

# Basic LaTeX

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This resource was adapted from  
notes provided by Jerry Marsden

## 1 Basic Formatting

### 1.1 Beginning a document

```
\documentclass{article}  
\usepackage{graphicx, amssymb}
```

```
\begin{document}
```

```
\textwidth 6.5 truein  
\oddsidemargin 0 truein  
\evensidemargin -0.50 truein  
\topmargin -.5 truein  
\textheight 8.5in
```

template for changing margin sizes  
insert after document opener

```
\title{...}  
\author{...}  
\thanks{...}  
\date{...}  
\maketitle
```

template for title and author

```
\begin{abstract}  
\end{abstract}
```

template for abstract

## 1.2 Format

<code>\section{</code>	numbered section
<code>\section*{</code>	unnumbered section
<code>\subsection{</code>	numbered subsection
<code>\subsection*{</code>	unnumbered subsection
<code>\begin{center}</code>	centers intermediate text
<code>\end{center}</code>	
<code>\centerline{</code>	centers a line
<code>\hfill</code>	fills line with horizontal space
<code>\begin{flushleft}</code>	places text flush with left margin
<code>\end{flushleft}</code>	
<code>\begin{flushright}</code>	places text flush with right margin
<code>\end{flushright}</code>	
<code>\begin{quotation}</code>	offsets intermediate text by wider margins
<code>\end{quotation}</code>	
<code>\noindent</code>	new paragraph starts without indent
<code>\\</code>	newline
<code>\newpage</code>	starts new page
<code>%</code>	following text on same line is invisible

## 1.3 Basic Braces and Parentheses

<code>{</code>	open brace
<code>}</code>	closing (end) brace
<code>\/}</code>	end brace for italics
<code>(</code>	open parenthesis
<code>)</code>	end parenthesis
<code>[</code>	open bracket
<code>]</code>	end bracket
<code>\{</code>	left literal braces
<code>\}</code>	right literal braces
<code>“</code>	begin quotation mark
<code>”</code>	end quotation mark
<code>&lt;</code>	<code>\langle</code>
<code>&gt;</code>	<code>\rangle</code>

## 1.4 Lists and Tables

<code>\begin{enumerate}</code>	makes a numbered list;
<code>\end{enumerate}</code>	
<code>\begin{itemize}</code>	makes list with bullets;
<code>\end{itemize}</code>	
<code>\begin{description}</code>	makes an unnumbered list;
<code>\end{description}</code>	
<code>\item</code>	produces items for above lists
<code>\item[</code>	for customized items, in enumerate lists
<code>\setcounter{enumi}{</code>	sets counter for enumerate list
<code>\setcounter{...}{...}</code>	fill in braces (don't leave spaces)
<code>\begin{tabbing}</code>	starts tabbing environment
<code>\end{tabbing}</code>	
<code>\&gt;</code>	next tab stop
<code>\begin{tabular}{ c c }</code>	tabular with vertical lines
<code>\end{tabular}</code>	
<code>\hline</code>	horizontal line
<code>&amp;</code>	separates columns in tabular environment

## 1.5 Labels, References and Bibliography

<code>\footnote{</code>	footnote
<code>\index{</code>	use for index entries
<code>\label{</code>	to label an equation, theorem, etc.
<code>\ref{</code>	to cross reference an equation, theorem, etc.
<code>(\ref{ })</code>	put cursor between { } by hand
<code>\cite{ }</code>	reference a bibitem entry

The following are designed for the author-year style of bibliography that is used after

```
\begin{thebibliography}
```

and before

```
\end{thebibliography}
```

<code>\bibitem[artref] Author [year]</code>	for articles
Title.	
<code>{\it Journal\}/} {\bf 11}, 123-223.</code>	

<code>\bibitem[bookref] Author [year]</code>	for books
<code>{\it Title.\}/} Publisher.</code>	

## 1.6 Foreign Accents

é	É	<code>\'e</code>	<code>\'E</code>
è	È	<code>\'e</code>	<code>\'E</code>
ä	Ä	<code>\"a</code>	<code>\"A</code>
ö	Ö	<code>\"o</code>	<code>\"O</code>
ü	Ü	<code>\"u</code>	<code>\"U</code>

## 1.7 Miscellaneous

@	@	at symbol
©	<code>\copyright</code>	copyright
¶	<code>\P</code>	paragraph
§	<code>\S</code>	section
ß	<code>\ss</code>	german ss

## 1.8 Spaces

<code>\vspace{0.2in}</code>	vertical space 0.2in
<code>\hspace{0.2in}</code>	horizontal space 0.2in
<code>\quad</code>	single character space
<code>\qquad</code>	double space
<code>\,</code>	small space
<code>\:</code>	medium space; only in math mode
<code>\;</code>	thick space; only in math mode
<code>\!</code>	negative space; only in math mode
<code>\! \!</code>	negative double space; only in math mode

