{0.5pt}
```

# 10. FOOTNOTES AND REFERENCES

## Footnotes and Endnotes

```
% Inline footnote
This is text\footnote{This is a footnote} here.

% Separate footnote text
This is text\footnotemark
\footnotetext{Footnote text}

% Custom marker
This is text\footnote[5]{Custom footnote}

% Endnote
\usepackage{endnotes}
This is text\endnote{Endnote text}
\theendnotes % Print at location

% Per-page footnotes
\usepackage[perpage]{footmisc}

% Multiple footnote anchors
\footnotemark
\addtocounter{footnote}{-1}
\footnotetext{Shared by two}

% Suppress footnote number
\footnotemark[0]
```

## Cross-References

```
% Create labels
\label{sec:introduction}
\label{fig:plot}
\label{tab:data}
\label{eq:einstein}

% Basic reference
\ref{sec:introduction} % Number only
\pager{sec:introduction} % Page number
\eqref{eq:einstein} % Numbered eqn

% With hyperref package
\usepackage{hyperref}
\hyperref[sec:intro]{text link}
\autoref{fig:plot} % "Figure 1"
\nameref{sec:intro} % Section name

% Varioref (page-aware)
\usepackage{varioref}
\vrref{fig:plot} % "Figure 1 on
```

# 11. BIBLIOGRAPHY AND CITED REFERENCES

## Bibliography Setup

```
% Manual bibliography
\begin{thebibliography}{99}
\bibitem{cite_key}
Author, "Title," \textit{Journal}, 2023.
```

```
\end{thebibliography}

% BibTeX method
\usepackage[natbib]
\bibliography{references}
\bibliographystyle{plain}
% Styles: plain, apalike, unsrt, ieetr
```

```
% Cite variations
\cite{cite_key}
\citep{cite_key} % (Author, Year)
\citet{cite_key} % Author (Year)
\citealp{key} % Author, Year
\citeyear{key} % Year only
```

```
% Biblatex (modern)
\usepackage[backend=biber]{biblatex}
\addbibresource{references.bib}
\cite{key}
\printbibliography
```

```
% Multiple citations
\cite{key1,key2}
\cite{key1, key2, key3}
```

## BibTeX Entries

```
% Article
\article{key1,
author={John Doe},
title={Article Title},
journal={Journal Name},
year=2023, volume=10, pages={1--10}}
```

```
% Book
\book{key2,
author={Jane Smith},
title={Book Title},
publisher={Publisher Name},
year=2023}
```

```
% Misc/Website
\misc{key3,
author={Anonymous},
title={Web Title},
url=(https://example.com),
year=2023}
```

```
% Conference
\inproceedings{key4,
author={Jane Doe},
title={Conference Paper},
booktitle={Conference Name},
year=2023, pages={1--5}}
```

# 12. DOCUMENT FEATURES

## Table of Contents and Indexes

```
% Table of Contents
\tableofcontents
\tableofcontents[level=2]
```

```
% List of Figures
\listoffigures
```

```
% List of Tables
\listoftables

% Manual TOC entry
\addcontentsline{toc}{section}{Section}

% Exclude from numbering
\section*{Unnumbered Section}

% Custom TOC entry
\addtocontents{toc}{\textbf{Part I}\par}

% Index
\usepackage{makeidx}
\makeindex
\index{term}
\index{term!subtopic}
\printindex

% Glossaries
\usepackage{glossaries}
\makeglossaries
\newglossaryentry{term}{name={Term}, description={Definition}}
\gls{term}
\printglossaries
```

## Special Environments

```
% Framed box
\usepackage{fancybox}
\begin{framed}
Framed text
\end{framed}

% Boxed equation
\boxed{x = y}

% Colored box
\usepackage{tcolorbox}
\begin{tcolorbox}[colback=yellow!50]
Yellow box
\end{tcolorbox}

% Quotation environments
\begin{quote}
Single paragraph quote
\end{quote}

\begin{quotation}
Multi-paragraph quotation
\end{quotation}

\begin{verse}
Poetry format\\
with line breaks
\end{verse}

% Code blocks (verbatim, listings, minted)
% Use verbatim environment for basic code
% Use lstlisting environment for syntax highlight
% Use minted environment (external tool)
```

## 13. USEFUL PACKAGES

### Essential Packages

```
% Encoding
\usepackage[utf-8]{inputenc}
\usepackage[T1]{fontenc}
\usepackage[english]{babel}

% Graphics
\usepackage{graphicx}
\usepackage{tikz}
\usepackage{pgfplots}

% Mathematics
\usepackage{amsmath}
\usepackage{amsymb}
\usepackage{mathtools}

% Page layout
\usepackage{geometry}
\usepackage{fancyhdr}
\usepackage{multicol}
\usepackage{setspace}

