1. Ordinary text

1.1 Punctuation

. period ...
, comma ...
; semicolon ...
: colon ...
? question mark ...
! exclamation ...
“ ‘ ” quotes ...
‘ ‘ ‘ ‘ quotes within quotes ...
\lq \rq single quotes ...
\dots ellipsis ...
( ) parentheses ...
\{ \} brackets ...
\" " " quotes within quotes ...
\{\{\}\}\{\{\}\} quotes within quotes ...

one-of-a-kind ...
2-3 tree ...
pages 6--15 ...
Wisconsin--Madison ...

I win— you lose. ...
I win---you lose. ...

1.2 Accents

é \`e acute ...
è \`e grave ...
ö \ö dieresis or umlaut ...
ő \H o long Hungarian umlaut ...
ö \~o circumflex ...

* \accent{c} General accent; put character \{c\} from the current font over the next character.

1.3 Special characters

# \# pound sign ...
$ \$ dollar sign ...
£ \{\textdialect{\textdollar}\} pounds sterling ...
¢ \hbox{\textdollar\rlap/c} cents sign ...
\% \% percent sign ...
\& \& ampersand ...
* \* asterisk ...
_ \_ underbar ...
\{\text{"\texttt"}\} ditto mark ...
æ, Æ \ae,\AE Latin and Scandinavian ...
oc, Ó \oe,\OE French ...
ß \ss German ...
â, Á \aa,\AA Scandinavian ...
ô, Ō \o,\O Scandinavian ...
ł, Ł \l,\L Polish ...

* \uppercase\{tokens\} Convert tokens to upper case.
* \lowercase\{tokens\} Convert tokens to lower case.
* \number{number} Convert number to arabic digits.
* \roman\{number\} Convert number to lowercase roman numerals.

\uppercase\{\roman\{number\}\} Convert number to uppercase roman numerals.

* \char\{c\} Print character with given code.
* \chardef\cs=\{c\} Define symbolic equivalent to character code.
1.4 Fonts, styles, sizes

\textrm roman \hspace{1cm} \textit italic \hspace{1cm} \textsl slanted
\textbf boldface \hspace{1cm} \texttt typewriter \hspace{1cm} \textsevenrm Seven point roman
\textsevenbf Seven point bold \hspace{1cm} \textsevenit Ten point italic \hspace{1cm} \textsevensl Ten point slanted
\tenrm Ten point roman \hspace{1cm} \tenbf Ten point bold \hspace{1cm} \tenit Ten point italic \hspace{1cm} \tensl Ten point slanted
\fiverm Five point roman \hspace{1cm} \fivebf Five point bold \hspace{1cm} \nullfont Font with no characters

\nullfont

\textit italic correction | extra space compensating for switch from slanted to unslanted fonts, as in \textit italic text / normal text.

\nullfont

\font\cs= \nullfont

\font\cs=\externalname \nullfont

\fontdimen\hnumber\font= \nullfont

\hyphenation{al-go-rithm zy-mur-gy} Add to hyphenation dictionary.

\- Discretionary hyphen: non\-negative.

* \uchyph= \nullfont

* \hyphenchar= \nullfont

* \discretionary{ \nullfont}

\brokenpenalty= \nullfont

\doublehyphendemerits= \nullfont

\hyphenpenalty= \nullfont

\exhyphenpenalty= \nullfont

1.5 Hyphenation

2. White space

2.1 Horizontal

\space Same as \( \hspace{1cm} \) (blank space).

\- Skip this much (breakable), the normal interword amount.

\~ Skip this much (unbreakable), the normal interword amount.

\enskip Skip this much (breakable).

\enspace Skip this much (unbreakable).

\quad Skip this much (breakable).

\qquad Skip this much (breakable).

\thinspace Skip this much (unbreakable).

\negthinspace Skip this much (unbreakable).

\negthinspace Skip this much (unbreakable).

\removelastskip Discard previous skip, if any.

\nonfrenchspacing Extra space after sentences \[ \on].

\frenchspacing No extra space after sentences \[ \off].

* \spaceskip= \nullfont

* \xspaceskip= \nullfont

* \spacefactor= \nullfont

* \sfcode= \nullfont

Use a tie ( ~ ) to avoid breaking line near short words or symbols, as in Chapter^4; Donald^E. Knuth; \$x$, \$y$, and \$z$; speeding is (a)^foolish, (b)^dangerous; algorithm^A; less than^0.
Say Call the FBI to end a sentence with a capital letter, lest \TeX{} omit the extra space after the period.

Say Murder, Inc. did it to end a word with a period in mid-sentence, lest \TeX{} insert extra space.

Use \texttt{\textbackslash frenchspacing} in bibliographies or other copy containing lots of abbreviations.

### 2.2 Vertical

\texttt{\textbackslash smallskip} \hspace{1cm} Skip \hspace{1cm} this much.
\texttt{\textbackslash smallbreak} \hspace{1cm} Skip \hspace{1cm} as above, and encourage page break slightly.
\texttt{\textbackslash medskip} \hspace{1cm} Skip \hspace{1cm} this much.
\texttt{\textbackslash medbreak} \hspace{1cm} Skip \hspace{1cm} as above, and encourage page break.
\texttt{\textbackslash bigskip} \hspace{1cm} Skip \hspace{1cm} this much.
\texttt{\textbackslash bigbreak} \hspace{1cm} Skip \hspace{1cm} as above, and encourage page break a lot.
\texttt{\textbackslash filbreak} \hspace{1cm} Encourage page break, fill bottom of page with white space if break is made.
* \texttt{\textbackslash kern\{dimen\}} \hspace{1cm} Skip given amount (unbreakable).
* \texttt{\textbackslash vskip\{glue\}} \hspace{1cm} Skip given amount (breakable).
\texttt{\textbackslash vglue\{glue\}} \hspace{1cm} Skip given amount (doesn’t disappear at breaks).
* \texttt{\textbackslash vss} \hspace{1cm} Skip by zero, with infinite stretch and shrink.
* \texttt{\textbackslash vfil} \hspace{1cm} Skip by zero, with infinite stretch.
* \texttt{\textbackslash vfill} \hspace{1cm} Skip by zero, with second order infinite stretch.
* \texttt{\textbackslash vfillneg} \hspace{1cm} Skip by zero, with infinite negative stretch.
\texttt{\textbackslash removelastskip} \hspace{1cm} Discard previous skip, if any.

### 3. Layout

#### 3.1 Page image

Line of full width (\texttt{\textbackslash hsize}).

Left-justified line \hspace{1cm} \texttt{\textbackslash leftline\{Left-justified line\}}

Centered line \hspace{1cm} \texttt{\textbackslash centerline\{Centered line\}}

Right-justified line \hspace{1cm} \texttt{\textbackslash rightline\{Right-justified line\}}

Move in both margins, making narrower paragraphs. This is traditional for long quotations.

#### 3. A New Section.

We shall solve a famous problem in Theorem 1.

The first paragraph of a new section is not indented.

**Theorem 1.** All zeros of the zeta function lie on the line $\Re z = 1/2$.

\beginsection 3. A New Section.
\begin{enumerate}
   \item We shall\ldots indented.
   \begin{itemize}
      \item Skips some space (or starts a new page if near the bottom), and displays the title paragraph in bold.
   \end{itemize}
   \end{enumerate}
\proclaim Theorem 1. All...$\Re z=1/2$.
\begin{itemize}
   \item Puts the title in bold and the paragraph in slanted. A period separates title from paragraph.
\end{itemize}

```
\hrule
```

Horizontal rule of given size [height 0.4pt depth 0pt].

```
\vrule
```

Vertical rule of given size [width 0.4pt].