## 2 Basic Mathematical Formatting

### 2.1 Equation Commands

<code>\$</code>	starts and terminates in-text formulas
<code>\[</code> <code>\]</code>	displayed one line formula, not numbered
<code>\begin{equation}</code> <code>\begin{equation}\label{</code> <code>\end{equation}</code>	displayed one line formula, numbered add label
<code>\begin{eqnarray}</code> <code>\begin{eqnarray}\label{</code> <code>\end{eqnarray}</code>	displayed multiline formula, numbered; add label
<code>\begin{eqnarray*}</code> <code>\end{eqnarray*}</code>	displayed multiline formula, not numbered
<code>\begin{array}{ccc}</code> <code>\end{array}</code>	produces matrices (see also §5.3)
<code>&amp;</code> <code>&amp; = &amp;</code>	use between columns for aligning equals in equation arrays
<code>\nonumber</code>	suppresses numbering
<code>\mbox{ }</code>	use before – and + signs in split equations
<code>\quad \mbox{...}\quad</code> <code>\quad \mbox{and}\quad</code>	for text within a formula makes box “and” within a formula
<code>\begin{eqnarray}</code> <code>\lefteqn{ } \nonumber \\\</code> <code>&amp; &amp;</code> <code>\end{eqnarray}</code>	numbered equation split over two lines, for equations with long lefthand sides use “lequs” for the unnumbered version

### 2.2 Basic Displayed Equations – Examples

`\[`

$$F(b) - F(a) = \int_a^b f(x)dx$$

`\begin{equation}`

$$F(b) - F(a) = \int_a^b f(x)dx \tag{1}$$

\[ containing text

$$\sum_{i=1}^n x_i^2 + y_i^2 \geq 0 \quad \text{for all real numbers } x_i \text{ and } y_i$$

\begin{eqnarray\*}

$$\begin{array}{rcl} & ^2 & = y + 1 \\ z^2 + 1 & = & u + v \end{array}$$

\begin{eqnarray}

$$\begin{array}{rcl} & ^2 & = y + 1 \\ z^2 + 1 & = & u + v \end{array} \tag{2}$$

$$\tag{3}$$

\begin{eqnarray} \begin{array}{c} \end{array} \quad \text{numbered as a group}

$$\begin{array}{rcl} a & = & b + c \\ d & = & e + f + g \end{array} \tag{4}$$

\begin{eqnarray\*} \quad \text{split (with leading minus sign on second line)}

$$\begin{array}{rcl} a & = & b + c + (c + d) \\ & & - e + f \end{array}$$

### 2.3 Specialized Displayed Equations – Examples

\begin{equation} \begin{array}{l} \end{array} \end{equation}

$$\left. \begin{array}{l} x = y \\ a = b^2 + b + 1 \end{array} \right\} \tag{5}$$

`\begin{equation} \begin{array}{c}`

$$\left. \begin{array}{c} x = y \\ a = b^2 + b + 1 \end{array} \right\} \quad (6)$$

`\begin{equation} \boxed{\}`

$$\boxed{\frac{x^2 + 1}{5} = y} \quad (7)$$

evaluation of expression

$$f\left(\frac{t}{2}\right)\Big|_{t=0}$$

`\begin{eqnarray} \left\{ \right.`

$$\begin{aligned} ax^2 + 2bxy + cy^2 + dx + ey + f \\ = \alpha u + \beta v + \gamma w + \delta \end{aligned} \quad (8)$$

equation array with big brackets on different lines

$$\hat{H}_c(\Delta\omega) : = \int_D \left[ \frac{1}{2} \Delta\omega (-\nabla^2)^{-1} \Delta\omega + \Phi(\omega_e + \Delta\omega) - \Phi(\omega_e) - \Phi'(\omega_e) \Delta\omega \right] dx dy$$

equation array with big braces on different lines

$$H_0^s(TM) = \left\{ \begin{array}{l} \in H^s(TM) \mid \text{there exists an } H^s\text{-extension} \\ \tilde{X} \in H^s(\tilde{TM}) \text{ with } X \text{ zero on } \tilde{M} \setminus M \end{array} \right\}.$$

## 2.4 Theorem Like Environments

<code>\newtheorem{cor}</code>	{Corollary}	to make new series of Corollaries
<code>\newtheorem{dfn}</code>	{Definition}	to make new series of Definitions
<code>\newtheorem{lem}</code>	{Lemma}	to make new series of Lemmas
<code>\newtheorem{prop}</code>	{Proposition}	to make new series of Propositions
<code>\newtheorem{thm}</code>	{Theorem}	to make new series of Theorems

<code>\begin{cor}</code>	to begin a Corollary
<code>\end{cor}</code>	to end a Corollary
<code>\begin{dfn}</code>	
<code>\end{dfn}</code>	
<code>\begin{lem}</code>	
<code>\end{lem}</code>	
<code>\begin{prop}</code>	
<code>\end{prop}</code>	
<code>\begin{thm}</code>	
<code>\begin{thm}[Gauss' Theorem]</code>	to begin a Theorem with title
<code>\end{thm}</code>	

**Example**

**Remarks**

**Proof**

**Solution**

<code>\noindent{\large \bf Example\,}</code>
<code>\noindent{\large \bf Remarks\,}</code>
<code>\noindent{\bf Proof\,}</code>
<code>\noindent{\bf Solution\,}</code>