% Lists and formatting
\usepackage{enumitem}
\usepackage{xcolor}

% References
\usepackage{hyperref}
\usepackage{natbib}

% With bibliography
\pdflatex filename.tex
\bibtex filename.aux
\pdflatex filename.tex
\pdflatex filename.tex

% With index
\pdflatex filename.tex
\makeindex filename.idx
\pdflatex filename.tex

% With glossary
\pdflatex filename.tex
\makeglossaries filename
\pdflatex filename.tex

% SyncTeX (editor sync)
\pdflatex -synctex=1 filename.tex

% Continuous compilation
\latexmk -pdf -pvc filename.tex

% DVI to PDF
\latex filename.tex
\pdfdvi filename.dvi
```

## Specialized Packages

```
% Text enhancement
\usepackage{ulem} % Underline/strike
\usepackage{soul} % Highlighting
\usepackage{lettrine} % Drop caps
\usepackage{microtype} % Better justification

% Tables
\usepackage{booktabs}
\usepackage{multirow}
\usepackage{array}
\usepackage{tabularx}

% Advanced boxes
\usepackage{fancybox}
\usepackage{tcolorbox}

% Code and syntax
\usepackage{listings}
\usepackage{minted}

% Graphics and wrapping
\usepackage{tikz}
\usepackage{rotating} % Rotate figures
\usepackage{wrapfig} % Text wrapping
\usepackage{graphics}

% References
\usepackage{varioref} % Smart references
\usepackage{hyperref}
```

```
% Advanced features
\usepackage{parskip} % Auto spacing
\usepackage{draft} % Draft marks
\usepackage{draftwatermark} % Watermark

% Define environment
\newenvironment{myenv}
{\begin{quote}}
{\end{quote}}
```

## 14. COMPILATION

### Build Commands

```
% PDF compilation
\pdflatex filename.tex

% With bibliography
\pdflatex filename.tex
\bibtex filename.aux
\pdflatex filename.tex
\pdflatex filename.tex

% With index
\pdflatex filename.tex
\makeindex filename.idx
\pdflatex filename.tex

% With glossary
\pdflatex filename.tex
\makeglossaries filename
\pdflatex filename.tex

% SyncTeX (editor sync)
\pdflatex -synctex=1 filename.tex

% Continuous compilation
\latexmk -pdf -pvc filename.tex
```

## 15. ADVANCED FEATURES

### Custom Commands

```
% Simple command
\newcommand{\mycommand}{replacement}
\mycommand

% With argument
\newcommand{\mycom}[1]{text with #1}
\mycom{argument}

% Multiple arguments
\newcommand{\formula}[2]{\frac{#1}{#2}}
\formula{x}{y}

% Optional argument
\newcommand{\myopt}[2][default]{#1 #2}
\myopt{custom}{text}

% With leading asterisk
\newcommand*{\shortmacro}{text}

% Renew command
\renewcommand{\mycommand}{new def}
```

### Environments and Counters

```
% Define environment
\newenvironment{myenv}
{\begin{quote}}
{\end{quote}}
```

```
% With arguments
\newenvironment{mybox}[1]
{\textbf{#1}\par}
{\par}

% Define counter
\newcounter{mycount}
\setcounter{mycount}{0}
\stepcounter{mycount}
\addtocounter{mycount}{5}
\themycount % Display

% Conditional logic
\usepackage{ifthen}
\ifthenelse{\equal{a}{b}}{yes}{no}
\ifthenelse{\value{page}=1}{first}{other}
\ifthenelse{\boolean{flag}}{yes}{no}

% If primitives
\ifdim 5cm > 3cm yes\else no\fi
\ifnum 5 > 3 yes\else no\fi
```

## 16. SYMBOLS REFERENCE

### Math Symbols Quick Reference

```
% Greek letters
\alpha \beta \gamma \delta \epsilon \zeta
\eta \theta \iota \kappa \lambda \mu \nu
\xi \nu \pi \rho \sigma \tau \upsilon
\phi \chi \psi \omega
```

```
% Capital Greek
\Gamma \Delta \Theta \Lambda \Xi \Pi
\Sigma \Upsilon \Phi \Psi \Omega
```

```
% Binary relations
\noteq \leq \geq \approx \sim \propto \equiv
\subset \subseteq \supset \supseteq
```

```
% Logical operators
\forall \exists \neg \wedge \vee
```

```
% Arrows
\rightarrow \leftarrow \leftrightarrow \Leftrightarrow
\Rightarrow \Leftarrow \Leftrightarrow
\mapsto \doteq \approx
```

```
% Set symbols
\in \notin \cap \cup \setminus \times \emptyset
```