\break \hspace{1cm} Break line or page.
\eject \hspace{1cm} Force page break.
\goodbreak \hspace{1cm} Desirable place for page break.
3.2 Paragraphs

This paragraph has no indentation. All its lines start at the left margin.

This is a normal indented paragraph. Usually no command is required, but \indent also works.

Fully indented paragraph. All its lines are indented.

Paragraph with hanging indentation. The indentation is twice the normal amount, and takes effect after two lines. The normal shape of paragraphs will be restored when this one is done.

- Normal paragraph with a tag in the indent. Only the first line is indented.
  - a) Indented paragraph with a tag in the indent. The whole paragraph is indented.
  - a.1) Doubly indented paragraph with a tag in the indent.

You can change the shape of paragraphs to leave room for figures, or create interesting designs filled with words. This paragraph has a two-tenths inch indent, and also has half an inch taken out of the right after two lines to leave room for a small figure.

* \noindent This...margin.

* \indent This is...works.

\hang Fully...indented.

- \hangindent=2\parindent Amount of hanging indentation (a \langle dimen\rangle).
  - Positive indents at the left, negative at the right.

- \hangafter=2 Paragraph...done.
  - Duration of hanging indentation. Positive indents after \n lines, negative indents first $-\n$ lines.

\textindent{$\bullet$} Normal...indented.

\item{a)} Indented...indented.

\itemitem{a.1)} Doubly...indent.

\parshape=3 .2in 2.8in 0pt 3in 0pt 2.5in

You...figure.

The first number tells how many shape pairs there are; then comes pairs of dimensions, giving indents and lengths of each line. The last pair is repeated for extra lines, if any.

* \par

\langle blank line\rangle

\endgraf

- \parskip=\langle glue\rangle
  - End the paragraph (synonym for \par).

- \parindent=\langle dimen\rangle
  - Indentation for first line of paragraphs [20pt].

- \looseness=\langle number\rangle
  - Try to make next paragraph \n lines longer/shorter.

- \parfillskip=\langle glue\rangle
  - Glue added to last line of paragraph [0pt plus 1fil].

- \interlinepenalty=\langle penalty\rangle
  - Between every line in a paragraph [0].

- \clubpenalty=\langle penalty\rangle
  - After first line of paragraph [150].

- \widowpenalty=\langle penalty\rangle
  - Before last line of paragraph [150].

- \displaywidowpenalty=\langle penalty\rangle
  - Before line preceding a display [50].

- \finalhyphendemerits=\langle merit\rangle
  - Demerits for ending penultimate line with discretionary break [5000].

Say \{\setbox0=\lastbox\} at the beginning of the paragraph to discard the indentation.

3.3 Lines

- \leftskip=\langle glue\rangle
  - Glue at left of every line of paragraph.

- \rightskip=\langle glue\rangle
  - Glue at right of every line of paragraph.

\raggedright

\tgravagedright

Use font \tt and don’t align right margins.
\normalbaselines Make lines the normal distance apart.
\openup ⟨dimen⟩ Add ⟨dimen⟩ to distance between lines, usually expressed in terms of \jot.
\strut Give line height and depth, separating it from its neighbors.
\strutbox Invisible box used for \strut.
\baselineskip = ⟨glue⟩ Distance between baselines [12pt].
\lineskip = ⟨glue⟩ Glue between close lines [1pt].
\lineskiplimit = ⟨dimen⟩ Threshold for lines to be close [0pt].
\normalbaselineskip = ⟨glue⟩ Distance between lines [12pt].
\normallineskip = ⟨glue⟩ Glue between close lines [1pt].
\normallineskiplimit = ⟨dimen⟩ Threshold for lines to be close [0pt].
\nointerlineskip Omit interline glue.
\offinterlineskip Turn off spacing between lines.
\adjdemerits = ⟨demerit⟩ Demerits for adjacent incompatible lines [10000].
\linepenalty = ⟨penalty⟩ Contributes to every line’s badness [10].
\tolerance = ⟨badness⟩ Badness threshold for acceptable line breaks [200].
\pretolerance = ⟨badness⟩ Badness threshold for breaks without hyphens [100].

3.4 Horizontal
\llap{⟨contents⟩} Overlap contents to the left.
\rlap{⟨contents⟩} Overlap contents to the right.
\underbar{⟨contents⟩} Underline contents.
\hrulefill Like \hfill, except use a rule (______).
\dotfill Like \hfill, except use dots (.........).
\leftarrowfill Like \hfill, except use a left arrow (−−−−−−).
\rightarrowfill Like \hfill, except use a right arrow (−−−−−−!).
\upbracefill Like \hfill, except use an upbrace (|{|}{}).
\downbracefill Like \hfill, except use a downbrace (|{}}{}).

4. Text constructions
4.1 Horizontal
* \hbox [to ⟨dimen⟩ spread ⟨dimen⟩] {⟨contents⟩} Create horizontal box.
* \lower ⟨dimen⟩ Move next box down.
* \raise ⟨dimen⟩ Move next box up.
* \leaders \leaders \leaders Fill the space occupied by the glue with copies of the box. Align the reference points of the boxes with the enclosing box.
* \cleaders Like \leaders, except align the boxes in the center of the glue, leaving white space at either end.
* \xleaders Like \leaders, except align the boxes within the glue, distributing leftover space equally between boxes.
\phantom{⟨contents⟩} Invisible box of height, depth, and width of contents.
\hphantom{⟨contents⟩} Invisible box of height and depth 0, width of contents.
\smash{⟨contents⟩} Visible box of height and depth 0, width of contents.
\null Empty hbox.
\leavevmode Start a paragraph.
* \lastskip Size of last glue, if any.
* \lastpenalty Amount of last penalty, if any.
* \lastkern Dimension of last kern, if any.
* \unskip Discard the last glue or leaders, if any.
* \unpenalty Discard last penalty, if any.
* \unkern Discard last kern, if any.
* \lastbox Remove last \hbox or \vbox from current list and use it here.
4.2 Vertical

* `\vbox` \to \{\dimen\} \{\langle\text{contents}\rangle\} Create vertical box.
* `\vtop` \to \{\dimen\} \{\langle\text{contents}\rangle\} Create vertical box with reference point at top.
* `\$\vcenter` \{\langle\text{vertical mode}\rangle\}$ Create vertical box centered around axis.
* `\moveleft` \{\dimen\} Shift next box left.
* `\moveright` \{\dimen\} Shift next box right.
* `\vphantom` \{\langle\text{contents}\rangle\} Invisible box of width 0, height and depth of contents.
* `\lastskip` Size of last glue, if any.
* `\lastpenalty` Amount of last penalty, if any.
* `\lastkern` Dimension of last kern, if any.
* `\unskip` Discard the last glue or leaders, if any (except in main vertical list).
* `\unpenalty` Discard last penalty, if any (except in main vertical list).
* `\unkern` Discard last kern, if any (except in main vertical list).
* `\lastbox` Remove last `\hbox` or `\vbox` from current list and use it here (except in main vertical list).
* `\everyvbox`\{\langle\text{tokens}\rangle\} Insert tokens into every `\vbox` \{\langle\text{null}\rangle\}.
* `\prevdepth` \{\dimen\} Depth of last box on current vertical list.
* `\boxmaxdepth` \{\dimen\} Maximum depth of vertical boxes \{\langle\text{1}\rangle\}.
* `\vsplit` \{\langle\text{breg}\rangle\} \to \{\dimen\} Split off material from beginning of box register to form `\vbox` of height \{\dimen\}.
* `\splitmaxdepth` \{\dimen\} Maximum depth of box formed via `\vsplit` \{\langle\text{1}\rangle\}.
* `\splittopskip` \{\langle\text{glue}\rangle\} Glue added before first box in a `\vsplit` \{\langle\text{10pt}\rangle\}.