## 2.5 End of Proofs, etc.

◆	<code>\quad \blacklozenge</code>	
◆	<code>\quad \$\blacklozenge\$</code>	
■	<code>\quad \blacksquare</code>	end proof
□	<code>\quad \square</code>	empty square
▽	<code>\quad \bigtriangledown</code>	empty triangle down
▼	<code>\quad \blacktriangledown</code>	black triangle down

### 3 Alphabets and Fonts

#### 3.1 Greek Letters

$\alpha$	<code>\alpha</code>		
$\beta$	<code>\beta</code>		
$\gamma$	<code>\gamma</code>	$\Gamma$	<code>\Gamma</code>
$\delta$	<code>\delta</code>	$\Delta$	<code>\Delta</code>
$\epsilon$	<code>\epsilon</code>		
$\varepsilon$	<code>\varepsilon</code>		
$\zeta$	<code>\zeta</code>		
$\eta$	<code>\eta</code>		
$\theta$	<code>\theta</code>	$\Theta$	<code>\Theta</code>
$\vartheta$	<code>\vartheta</code>		
$\iota$	<code>\iota</code>		
$\kappa$	<code>\kappa</code>		
$\lambda$	<code>\lambda</code>	$\Lambda$	<code>\Lambda</code>
$\mu$	<code>\mu</code>		
$\nu$	<code>\nu</code>		
$\pi$	<code>\pi</code>	$\Pi$	<code>\Pi</code>
$\varpi$	<code>\varpi</code>		
$\rho$	<code>\rho</code>		
$\varrho$	<code>\varrho</code>		
$\sigma$	<code>\sigma</code>	$\Sigma$	<code>\Sigma</code>
$\varsigma$	<code>\varsigma</code>		
$\tau$	<code>\tau</code>		
$\upsilon$	<code>\upsilon</code>	$\Upsilon$	<code>\Upsilon</code>
$\phi$	<code>\phi</code>	$\Phi$	<code>\Phi</code>
$\varphi$	<code>\varphi</code>		
$\chi$	<code>\chi</code>		
$\psi$	<code>\psi</code>	$\Psi$	<code>\Psi</code>
$\omega$	<code>\omega</code>	$\Omega$	<code>\Omega</code>

#### 3.2 Italics, Bold, etc.

<i>example</i>	<code>{\it</code>	<i>italic</i> type, “eit” to finish
example	<code>{\rm</code>	roman type
<b>example</b>	<code>{\bf</code>	<b>boldface</b> type
EXAMPLE	<code>{\sc</code>	SMALL CAPS type
example	<code>{\sf</code>	sans serif type
<i>example</i>	<code>{\sl</code>	<i>slanted</i> type
example	<code>{\tt</code>	<b>typewriter</b> type
<i>example</i>	<code>{\em</code>	<i>emphasized</i> type
ξ	<code>\mbox{\boldmath\$. . . \$}</code>	
$\mathcal{A}$	<code>{\cal</code>	only in math mode, only cap.letters
$\mathbf{g}$	<code>\mathbf</code>	only in math mode
$\mathbb{R}$	<code>{\mathbb</code>	only in math mode

### 3.3 Boldface Letters

	<code>{\bf</code>	
<b>0 – 10</b>	<code>{\bf 0} – {\bf 10}</code>	
<b>a – d</b>	<code>{\bf a} – {\bf d}</code>	
<b>e</b>	<code>{\bf e}</code>	(because of the word “be”)
<b>f</b>	<code>{\bf f}</code>	(because of the command “bf”)
<b>g – x</b>	<code>{\bf g} – {\bf x}</code>	
<b>y</b>	<code>{\bf y}</code>	(because of the word “by”)
<b>z</b>	<code>{\bf z}</code>	
<b>A – Z</b>	<code>{\bf A} – {\bf Z}</code>	
<b>e<sub>1</sub></b>	<code>{\bf e}_1</code>	

### 3.4 Boldmath Symbols

	<code>\mbox{\boldmath\$. . \$}</code>
<b>ω</b>	<code>\mbox{\boldmath\$\omega\$}</code>
<b>ξ</b>	<code>\mbox{\boldmath\$\xi\$}</code>

### 3.5 Calligraphic Letters

	<code>{\cal</code>	only in math mode, cap. letters
<b>A – Z</b>	<code>{\cal A} – {\cal Z}</code>	

### 3.6 German (Fraktur) Letters

	<code>\mathfrak. . .</code>	only in math mode
<b>b</b>	<code>\mathfrak b</code>	german b,
<b>g</b>	<code>\mathfrak g</code>	german g,
<b>h</b>	<code>\mathfrak h</code>	german h,
<b>k</b>	<code>\mathfrak k</code>	german k,
<b>p</b>	<code>\mathfrak p</code>	german p,
<b>t</b>	<code>\mathfrak t</code>	german t,
<b>A</b>	<code>\mathfrak A</code>	german A,
<b>G</b>	<code>\mathfrak G</code>	german G,
<b>H</b>	<code>\mathfrak H</code>	german H,
<b>K</b>	<code>\mathfrak K</code>	german K,
<b>T</b>	<code>\mathfrak T</code>	german T,
<b>X</b>	<code>\mathfrak X</code>	german X,

### 3.7 Open Letters

	<code>{\mathbb</code>	only in math mode
$\mathbb{C}$	<code>{\mathbb C}</code>	\$
$\mathbb{I}$	<code>{\mathbb I}</code>	
$\mathbb{R}$	<code>{\mathbb R}</code>	
$\mathbb{R}^1$	<code>{\mathbb R}^1</code>	
$\mathbb{R}^2$	<code>{\mathbb R}^2</code>	
$\mathbb{R}^3$	<code>{\mathbb R}^3</code>	
$\mathbb{R}^m$	<code>{\mathbb R}^m</code>	
$\mathbb{R}^n$	<code>{\mathbb R}^n</code>	
$\mathbb{T}$	<code>{\mathbb T}</code>	
$\mathbb{Z}$	<code>{\mathbb Z}</code>	

## 4 Basic Mathematical Operations and Symbols

### 4.1 Universal Operations

	<code>\frac{ }{ }</code>	for general fractions
$\sqrt{\quad}$	<code>\sqrt{ }</code>	universal square root
	<code>{</code>	superscript universal
	<code>-{</code>	subscript universal
$\lim$	<code>\lim_{ }</code>	limit universal
$\vec{a}$	<code>\vec{ }</code>	
$\bar{a}$	<code>\overline{ }</code>	
$\bar{a}$	<code>\bar{ }</code>	
$\check{a}$	<code>\check{ }</code>	
$\dot{a}$	<code>\dot{ }</code>	
$\ddot{a}$	<code>\ddot{ }</code>	
$\hat{a}$	<code>\hat{ }</code>	
$\tilde{a}$	<code>\tilde{ }</code>	
$\{\}$	<code>{\mid}</code>	in-line set
$\{\}$	<code>\left\{ \left. \right  \right\}</code>	sized set for large displays
	<code>{\displaystyle}</code>	for larger math mode formulas

### 4.2 Single Symbols included in \$ Signs

$a - z$	<code>\$a\$ - \$z\$</code>	(except: “do” for \$o\$)
$A - Z$	<code>\$A\$ - \$Z\$</code>	
$1 - 10$	<code>\$1\$ - \$10\$</code>	
$\mathbf{a} - \mathbf{z}$	<code>\${\bf a}\$ - \${\bf z}\$</code>	
$\mathbf{A} - \mathbf{Z}$	<code>\${\bf A}\$ - \${\bf Z}\$</code>	
$\mathbf{0} - \mathbf{10}$	<code>\${\bf 0}\$ - \${\bf 10}\$</code>	

### 4.3 Roots

$\sqrt{2}$	<code>\sqrt{2}</code>	
$\sqrt{\pi}$	<code>\sqrt{\pi}</code>	
$\sqrt[3]{2}$	<code>\sqrt[3]{2}</code>	cube root over 2
$\sqrt[n]{2}$	<code>\sqrt[n]{2}</code>	$n$ -root over 2

## 4.4 Specific Fractions

$$\frac{1}{2} \quad \backslash\text{frac}\{1\}\{2\}$$

$$\frac{1}{3} \quad \backslash\text{frac}\{1\}\{3\}$$

$$\frac{1}{4} \quad \backslash\text{frac}\{1\}\{4\}$$

$$\frac{d}{dt} \quad \backslash\text{frac}\{d\}\{dt\}$$

$$\frac{du}{dt} \quad \backslash\text{frac}\{du\}\{dt\}$$

$$\frac{dx}{dt} \quad \backslash\text{frac}\{dx\}\{dt\}$$

$$\frac{dy}{dt} \quad \backslash\text{frac}\{dy\}\{dt\}$$

$$\frac{dz}{dt} \quad \backslash\text{frac}\{dz\}\{dt\}$$

$$\frac{\partial}{\partial x} \quad \backslash\text{frac}\{\backslash\text{partial}\}\{\backslash\text{partial } x\}$$

$$\frac{\partial}{\partial y} \quad \backslash\text{frac}\{\backslash\text{partial}\}\{\backslash\text{partial } y\}$$

$$\frac{\partial z}{\partial x} \quad \backslash\text{frac}\{\backslash\text{partial } z\}\{\backslash\text{partial } x\}$$

$$\frac{\partial^2}{\partial x \partial y} \quad \backslash\text{frac}\{\backslash\text{partial}^2\}\{\backslash\text{partial } x \backslash\text{partial } y\}$$

$$\frac{\partial^3}{\partial x \partial y \partial z} \quad \backslash\text{frac}\{\backslash\text{partial}^3\}\{\backslash\text{partial } x \backslash\text{partial } y \backslash\text{partial } z\}$$