4.3 Paragraphs

* `\vadjust`\{\langle\text{vertical mode}\rangle\} Add to paragraph after current line.
* `\obeylines` End of input line generates `\par`.
* `\obeyspaces` Don’t ignore consecutive spaces between words.
* `\everypar`\{\langle\text{tokens}\rangle\} Read tokens at the beginning of every paragraph.
* `\prevgraf` Number of lines in the last paragraph. Displays count as 3 lines.

To make a paragraph in a box, say `\vbox\{\hspace{\dimen}\} \indent \langle\text{text}\rangle\}$. `\vtop` works similarly.

5. Mathematics

\begin{verbatim}
\{\langle\text{math mode}\rangle\} \$ \quad \{\langle\text{math mode}\rangle\} \$
\{\langle\text{display math mode}\rangle\} \$
\{\langle\text{superscript}\rangle\} \quad \{\langle\text{script}\rangle\}
\{\langle\text{subscript}\rangle\} \quad \{\langle\text{subscript}\rangle\}
\end{verbatim}

5.1 Special characters

<table>
<thead>
<tr>
<th>Character</th>
<th>Symbol</th>
<th>Pronunciation</th>
</tr>
</thead>
<tbody>
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5.2 Arithmetic

<table>
<thead>
<tr>
<th>Operation</th>
<th>TeX Code</th>
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<tr>
<td>Sum</td>
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</tr>
<tr>
<td>Product</td>
<td>\prod</td>
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<tr>
<td>Plus</td>
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<tr>
<td>Minus</td>
<td>\mp</td>
</tr>
<tr>
<td>Sum'</td>
<td>\mathop{{\sum}'}</td>
</tr>
<tr>
<td>Not equal</td>
<td>\neq</td>
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<tr>
<td>Greater than</td>
<td>\succ</td>
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<tr>
<td>Less than</td>
<td>\prec</td>
</tr>
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<td>Greater than or equal to</td>
<td>\geq</td>
</tr>
<tr>
<td>Less than or equal to</td>
<td>\leq</td>
</tr>
<tr>
<td>Absolute value</td>
<td>\left</td>
</tr>
<tr>
<td>Division</td>
<td>\div</td>
</tr>
<tr>
<td>Square root</td>
<td>\sqrt{x}</td>
</tr>
</tbody>
</table>

Put physical units in roman, preceded by a thin space: 2.54 cm (2.54 \, \text{cm}).

Put thin space after square root followed by letter or digit: \sqrt{\pi \, n}.

5.3 Sets

<table>
<thead>
<tr>
<th>Set Notation</th>
<th>TeX Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>{</td>
<td>{</td>
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<tr>
<td>\emptyset</td>
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<tr>
<td>\mid</td>
<td>\mid</td>
</tr>
</tbody>
</table>

Use thin spaces to set off set brackets when the set is defined by membership test:

\{ x : f(x) = 0 \} (\{ x \mid x : f(x) = 0 \}).

Don't use thin spaces for explicitly given sets: \{1, 4, 9\} (\{1, 4, 9\}).

5.4 Algebra

<table>
<thead>
<tr>
<th>Algebraic Operation</th>
<th>TeX Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree</td>
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</tr>
<tr>
<td>Determinant</td>
<td>\det</td>
</tr>
<tr>
<td>Dimension</td>
<td>\dim</td>
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<tr>
<td>Homomorphism</td>
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<tr>
<td>Kernel</td>
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</tbody>
</table>

7
5.5 Analysis

\sin \quad \sinh \quad \exp \quad f' \quad f''
\cos \quad \cosh \quad \log \quad f' \quad f'''
\tan \quad \tanh \quad \ln \quad f'' \quad f'''
\sec \quad \sech \quad \lg \quad \partial \quad \partial
\csc \quad \csch \quad \Re \quad \Im \quad \nabla
\cot \quad \coth \quad \Im \quad \Im \quad \int
\arcsin \quad \arcsinh \quad \arg \quad \arg \quad \int
\arccos \quad \arccosh \quad \deg \quad \deg \quad \int
\arctan \quad \arctanh \quad \asymp \quad \asymp \quad \oint

Put a thin space before differentials: \( f(x) \, dx \) (\( f(x) \, dx \)).
Put negative thin spaces between multiple integrals: \( \int \int f(x,y) \) (\( \int \int f(x,y) \)).

5.6 Logic

\neg \quad \Rightarrow \quad \models \quad \bigvee
\lnot \quad \iff \quad \vdash \quad \bot
\land \quad \leftarrow \quad \exists \quad \bigwedge
\lor \quad \rightarrow \quad \forall \quad \top

5.7 Discrete math

! \quad ! \ (\text{factorial}) \quad \backslash \quad \\%
\lg \quad \lg \quad \cong \quad \\cong
\gcd \quad \gcd \quad \equiv \quad \equiv
\lfloor \quad \rfloor \quad a \mod p = 1 \quad a \bmod p = 1 \ (\text{mod as binary operator})
\lceil \quad \rceil \quad a \equiv 0 \ (\text{mod } p) \quad a \equiv 0 \pmod{p} \ (\text{mod as adverb})
{n \choose k} \quad \{n\choose k} \quad \prec \quad \prec
{n \brace k} \quad \{n\brace k} \quad \preceq \quad \preceq
{n \brack k} \quad \{n\brack k} \quad \succ \quad \succ
{n \backslash k} \quad \{n\backslash k} \quad \succ \quad \succ

Put a thin space after factorials followed by a letter, digit, or left delimiter: \( k!(n-k)! \) (\( k!(n-k)! \)).

5.8 Geometry and probability

\angle \quad \parallel \quad \Pr \quad \Pr
\triangle \quad \perp

5.9 Accents and diacritics

\hat \quad \dot \quad \acute \quad \overline{w+x}
\widehat \quad \ddot \quad \grave \quad \underline{w+x}
\bar \quad \tilde \quad \check \quad \imath
\vec \quad \widetilde \quad \breve \quad \jmath

\skew(number)(accent)(char) \quad \text{Place accent over character, moved right (number) \text{math units}.}
* \mathaccent(ncode)(formula) \quad \text{Place character as accent over formula.}
\textbullet \skewchar(font)(ccode) \quad \text{Kern accents as if the accentee were followed by this character.}
5.10 Miscellaneous operators and relations

\not (overstrikes next character) \dagger \ddagger \wedge \triangleleft \triangleright \bigtriangledown \bigtriangleup \diamond \bowtie \uplus \Uplus \biguplus \dagger \ddagger \^ \_ \frown \oplus \ominus \otimes \odot \oslash \bigoplus \bigotimes \bigodot ^ \_ \wedge \vee \sqsubseteq \sqsupseteq \sqcap \sqcup \bigwedge \bigvee \bigsqcup

\buildrel (superscript) \over (relation) Form new relation with superscript:

\rightarrow (null delimiter)

5.11 Delimiters and punctuation

\big \Big \bigg \Bigg

\left \right \middle \bigl \bigr \bigm \Bigl \Bigr \Bigm \lgroup \rgroup \lmoustache \rmoustache

\{ {,} \} \lgroup \rgroup \llav\\rav

\langle \rangle \lceil \rceil \langle \rangle \\langle \rangle

| (\ldots) (a_1,\ldots,a_n) \cdot

| (a \atop b) \atop (c) \atop (a) \atop (b) \atop (c)

\colon \colon \colon \colon \colon

Comma within number.