## 4.5 Superscripts

$\hat{\{$		high universal
$a - z$	$\hat{a} - \hat{z}$	(except: “hee” for $e$ , “huu” for $u$ )
$A - Z$	$\hat{A} - \hat{Z}$	
$0 - 10$	$\hat{0} - \hat{\{10\}}$	
$2$	$\hat{2}$	to avoid typing the number
$3$	$\hat{3}$	to avoid typing the number
$x^2, y^2, z^2$	$x^{\hat{2}}, y^{\hat{2}}, z^{\hat{2}}$	
$-1$	$\hat{\{-1\}}$	
$ij$	$\hat{\{ij\}}$	
$ijk$	$\hat{\{ijk\}}$	
$jk$	$\hat{\{jk\}}$	

†	<code>^\dagger</code>
⊥	<code>^\perp</code>
'	<code>^\prime</code>
*	<code>^\ast</code>
★	<code>^\star</code>

## 4.6 Subscripts

<code>-{</code>		low universal
<code>a - z</code>	<code>._a - ._z</code>	(except: “luu” for <i>u</i> )
<code>A - Z</code>	<code>._A - ._Z</code>	
<code>0 - 10</code>	<code>._0 - ._{10}</code>	
<code>ij</code>	<code>._{ij}</code>	
<code>ijk</code>	<code>._{ijk}</code>	
<code>jk</code>	<code>._{jk}</code>	
<code>y<sub>n</sub></code>	<code>y._n</code>	
<code>z<sub>n</sub></code>	<code>z._n</code>	
*	<code>._\ast</code>	
★	<code>._\star</code>	

## 4.7 Overcharacters

$\bar{p}$	<code>\bar{p}</code>
$\bar{\alpha}$	<code>\bar{\alpha}</code>
$\dot{p}$	<code>\dot{p}</code>
$\ddot{p}$	<code>\ddot{p}</code>
$\overline{p}$	<code>\overline{p}</code>
$\hat{p}$	<code>\hat{p}</code>
$\vec{a}$	<code>\vec{a}</code>
$\xrightarrow{PP}$	<code>\stackrel{\textstyle\longrightarrow}{\rm PP}</code>
$\xrightarrow{PQ}$	<code>\stackrel{\textstyle\longrightarrow}{\rm PQ}</code> ;

## 4.8 Binary Operations and Relations

$+$	<code>+</code>	plus
$-$	<code>-</code>	minus
$\pm$	<code>\pm</code>	plus-minus
$\mp$	<code>\mp</code>	minus-plus
$\div$	<code>\div</code>	divide
$\circ$	<code>\circ</code>	composite
$\bullet$	<code>\bullet</code>	bullet
$\oplus$	<code>\oplus</code>	direct sum
$\ominus$	<code>\ominus</code>	direct difference
$\times$	<code>\times</code>	times
$\otimes$	<code>\otimes</code>	tensor product
$\circledast$	<code>\circledast</code> ,	semi direct product
$\wedge$	<code>\wedge</code>	wedge product
$=$		equals
$= 0$		equals zero
$\geq$	<code>\geq</code>	greater than or equal
$\leq$	<code>\leq</code>	less than equal
$\neq$	<code>\neq</code>	not equal
$\cong$	<code>\cong</code>	isomorphic
$\equiv$	<code>\equiv</code>	equivalent
$\ll$	<code>\ll</code>	much less than
$\gg$	<code>\gg</code>	much greater than
$\approx$	<code>\approx</code>	approximately

## 4.9 Sized Parentheses

(	<code>\left(</code>	The “left” and “right” commands
)	<code>\right)</code>	effect the size of the braces.
[	<code>\left[</code>	They always have to appear in pairs!
]	<code>\right]</code>	Invisible braces are made with <code>\left.</code> and <code>\right.</code>
{	<code>\left\{</code>	
}	<code>\right\}</code>	
<	<code>\left\langle</code>	
<<	<code>\left\langle\!\!\left\langle</code>	
>	<code>\right\rangle</code>	
>>	<code>\right\rangle\!\!\right\rangle</code>	
	<code>\left.</code>	
	<code>\right.</code>	

## 4.10 Single Mathematical Symbols

$\aleph$	<code>\aleph</code>	aleph
$\hbar$	<code>\hbar</code>	Planck’s constant
$\prime$	<code>\prime</code>	prime, use “hpr” for superscript
$\flat$	<code>\flat</code>	flat sign, “hfl” for superscript
$\sharp$	<code>\sharp</code>	sharp sign, “hsh” for superscript
$\heartsuit$	<code>\heartsuit</code>	sweetheart
$\propto$	<code>\propto</code>	proportional to
$\ $	<code>\ </code>	
$\pounds$	<code>\pounds</code>	Lie derivative
$\pitchfork$	<code>\pitchfork</code>	transversal
$\ell$	<code>\ell</code>	script l
$\ $	<code>\ </code>	norm
$\nabla$	<code>\nabla</code>	nabla
$\partial$	<code>\partial</code>	partial derivative
$\infty$	<code>\infty</code>	infinity
$\wp$	<code>\wp</code>	Weierstrass $p$ -function
$\Re$	<code>\Re</code>	real part alternate
$\Im$	<code>\Im</code>	imaginary part alternate
$\sphericalangle$	<code>\angle</code>	angle

## 4.11 Set Theoretic Symbols

$\Rightarrow$	<code>\Rightarrow</code>	implies
$\Leftarrow$	<code>\Leftarrow</code>	implied by
$\Leftrightarrow$	<code>\Leftrightarrow</code>	equivalent to
$\emptyset$	<code>\varnothing</code>	empty set
$\emptyset$	<code>\emptyset</code>	empty set alternate
$\in$	<code>\in</code>	element of
$\notin$	<code>\notin</code>	not an element of
$\setminus$	<code>\setminus</code>	set difference
$\subset$	<code>\subset</code>	subset
$\subseteq$	<code>\subseteq</code>	subset or equals
$\supset$	<code>\supset</code>	superset
$\supseteq$	<code>\supseteq</code>	superset or equals
$\cap$	<code>\cap</code>	intersection
$\bigcap$	<code>\bigcap</code>	big intersection
$\cup$	<code>\cup</code>	union
$\bigcup$	<code>\bigcup</code>	big union
$\mid$	<code>\mid</code>	vertical bar, with spacing
$\exists$	<code>\exists</code>	there exists
$\forall$	<code>\forall</code>	for all

## 4.12 Arrows and Dots

$\mapsto$	<code>\mapsto</code>	arrow with tail
$\rightarrow$	<code>\rightarrow</code>	rightarrow
$\longrightarrow$	<code>\longrightarrow</code>	longrightarrow
$\leftrightarrow$	<code>\leftrightarrow</code>	leftrightarrow
$\leftarrow$	<code>\leftarrow</code>	leftarrow
$\uparrow$	<code>\uparrow</code>	uparrow
$\upharpoonright$	<code>\upharpoonright</code>	upharpoonright
$\nearrow$	<code>\nearrow</code>	slanted up right
$\searrow$	<code>\searrow</code>	slanted down right
$\cdot$	<code>\cdot</code>	centered dot
$\cdots$	<code>\cdots</code>	centered dots
$\ddots$	<code>\ddots</code>	diagonal dots
$\dots$	<code>\ldots</code>	lower dots
$\vdots$	<code>\vdots</code>	vertical dots

### 4.13 Trig Functions

<code>cos</code>	<code>\cos</code>	
<code>cosh</code>	<code>\cosh</code>	hyperbolic cosine
<code>cos<sup>2</sup></code>	<code>\cos<sup>2</sup></code>	cosine squared
<code>cos <math>\theta</math></code>	<code>\cos \theta</code>	cosine of theta
<code>cos <math>\phi</math></code>	<code>\cos \phi</code>	cosine of phi
<code>sin</code>	<code>\sin</code>	
<code>sinh</code>	<code>\sinh</code>	hyperbolic sine
<code>sin<sup>2</sup></code>	<code>\sin<sup>2</sup></code>	sine squared
<code>sin <math>\theta</math></code>	<code>\sin \theta</code>	sine of theta
<code>sin <math>\phi</math></code>	<code>\sin \phi</code>	sine of phi
<code>sech</code>	<code>{\rm sech}</code>	hyperbolic sech
<code>tan</code>	<code>\tan</code>	
<code>tanh</code>	<code>\tanh</code>	hyperbolic tangent

### 4.14 Log-like Symbols

<code>exp</code>	<code>\exp</code>	exponential
<code>log</code>	<code>\log</code>	logarithm
<code>ln</code>	<code>\ln</code>	natural logarithm
<code>sup</code>	<code>\sup</code>	supremum
<code>inf</code>	<code>\inf</code>	infimum
<code>max</code>	<code>\max</code>	maximum
<code>min</code>	<code>\min</code>	minimum
<code>lim</code>	<code>\lim</code>	limit universal
<code>lim inf</code>	<code>\liminf</code>	limit inferior
<code>lim sup</code>	<code>\limsup</code>	limit superior
<code>det</code>	<code>\det</code>	determinant
<code>ker</code>	<code>\ker</code>	kernel
<code>dim</code>	<code>\dim</code>	dimension
<code>arg</code>	<code>\arg</code>	argument
<code>gcd</code>	<code>\gcd</code>	greatest common divisor