2.71828 2{\cdot}71828 Raised decimal point.

\colon \colon \colon \colon \colon \colon \colon \colon \colon \colon \colon

Colon as punctuation, instead of operator ( f\colon A \to B).

(a_1,\ldots,a_n) Ellipsis

b_1\cdots b_n Centered ellipsis

\ddots Diagonal ellipsis (for matrices)

\vdots Vertical ellipsis

* \left(\del_1\right)\right) \text{ Variable size delimiters.}

• \nulldelimiterspace=dimen \text{ Width of null delimiter [1.2pt].}

Put sentence punctuation outside text math mode: Given-\$a\$, \$b\$, and-\$c\$, find their average ;

but inside display math mode: The answer is $$\{a+b+c \over 3\}.$$.

Put a thin space after an ellipsis followed by more punctuation:

Let \(f(z) = 1 + z + z^2 + \cdots\). ( Let $$f(z) = 1 + z + z^2 + \cdots.$$.)
5.12 Pointers

\leftarrow \rightarrow \Leftarrow \Rightarrow \leftrightarrow \Leftrightarrow \to \longmapsto \hookrightarrow \lefttharpoonup \leftharpoondown \rightharpoonup \rightharpoonup \rightleftharpoons \downarrow \uparrow \Uparrow \Downarrow \updownarrow \nearrow \searrow \swarrow \nwarrow \lhook \rhook \mapstochar \surd

5.13 Character pieces

\braceld \bracelu \bracerd \braceru \relbar \Rightarrow \leftarrow \relbar \Leftarrow \rightarrow \relbar \Rightarrow \leftarrow \relbar \Rightarrow \leftarrow \rightarrow \relbar \Rightarrow \leftarrow \rightarrow \relbar \Rightarrow \leftarrow

6. Mathematics layout

6.1 Math text

\frac{1}{1-x} \quad \frac{\frac{1}{x}}{\frac{1}{1-x}} \quad \frac{x}{y} \quad \frac{\overbrace{\text{formula}}}{\underbrace{\text{formula}}} \quad \overrightarrow{\text{ formula}} \quad \overleftarrow{\text{ formula}}

\cases{f_1 & \text{first line} \\
          f_2 & \text{second line}}

\begin{pmatrix} 1 & 1 \\ 0 & 1 \end{pmatrix}

\begin{bmatrix} u & 1 & 1 \\ v & 0 & 1 \end{bmatrix}

\sum_{n>0} f(n) \quad \sum \limits_{n>0} f(n)
* \nolimits
Put next super/subscripts beside previous large operator:
\[ \sum_{n>0} f(n) \text{ (\sum\nolimits_{n>0} f(n)).} \]

* \displaylimits
Put limits over operator in display style, beside in text style.

Use \atop and \scriptstyle for many-line limits:
\[ \sum_{0<i<n \atop 0<j<n} A[i,j]. \]

Use \displaystyle and \strut to get continued fractions:
\[ a_0 \frac{1}{a_1 \frac{1}{a_2 \frac{1}{a_3}}}. \]

6.2 Displays

* \eqno(formula)
At end of display mode: Display \( \text{formula} \) as an equation number.

* \leqno(formula)
At end of display mode: Display \( \text{formula} \) as equation number at left.

\[ LHS_1 = RHS_1 \]
\[ LHS_2 < RHS_2 \]
\[ \text{eqalign}{LHS_1 &= RHS_1 \cr LHS_2 &< RHS_2 \cr}. \text{Aligned equations. Any number of lines. Produces a vertically centered box.} \]
\[ \text{eqalignno}{LHS_1 &= RHS_1 \cr EQNO_1 \cr}. \text{Aligned equations with individual equation numbers. Any number of lines. Produces lines of full display width.} \]
\[ \text{eqalignno} \]
Like \text{eqalignno}, but puts equation numbers on the left.
\[ \text{displaylines}{\langle \text{formula}_1 \rangle \cr \langle \text{formula}_2 \rangle \cr}. \text{Unaligned formulas, one per line. Any number of lines.} \]
\[ \text{openup}(\dimen) \]
Add \( \langle \dimen \rangle \) to distance between lines, usually expressed in terms of \hsize.
\[ \text{displaywidth}(\dimen) \]
Goal width for current display \( \hsize \).
\[ \text{displayindent}(\dimen) \]
Indentation for current display \( \text{\hsize} \).
\[ \text{predisplaysize} \]
Width of line preceding current display.
\[ \text{predisplaypenalty}(\text{penalty}) \]
Penalty before a display \( 10000 \).
\[ \text{postdisplaypenalty}(\text{penalty}) \]
Penalty after a display \( 0 \).
\[ \text{abovedisplayskip}(\text{glue}) \]
Glue before a display \( 12pt \text{ plus } 3pt \text{ minus } 9pt \).
\[ \text{belowdisplayskip}(\text{glue}) \]
Glue after a display \( 12pt \text{ plus } 3pt \text{ minus } 9pt \).
\[ \text{abovedisplayshortskip}(\text{glue}) \]
Glue before a display preceded by a short line \( 0pt \text{ plus } 3pt \).
\[ \text{belowdisplayshortskip}(\text{glue}) \]
Glue after a display preceded by a short line \( 7pt \text{ plus } 3pt \text{ minus } 4pt \).

Use \text{eqalignno} instead of \text{eqalign} when (1) equation numbers apply to one line rather than the whole display, (2) page breaks are allowed between lines, or (3) short lines of text come between aligned lines of display, as in \text{eqalignno}{x=x \cr \noalign{\hbox{and}} y=z \cr}.

Set \text{postdisplaypenalty} to \text{-10000} inside a display to force it to appear at the bottom of the page.

6.3 Fonts, styles, and families

* \displaystyle
Switch to display style.

* \textstyle
Switch to text style.

* \scriptstyle
Switch to script style.

* \scriptscriptstyle
Switch to scriptscript style.

* \textfont
Define text font of family.

* \scriptfont
Define subscript font of family.

* \scriptscriptfont
Define subsubscript font of family.

* \newfam
Allocate symbolic family.

* \fam
Select family.
\rm Switch to roman: $Ax = b + \text{error}$.
\bf Switch to bold: $\mathbf{Ax} = \mathbf{b} + \text{error}$.
\it Switch to text italic: $Ax = b + \text{error}$ (text size only).
\sl Switch to slanted: $Ax = b + \text{error}$ (text size only).
\tt Switch to typewriter: $\texttt{Ax} = \texttt{b} + \texttt{error}$ (text size only).

7. Mathematics constructions

* \vcenter{to (dimen)} \spaced (dimen) \{vertical mode\} Create vertical box centered around axis.
\mathstrut Invisible box, forcing height and depth of left paren.