## 4.15 Combinations of Mathematical Symbols

-1	-1	minus one
$\ \mathbf{u}\ $	$\ \{\bf u}\ $	
$ a $	$ a $	absolute value;
$A^i_a$	$A^i_{;a}$	staggered, high and low
$L_A^\mu$	$L_A\{\}^\mu$	staggered, variation 1
$v^A_\nu$	$v^A\{\}_\nu$	staggered, variation 2
$\mathfrak{g}^*$	$\mathfrak{g}^{\ast}$	german g star;
$\mathfrak{g}^*$	$\mathfrak{g}^{\ast}$	
$\mathfrak{so}(3)$	$\mathfrak{so}(3)$	
$so(3)$	$so(3)$	
$SO(3)$	$SO(3)$	
$T^*Q$	$T^{\ast}Q$	
$T_q^*Q$	$T^{\ast}_{q}Q$	
div	$\{\rm div}\}$	divergence
Aut(	$\{\rm Aut}\}$	automorphism universal
Diff(	$\{\rm Diff}\}$	diffeomorphism universal
Im(	$\{\rm Im}\}$	real part universal
Im( $z$ )	$\{\rm Im}\}(z)$	real part of $z$
Re(	$\{\rm Re}\}$	real part universal
Re( $z$ )	$\{\rm Re}\}(z)$	real part of $z$
(0)		
(0, 0)		
(0, 0, 0)		
$(a_1, a_2, a_3)$		
$(x, y)$		
$(x, y, z)$		
$x^2 + y^2$		
$dx dy$		
$dx dy dz$		
$dy/dt$	$dy/dt$	
$dx/dt$	$dx/dt$	
$dz/dt$	$dz/dt$	
$\partial z/\partial y$	$\partial z/\partial y$	
$\mathbf{a} + \mathbf{b}$	$\{\bf a}\} + \{\bf b}\}$	
$\mathbf{a} \times \mathbf{b}$	$\{\bf a}\} \times \{\bf b}\}$	
$(\mathbf{a} \times \mathbf{b})$	$(\{\bf a}\} \times \{\bf b}\})$	

## 5 Integrals, Sums, Products and Matrices

### 5.1 Integrals

$\int$             `\int`            integral universal; add limits with “hu” and “lu”

$\iint$             `\int \!\! \int`            double integral

$\iiint$             `\int \!\! \int \!\! \int`            triple integral

$\oint$             `\oint`            contour integral

$\int_0^1$             `\int^1_0`

$\int_a^b$             `\int^b_a`

$\int_D$             `\int_D`

$\int_{\mathbb{R}^3}$             `\int_{\{\{\mathbb{R}\}^3\}}`

$\int_{-\infty}^{\infty}$             `\int^{\infty}_{-\infty}`

$\int_0^{2\pi}$             `\int^{2\pi}_0`

## 5.2 Sums, Limits, etc.

$\sum$       \sum                       $\Sigma$               (in-text)

$\sum_{i=1}^n$               (displayed)                       $\sum_{i=1}^n$               (in-text)

$\prod_{i=1}^n$               (displayed)                       $\prod_{i=1}^n$               (in-text)

$\bigcup_{i=1}^n$               (displayed)                       $\bigcup_{i=1}^n$               (in-text)

$\bigcap_{i=1}^n$               (displayed)                       $\bigcap_{i=1}^n$               (in-text)

$\lim_{(x,y) \rightarrow (0,0)}$               (displayed)                       $\lim_{(x,y) \rightarrow (0,0)}$               (in-text)

$\lim_{a \rightarrow \infty}$               (displayed)                       $\lim_{a \rightarrow \infty}$               (in-text)

$\lim_{x \rightarrow x_0}$               (displayed)                       $\lim_{x \rightarrow x_0}$               (in-text)

### 5.3 Sample Matrices

$\begin{pmatrix} x_1 \\ x_2 \\ x_3 \end{pmatrix}$	<code>\left( \begin{array}{c} x_1 \\ x_2 \\ x_3 \end{array} \right)</code>
$\begin{bmatrix} x \\ y \end{bmatrix}$	<code>\left[ \begin{array}{c} x \\ y \end{array} \right]</code>
$\begin{pmatrix} a & b \\ c & d \end{pmatrix}$	<code>\left( \begin{array}{cc} a &amp; b \\ c &amp; d \end{array} \right)</code>
$\begin{bmatrix} a & b \\ c & d \end{bmatrix}$	<code>\left[ \begin{array}{cc} a &amp; b \\ c &amp; d \end{array} \right]</code>
$\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$	<code>\left[ \begin{array}{cc} 1 &amp; 0 \\ 0 &amp; 1 \end{array} \right]</code>
$\begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix}$	<code>\left[ \begin{array}{cc} 0 &amp; 1 \\ -1 &amp; 0 \end{array} \right]</code>
$\begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$	<code>\left( \begin{array}{ccc} 1 &amp; 0 &amp; 0 \\ 0 &amp; 1 &amp; 0 \\ 0 &amp; 0 &amp; 1 \end{array} \right)</code>
$\begin{vmatrix} a & b & c \\ d & e & f \\ g & h & i \end{vmatrix}$	<code>\left  \begin{array}{ccc} a &amp; b &amp; c \\ d &amp; e &amp; f \\ g &amp; h &amp; i \end{array} \right </code>
$\begin{pmatrix} a & b & c \\ d & e & f \\ g & h & i \end{pmatrix}$	<code>\left( \begin{array}{ccc} a &amp; b &amp; c \\ d &amp; e &amp; f \\ g &amp; h &amp; i \end{array} \right)</code>
$\begin{bmatrix} a & b & c \\ d & e & f \\ g & h & i \end{bmatrix}$	<code>\left[ \begin{array}{ccc} a &amp; b &amp; c \\ d &amp; e &amp; f \\ g &amp; h &amp; i \end{array} \right]</code>

## 6 Boxes, Tabbing and Tabular Environment Samples

### 6.1 Boxes

**Note:** text

framed box, edit its size

**type header**  
text

framed box, edit its size

**type header**  
text

double framed box, edit its size

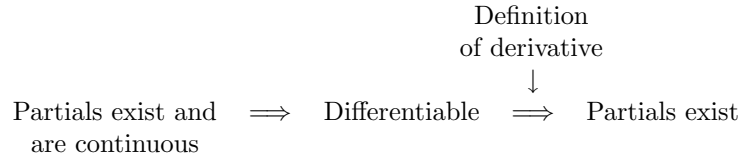
### 6.2 Tabbing

tabbing example 1

items	for	row	one
items	for	row	two

### 6.3 Tabular

tabular example 1 (5 columns)



tabular example 2 (2 columns within a fbox-parbox)

<b>Box 2.1.1 Summary of Important Formulas for §2.1</b>	
<i>Velocity</i>	
$V = \frac{\partial \phi}{\partial t}$	$V^a = \frac{\partial \phi^a}{\partial t}$
$v_t = V_t \circ \phi_t^{-1}$	$v_t^a = V_t^a \circ \phi_t^{-1}$
<i>Covariant Derivative</i>	
$Dv \cdot w = \nabla_w v$	$(\nabla_w v)^a = \frac{\partial v^a}{\partial x^b} w^b + \gamma_{bc}^a w^b v^c$

tabular example 3 (3 columns without a frame)

<i>Classical Tensor Analysis</i>		<i>Tensor Analysis on Manifolds</i>
$\{x^a\}$	Coordinates	$\{x^a\}$
$e_a = \frac{\partial z^i}{\partial x^a} \hat{i}_i$	coordinate basis vectors	$\frac{\partial}{\partial x^a} = e_a$
$\left. \begin{aligned} \bar{e}_a &= \frac{\partial x^b}{\partial \bar{x}^a} e_b \\ \bar{e}^a &= \frac{\partial \bar{x}^a}{\partial x^b} e^b \end{aligned} \right\}$	change of coordinates	$\left\{ \begin{aligned} \frac{\partial}{\partial \bar{x}^a} &= \frac{\partial x^b}{\partial \bar{x}^a} \frac{\partial}{\partial x^b} \\ d\bar{x}^a &= \frac{\partial \bar{x}^a}{\partial x^b} dx^b \end{aligned} \right.$

tabular example 4 (2 columns with lines)

Classical Mechanics	Quantum Mechanics
immersed Lagrangian manifold $\Lambda \rightarrow (T^*Q, \Omega)$	element of $L^2(Q)$ or $\mathcal{D}'(Q)$
$\Lambda = \text{graph of } \mathbf{d}S$	$\psi = \exp(iS/\hbar)$
$T^*Q$	Hilbertspace
Lagrangian manifold $\Omega \subset (T^*Q, \Omega_Q) \times (T^*R, -\Omega_R)$	(possibly unbounded) $L^2(R)$ to $L^2(Q)$
composition of canonical relations	composition of operators

tabular example 5 (same as tabex4, but within a framed box)

Classical Mechanics	Quantum Mechanics
immersed Lagrangian manifold $\Lambda \rightarrow (T^*Q, \Omega)$	element of $L^2(Q)$ or $\mathcal{D}'(Q)$
$\Lambda = \text{graph of } \mathbf{d}S$	$\psi = \exp(iS/\hbar)$
$T^*Q$	Hilbertspace
Lagrangian manifold $\Omega \subset (T^*Q, \Omega_Q) \times (T^*R, -\Omega_R)$	(possibly unbounded) $L^2(R)$ to $L^2(Q)$
composition of canonical relations	composition of operators

tabular example 6 (3 columns with lines)

Case	Conditions	Connection
Unconstrained	$\mathcal{D}_q = T_qQ$	$\mathcal{A}^{\text{sym}}(\dot{q}) = \mathbb{I}^{-1}J(\dot{q})$
Purely Kinematic	$\mathcal{D}_q \cap T_q(\text{Orb}(q)) = \{0\}$	$\mathcal{A}^{\text{kin}}(\dot{q}) = 0$
Horizontal symmetries	$\mathcal{D}_q \cap T_q(\text{Orb}(q))_{\mathcal{G}} = T_q(\text{Orb}(q))_H$	$\mathcal{A}^{\text{sym}}(\dot{q}) + \mathcal{A}^{\text{kin}}(\dot{q}) = \mathbb{I}^{-1}J_H(\dot{q})$
General principal bundle case	$\mathcal{D}_q + T_q(\text{Orb}(q)) = T_qQ$	$\mathcal{A}^{\text{sym}}(\dot{q}) + \mathcal{A}^{\text{kin}}(\dot{q}) = \mathbb{I}^{-1}J^{\text{nhc}}(\dot{q})$

## 7 Pictures

You must include the line

```
\usepackage{graphicx}
```

at the beginning of your document in order to use these commands.

```
\begin{figure}  
\vspace{2in}  
\hspace*{.4in}  
\includegraphics{myfigure.eps}  
\caption{}  
\end{figure}
```