\everymath={h tokens} Insert $h$ tokens before every formula.
\everydisplay={h tokens} Insert $h$ tokens before every display.
\relpenalty=$h$ penalty Penalty for breaking line after Rel atom [ 500]
\binoppenalty=$h$ penalty Penalty for breaking line after Bin atom [ 700]

7.1 White space

\, thin space (before $dx$, units, some left parens; after factorials)
\> medium space
\; thick space
\! negative thin space

\mskip{muglue} Explicit math glue (breakable).
\m kern{madimen} Explicit math space (unbreakable).
\mathsurround=$h$ glue Spacing before and after inline formulas [ 0pt].
\th mmumskip{muglue} Thin space amount [ 3mu]
\medmuskip{muglue} Medium space amount [ 4mu plus 2mu minus 4mu]
\thickmuskip{muglue} Thick space amount [ 5mu plus 5mu]
\scriptspace={dimen} Extra space after a sub/superscript [ 0.5pt].
\nonscript Next glue or kern ignored in script or scriptscript style.

7.2 Packaging

* \mathord{(formula)} Ordinary character.
* \mathbin{(formula)} Binary operation.
* \mathop{(formula)} Large operator.
* \mathrel{(formula)} Relation.

* \radical{dcode}(formula) Form radical using given delimiter code.
* \mathaccent{mcode}(formula) Place character as accent over formula.
* \delcode{ccode} ={dcode} Define small and large delimiter codes for character.
* \delimiter{dcode} Use explicit delimiter code.

8. Tables

8.1 Tabbing

\settabs\{ \cr \} Set tab stops in equally spaced columns, or as in sample line.
\+{text\_1} \&{text\_2} \cr Print line with tabs; successive \text{}s start at successive tab stops. Any number of \text{}s. A \& after existing tabs sets a new tab stop.
\tabalign Like \+, except permissible in “inner” contexts.
\cleartabs Erase tab stops to the right of current stop.
\tabs Register number of tab box.

Normal tab fields are flushed left. To flush a field right, say \texttt{\hfill{text}}; to center a field, say \texttt{\hfill{text}} \texttt{\hfill}.  

12
8.2 Alignment

* \halign[\to\{\hdimen\} \spread\{\hdimen\}]
  \{\{\halign\} \cr \{\halign\}}
  Form table from body with column templates given in preamble. In body, columns are
  separated by \&halign text, each row ends with \crhalign text.

* \valign[\to\{\hdimen\} \spread\{\hdimen\}]
  \{\{\halign\} \cr \{\halign\}}
  Form table in vertical mode from body, with row templates given in preamble. In body, rows
  are separated by \&halign text, each column ends with \crhalign text.

\& Column (row) separator.
* \crhalign text End of aligned row (column).
* \endlinehalign text Synonym for \crhalign text.
* \crrchalign text Force \crhalign text.
* \&&halign text In preamble, or \& at beginning of preamble: Cycle through remaining
  templates as often as needed.

* \noalignhalign text Insert contents between rows (columns) of \halignhalign text (\valignhalign text).
  \tabskip=\hglue Glue between columns (rows).
* \omit As first token in a column: Use # instead of template from the preamble.
* \spanhalign text In body (in place of \&halign text): Merge adjacent columns. In preamble:
  Expand the next token while reading preamble.

\multispan\{number\} Merge \{number\} columns without their templates.
\hidewidth\{entry\} Allow entry to stick out of column at the left.
\entry\hidewidth\{entry\} Allow entry to stick out of column at the right.
* \everycr=\{tokens\} Insert tokens after every \crhalign text.

\oalignhalign text Put characters over each other.
\ooalignhalign text Superimpose characters.
* \floatpenalty=\{penalty\} Penalty for splitting insertions across page [0].

To make tables with butting \vrules in each row, use \offinterlineskip (to butt rows together) and
\strut (to make height of rows the same).

9. Figures and footnotes

\footnote\{mark\} \{(text\} Print reference mark, and insert footnote at bottom of page.
\vfootnote\{mark\} \{(text\} Insert footnote at bottom of page. Use near an insertion to generate a
footnote to the insertion.
\footnoterule Line separating page from footnotes [\hrule width 2truein, raised 3pt].
\midinsert\{vertical mode\} \endinsert Insert nearby.
\topinsert\{vertical mode\} \endinsert Insert at top of nearby page.
\pageinsert\{vertical mode\} \endinsert Insert a full page nearby.
\footins Insertion class for footnotes.
\topins Insertion class for top insertions.
\newinsert\cs Allocate symbolic insertion class.
* \insert\{number\} Insertion class.
* \floatpenalty=\{penalty\} Penalty for splitting insertions across page [0].

10. Computer programs

: : =
\gets

Use text italic for identifiers, boldface for keywords, math mode for expressions.
One way to get indenting using tabs, indenting to fit text:

\texttt{\for \(k \gets 1 \to n\) \do \value \gets f(k) \if \value > \max \then \max \gets \value \index \gets k \fi \od}

Another way, using \texttt{\leftskip} with fixed indentation:

\texttt{\newdimen\progindent \progindent=20pt \def\bumpindent{\advance\leftskip by \progindent} \def\exdent{\advance\leftskip by -\progindent} {\obeylines \everypar={\hangindent 2\progindent} \for \(k \gets 1 \to n\) \bumpindent \\{bf for\} \$k$ \gets \$n$\$ \bumpindent \value \gets f(k) \bumpindent \if \value > \max \then \max \gets \value \index \gets k \fi \exdent \od\exdent \} \% turn off \obeylines

11. Macros

11.1 Definitions

* \texttt{\def\cs\{parameter text\} \{replacement text\}} Define macro \texttt{\cs}.

* \texttt{\edef} Like \texttt{\def}, but definition is global.

* \texttt{\gdef} Like \texttt{\def}, but expands replacement text before definition.

* \texttt{\xdef} Like \texttt{\gdef}, but expands replacement text before definition.

* \texttt{\long} Next-defined macro allows its arguments to include \par.

* \texttt{\outer} Next-defined macro cannot appear as an argument, in a definition, in an alignment preamble, or in conditional text.

* \texttt{\#} Parameter number \(n\) (in parameter or replacement text).

* \texttt{\##} In replacement text, yields a single \#.

* \texttt{\{\}} At end of parameter text, delimits last argument by \{ and yields \} at the end of replacement text.

* \texttt{\let\cs\{token\}} Give \cs the token’s current meaning.

* \texttt{\futurelet\cs\{token\}} Give \cs the second token’s meaning, then read \texttt{\cs\{token\}}.

11.2 Scoping and expansion

\texttt{\{} Block structure.

\texttt{\begingroup \egroup} Implicit \{\}.

\texttt{\begin{group}} Alternate block structure.

\texttt{\global} Next command affects all blocks.

\texttt{\afterassignment\{token\}} Save token and reread it after the next assignment. If the assignment is a \texttt{\setbox}, reread the token as first token of \texttt{\hbox}, \texttt{\vbox}, or \texttt{\vtop}.

\texttt{\aftergroup\{token\}} Save token and reread it after leaving the current group.
\* \expandafter\(\text{token}_1\langle\text{token}_2\rangle\) Expand \text{token}_2, then read \text{token}_1 followed by the expansion.
\* \noexpand\(\text{token}\) Don’t expand \text{token}.
\* \ignorespaces Ignore input tokens until a non-white one.
\* \relax Do nothing.
\empty Macro that expands to nothing.

11.3 Control flow
\* \if\(\text{if-command}\langle\text{true text}\rangle\) \else\(\langle\text{false text}\rangle\) \fi Conditional. Else part (\\else\langle\text{false text}\rangle\) is optional.
\* \ifnum\(\langle\text{number}_1\rangle\langle\text{relation}\rangle\langle\text{number}_2\rangle\) Numeric comparison; \langle\text{relation}\rangle is <, =, or >.
\* \ifodd\langle\text{number}\rangle True if \langle\text{number}\rangle is odd.
\* \ifcase\langle\text{number}\rangle\langle\text{text}_1\rangle \or\langle\text{text}_2\rangle \else\langle\text{default text}\rangle\fi Multi-way conditional. The \langle\text{number}\rangle selects the text to use. Any number of cases allowed.
\* \ifdim\langle\text{dimen}_1\rangle\langle\text{relation}\rangle\langle\text{dimen}_2\rangle\) Numeric comparison of dimensions; \langle\text{relation}\rangle is <, =, or >.
\* \if\(\langle\text{relation}\rangle\) True if next two tokens (without expansion) are either (a) macros with same parameters and definitions, or (b) non-macros with same character codes and same category codes.
\* \if\(\langle\text{relation}\rangle\) True if next two tokens (after expanding macros) have same character codes.
\* \if\(\langle\text{relation}\rangle\) True if next two tokens (after expanding macros) have same category codes.
\* \if\(\langle\text{relation}\rangle\) True if next two tokens (after expanding macros) have same character codes.
\* \if\(\langle\text{relation}\rangle\) Unexpandable control sequence tokens (like \relax have character code 256.
\* \if\(\langle\text{relation}\rangle\) True if next two tokens (after expanding macros) have same category codes.
\* \if\(\langle\text{relation}\rangle\) Unexpandable control sequence tokens (like \relax have category code 16.
\* \ifhbox\langle\text{number}\rangle True if \box\langle\text{number}\rangle is an hbox.
\* \ifvbox\langle\text{number}\rangle True if \box\langle\text{number}\rangle is a vbox.
\* \ifvoid\langle\text{number}\rangle True if \box\langle\text{number}\rangle is void.
\* \ifhmode True if \TeX is in horizontal or restricted horizontal mode.
\* \ifvmode True if \TeX is in vertical or internal vertical mode.
\* \ifmodemode True if \TeX is in math or display math mode.
\* \ifinner True if \TeX is in restricted horizontal, internal vertical or text math mode.
\* \ifeof\langle\text{stream}\rangle True if stream cannot supply more tokens.
\* \iftrue Always true.
\* \iffalse Always false.
\newif\iffoo Define switch and three macros: \footrue turns switch on, \foofalse turns switch off, \iffoo tests switch. Use any word instead of foo.
\loop\langle\text{text}_1\rangle\langle\text{if-command}\rangle\langle\text{text}_2\rangle \repeat Iterate commands in the two texts until the \if fails.

11.4 Numeric registers
\newcount\cs Allocate symbolic count register.
\newdimen\cs Allocate symbolic dimen register.
\newskip\cs Allocate symbolic skip register.
\newmuskip\cs Allocate symbolic math glue register.
\* \count\langle\text{number}\rangle Count register.
\* \dimen\langle\text{number}\rangle Dimension register.
\* \skip\langle\text{number}\rangle Glue register.
\* \muskip\langle\text{number}\rangle Math glue register.
\* \countdef\cs=\langle\text{number}\rangle Define symbolic count register.
\* \dimendef\cs=\langle\text{number}\rangle Define symbolic dimen register.
\* \skipdef\cs=\langle\text{number}\rangle Define symbolic skip register.
\* \muskipdef\cs=\langle\text{number}\rangle Define symbolic math glue register.
\* \advance\langle\text{register}\rangle by \langle\text{number}\rangle Add to register.
\* \multiply\langle\text{register}\rangle by \langle\text{number}\rangle Multiply register.
\* \divide\langle\text{register}\rangle by \langle\text{number}\rangle Divide register.
\count0 holds the page number. \count0 through \count9 are logged and displayed on the terminal when page is shipped out.

11.5 Box registers
\newbox\cs Allocate symbolic box register.
* \setbox(breg) ={(box)} Assign to box register.
* \box(breg) Use box register.
* \unhbox(breg) Use box register without outer level of horizontal boxing.
* \unvbox(breg) Use box register without outer level of vertical boxing.
* \copy(breg) Copy box register.
* \unhcopy(breg) Copy box register without outer level of horizontal boxing.
* \unvcopy(breg) Copy box register without outer level of vertical boxing.

11.6 Converting tokens, variables, strings, csnames, etc
\day Day of month (a \number).
\month Month of year (a \number).
\year Current year (a \number).
\time Time of day (a \number), in minutes since midnight.
* \uppercase{tokens} Convert tokens to upper case.
* \lowercase{tokens} Convert tokens to lower case.
* \number{number} Convert number to arabic digits.
* \romannumeral{number} Convert number to lowercase roman numerals.
• \fontname{Name of font, including scaling.}
* \jobname{Name of TEX job, used to name .dvi and .log files.}
* \csname{tokens}\endcsname Expand tokens and convert to control sequence.
* \string{cs} Convert name of \cs to token list.
• \escapechar= Code used when converting \cs to tokens [ `\].
* \the{internal quantity} Token list describing a \TeX variable.
\newtoks\cs Allocate symbolic token list.
* \toks{number} Token list register.
* \toksdef{cs}{(number)} Define symbolic token list register.

12. Page design
12.1 Size
• \hsize=\dimen Define width of lines.
• \vsize=\dimen Define height of pages.
• \hoffset=\dimen Move page image to the right.
• \voffset=\dimen Move page image down.
\magnification=number Enlarge document by factor of (\number)/1000.
\magstep{number} \[1000 * 1.2^{(number)}\], for use in \magnification and scaled size of fonts.
\magstephalf \[1000 * \sqrt{2}\], likewise.
• \mag=\number Global magnification factor + 1000 [ 1000].

12.2 Headers, footers, page numbers
\headline={\contents} Print contents at top of every page.
\footline={\contents} Print contents at bottom of every page.
• \pageno Page number.
\folio Page number in arabic if \pageno \geq 0, in roman numerals if \pageno < 0.
\nopagenumbers Don’t print page numbers.
\advancepageno Increase magnitude of page number.
• \topskip=\glue Glue before first box of each page [10pt].
\normalbottom Move last line to bottom of page [on].
\raggedbottom Don’t move last line to bottom of page [off].
Increase `\voffset` for nonempty `\headline` to keep 1in margin at top.

### 12.3 Marks

* `\mark{<contents>}` Put mark into page.
* `\topmark` Last mark seen before current page.
* `\firstmark` First mark on page if any; if none, same as `\topmark`.
* `\botmark` Last mark seen up to end of page.
* `\splitfirstmark` First mark in most recent `\vsplit`.
* `\splitbotmark` Last mark in most recent `\vsplit`.

Put `\marks` after boxes, not before.

### 12.4 Output routines

* `\output={<tokens>}` Define output routine.
  - `\pagebody` Box containing page contents.
  - `\pagecontents` Vertical list of page, including insertions.
* `\outputpenalty` Penalty observed at page break.
* `\box255` In output routine: Contents of page.
* `\shipout{<box>}` Send box to DVI file.
* `\deadcycles=(number)` Number of `\outputs` since last `\shipout`.
* `\maxdeadcycles=(number)` Error if `\deadcycles` exceeds this [25].

### 12.5 Page in progress

* `\pagetotal=(dimen)` Height of current page so far.
* `\pagegoal=(dimen)` Page height goal.
* `\pagelstretch=(dimen)` Amount of normal stretch on page so far.
* `\pagefillstretch=(dimen)` Amount of infinite stretch on page so far.
* `\pagefillfillstretch=(dimen)` Amount of doubly infinite stretch on page so far.
* `\pagefillfillfillstretch=(dimen)` Amount of triply infinite stretch on page so far.
* `\pageshrink=(dimen)` Amount of shrink on page so far.
* `\pagedepth=(dimen)` Depth of page so far.
* `\insertpenalties=(number)` Penalty due to insertions on page so far.

### 13. Controlling \TeX

#### 13.1 Starting, stopping, reading files

* `\input{<file>}` Read from file.
* `\endinput` Stop reading from current file.
* `\blank` Generate `\par`, ending paragraph.
* `\obeylines` End of input line generates `\par`.
* `\obeyspaces` Don’t ignore consecutive spaces between words.
* `\bye` End the document.
* `\end` Stop processing.
* `\everyjob={<tokens>}` Read tokens at start of every document.

#### 13.2 Auxiliary files

* `\newread\cs` Allocate symbolic input stream.
* `\openin(stream) ={<file>}` Prepare to read file through a stream.
* `\read(stream) to \cs` Define `\cs` to be a macro without parameters whose replacement text is next line of stream (or more if necessary to balance braces). If stream isn’t open, use terminal (suppressing prompt if stream is negative).
* `\closein(stream)` Stop reading from stream.
* `\newwrite\cs` Allocate symbolic output stream.
* `\openout(stream) ={<file>}` Prepare to write to file through a stream.
\texttt{\write\{stream\}\{\langle tokens\rangle\}} \hspace{1em} \text{Expand and append tokens to the stream, followed by a newline. Doesn’t actually happen until page is shipped out (unless preceded by \texttt{immediate}).}

\texttt{\closeout\{stream\}} \hspace{1em} \text{Stop writing to stream.}

\texttt{\immediate} \hspace{1em} \text{Do next stream operation now, instead of waiting for \texttt{\shipout}.}

\texttt{\wlog\{\langle tokens\rangle\}} \hspace{1em} \text{Write tokens in log file (only).}

\texttt{\endlinechar\{ccode\}} \hspace{1em} \text{Append this char to every input line.}

\texttt{\newlinechar\{ccode\}} \hspace{1em} \text{Character to use for newlines in \write [ ‘\^\vfill}.}

\texttt{\special\{\langle tokens\rangle\}} \hspace{1em} \text{Expand tokens and send them to DVI file at the current position on the page.}

\subsection{13.3 Reserved characters}

\begin{itemize}
  \item \texttt{\\} \hspace{1em} \text{Escape character}
  \item \texttt{\{ \hspace{1em} \text{Grouping}
  \item \texttt{\%} \hspace{1em} \text{Comment}
  \item \texttt{\~} \hspace{1em} \text{Tie}
  \item \texttt{\$} \hspace{1em} \text{Math mode shift}
  \item \texttt{\^} \hspace{1em} \text{Superscript}
  \item \texttt{\_} \hspace{1em} \text{Subscript}
  \item \texttt{\#} \hspace{1em} \text{Parameter}
  \item \texttt{&} \hspace{1em} \text{Alignment tab}
  \item \texttt{\active} \hspace{1em} \text{Category 13, one-character macro.}
  \item \texttt{\catcode\{ccode\}=\{category\}} \hspace{1em} \text{Assign category to character}
\end{itemize}

\subsection{13.4 Interaction}

\begin{itemize}
  \item \texttt{\message\{\langle tokens\rangle\}} \hspace{1em} \text{Print message on terminal (and in log file).}
  \item \texttt{\errmessage\{\langle tokens\rangle\}} \hspace{1em} \text{Print error message on terminal (and in log file).}
  \item \texttt{\newhelp\cs\{\langle tokens\rangle\}} \hspace{1em} \text{Define symbolic help message.}
  \item \texttt{\errhelp=\cs\{\langle tokens\rangle\}} \hspace{1em} \text{Define help message to print after \texttt{\errmessage}, if user asks for it.}
\end{itemize}

\text{If prompt is \texttt{?}:}
\begin{itemize}
  \item \texttt{i(text)} \hspace{1em} \text{Insert text.}
  \item \texttt{\langle number\rangle} \hspace{1em} \text{Delete \langle number\rangle tokens.}
  \item \texttt{\langle return\rangle} \hspace{1em} \text{Try to recover.}
  \item \texttt{x} \hspace{1em} \text{Quit.}
  \item \texttt{e} \hspace{1em} \text{Switch to editor.}
  \item \texttt{h} \hspace{1em} \text{Print help message.}
  \item \texttt{?} \hspace{1em} \text{Print help message.}
  \item \texttt{s} \hspace{1em} \text{Don’t stop for $\TeX$ errors.}
  \item \texttt{r} \hspace{1em} \text{Don’t stop for file errors either.}
  \item \texttt{q} \hspace{1em} \text{Don’t even print errors on screen.}
\end{itemize}

\text{If prompt is \texttt{*}:}
\begin{itemize}
  \item \texttt{\langle anything\rangle} \hspace{1em} \text{Process.}
  \item \texttt{\langle file name\rangle} \hspace{1em} \text{Do \texttt{\input} from given file.}
\end{itemize}

\text{In $\TeX$ source:}
\begin{itemize}
  \item \texttt{\errorstopmode} \hspace{1em} \text{Stop for $\TeX$ errors [ on].}
  \item \texttt{\scrollmode} \hspace{1em} \text{Don’t stop for $\TeX$ errors.}
  \item \texttt{\nonstopmode} \hspace{1em} \text{Don’t stop for file errors.}
  \item \texttt{\batchmode} \hspace{1em} \text{Don’t print errors on screen.}
\end{itemize}

\subsection{13.5 Dimensions and Glue}

\begin{itemize}
  \item \texttt{in} \hspace{1em} \text{inch \hspace{1em} 1.4 in \hspace{1em} \text{em \hspace{1em} Quad width of current font.}}
  \item \texttt{cm} \hspace{1em} \text{centimeter \hspace{1em} 3 cm \hspace{1em} ex \hspace{1em} x-height of current font.}
  \item \texttt{mm} \hspace{1em} \text{millimeter \hspace{1em} 35 mm \hspace{1em} mu \hspace{1em} 1/18 em of math symbol font.}
  \item \texttt{pt} \hspace{1em} \text{printer’s point \hspace{1em} 100 pt \hspace{1em} \\jot \hspace{1em} Incremental baseline distance [ 3pt].}
  \item \texttt{bp} \hspace{1em} \text{big point \hspace{1em} 100 bp \hspace{1em}}
  \item \texttt{pc} \hspace{1em} \text{pica \hspace{1em} 8 pc \hspace{1em}}
  \item \texttt{sp} \hspace{1em} \text{scaled point \hspace{1em} 7000000 sp \hspace{1em}}
  \item \texttt{dd} \hspace{1em} \text{didot point \hspace{1em} 100 dd \hspace{1em}}
  \item \texttt{cc} \hspace{1em} \text{cicero \hspace{1em} 8 cc \hspace{1em}}
\end{itemize}

\begin{itemize}
  \item \texttt{fil} \hspace{1em} \text{Infinite stretch or shrink.}
  \item \texttt{fill} \hspace{1em} \text{Second order infinite stretch or shrink.}
  \item \texttt{filll} \hspace{1em} \text{Third order infinite stretch or shrink.}
  \item \texttt{true} \hspace{1em} \text{Prefix to unit to bypass magnification.}
\end{itemize}
13.6 Debugging

\ddt \* \show(token) \* \showboxthe(internal quantity) \* \showbox(number) \* \showlists
\* \showboxbreadth=\hnumber \* \showboxdepth=\hnumber \* \showbox{\text} \* \showhyphens({\text}) \* \meaning(token) \* \tracingonline=\hnumber \* \tracingmacros=\hnumber \* \tracingpages=\hnumber \* \tracingparagraphs=\hnumber \* \tracingoutput=\hnumber \* \tracinglostchars=\hnumber \* \tracingstats=\hnumber \* \tracingcommands=\hnumber \* \hbadness=\hnumber \* \pausing=\hnumber

\tracingall \tracingall
\* \hbadness=\hnumber \* \tracingall

14. Legend

\* (Before a control sequence): \TeX\ primitive command.
\* (Before a control sequence): \TeX\ variable or parameter.
\[ \text{option}_1 \]
\[ \text{option}_2 \]
\{ \text{alternative}_1 \}
\{ \text{alternative}_2 \}
\[ \text{option}_1 \]
\[ \text{option}_2 \]
\[ \text{option}_3 \]
\[ \hbadness \]
\[ \hbox \]
\[ \text{box} \]
\[ \text{breg} \]
\[ \text{dcode} \]
\[ \text{demerit} \]
\[ \text{dimen} \]
\[ \text{external name} \]
\[ \text{family} \]
\[ \text{font} \]
\[ \text{glue} \]
\[ \text{internal quantity} \]
\[ \text{magnification} \]

\text{Integer measuring amount of stretch or shrink in a line.}
\text{A \hbox, \vbox, \vtop, \copy, \box, \vsplit, or \lastbox.}
\text{Box register, usually a symbolic named (defined by \newbox).}
\text{Character code, usually given by quoting a character [ \textbackslash a], or in octal [ \textbackslash 40].}
\text{Text, control sequences, and whatever.}
\text{Delimiter code, usually given in hexadecimal [ "123456], meaning small version is in family 1 position 23, large version is in family 4 position 56.}
\text{An integer measuring desirability of line breaking decisions within a paragraph.}
\text{An optional factor and a dimension unit [ .5\vsizer ]}.
\text{Name of font, including size [ \text\cmr10].}
\text{A number between 0 and 15, usually a symbolic name (defined by \newfam). A family of math fonts describes a \textfont, a \scriptfont, and a \displayfont. \TeX\ expects roman in family 0, math italic in family 1, symbols in family 2, and extensible characters in family 3.}
\text{A symbolic font name (defined by \text\font\cs=\ldots), or \text\font (denoting the current font).}
\text{A \dimen with optional stretch [ plus 1em] and shrink [ minus 3pt] components.}
\text{A \TeX\ variable, (register), or parameter.}
\text{1000 times the magnification factor, usually given as \magstepn or \magstephalf.}
Math code, usually given in hexadecimal [ "1234"], meaning class 1, family 2, position "34.

A math dimension, like \texttt{(dimen)} except units must be \texttt{mu} (or something which is defined in terms of \texttt{mu}).

A math glue, like \texttt{(glue)} except units must be \texttt{mu} (or something which is defined in terms of \texttt{mu}).

Explicit integer [ 25], or \texttt{(register)} [ \texttt{\pagename}], or variable [ \texttt{\year}], or (by coercion) \texttt{(dimen)} [ \texttt{\hsize}], or \texttt{(glue)} ( \texttt{\parskip}).

Template for finding arguments to a macro by pattern matching, where tokens in parameter text match themselves except \texttt{#n}, which matches any string and defines the \texttt{n}-th argument.

An integer giving desirability of break, from -10000 (required) to 0 (neutral) to 10000 (forbidden).

A \texttt{\count}, \texttt{\skip}, \texttt{\dimen}, or \texttt{\muskip} register, usually a symbolic name (defined by \texttt{\newcount}, \texttt{\newskip}, \texttt{\newdimen}, or \texttt{\newmuskip}).

Result of macro expansion, where \texttt{#n} is replaced by the \texttt{n}-th argument.

Space factor, an integer roughly 1000 times the amount to multiply the next interword space.

Stream number, usually a symbolic name (defined with \texttt{\newread} or \texttt{\newwrite}), or 16 for the terminal (and log file), or -1 for the log file.

A list of tokens.

Material to be made into a vertical list.
This guide is intended to remind the \TeX{} user what the control sequences of plain \TeX{} do. See the legend to find out the meanings of some of the notation used herein. For more information, see the \TeX{}book.

1. Ordinary text ........................................... 1
   1.1 Punctuation ......................................... 1
   1.2 Accents ............................................... 1
   1.3 Special characters ................................. 1
   1.4 Fonts, styles, sizes ............................. 2
   1.5 Hyphenation ....................................... 2
2. White space .................................................. 2
   2.1 Horizontal .......................................... 2
   2.2 Vertical ............................................. 3
3. Layout .......................................................... 3
   3.1 Page image .......................................... 3
   3.2 Paragraphs ......................................... 4
   3.3 Lines ................................................ 4
   3.4 Horizontal ........................................... 5
4. Text constructions ........................................ 5
   4.1 Horizontal .......................................... 5
   4.2 Vertical ............................................. 6
   4.3 Paragraphs ......................................... 6
5. Mathematics .................................................... 6
   5.1 Special characters ................................. 6
   5.2 Arithmetic .......................................... 7
   5.3 Sets ................................................ 7
   5.4 Algebra .............................................. 7
   5.5 Analysis ............................................ 8
   5.6 Logic ................................................ 8
   5.7 Discrete math ....................................... 8
   5.8 Geometry and probability ....................... 8
   5.9 Accents and diacritics .......................... 8
   5.10 Miscellaneous operators and relations .......... 9
   5.11 Delimiters and punctuation .................... 9
   5.12 Pointers .......................................... 10
   5.13 Character pieces ................................ 10
6. Mathematics layout ........................................ 10
   6.1 Math text .......................................... 10
   6.2 Displays ............................................ 11
   6.3 Fonts, styles, and families .................... 11
7. Mathematics constructions .................................. 12
   7.1 White space ........................................ 12
   7.2 Packaging .......................................... 12
8. Tables .......................................................... 12
   8.1 Tabbing .............................................. 12
   8.2 Alignment ........................................... 13
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>Figures and footnotes</td>
<td>13</td>
</tr>
<tr>
<td>10</td>
<td>Computer programs</td>
<td>13</td>
</tr>
<tr>
<td>11</td>
<td>Macros</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>11.1 Definitions</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>11.2 Scoping and expansion</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>11.3 Control flow</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>11.4 Numeric registers</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>11.5 Box registers</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>11.6 Converting tokens, variables, strings, csnames, etc</td>
<td>16</td>
</tr>
<tr>
<td>12</td>
<td>Page design</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>12.1 Size</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>12.2 Headers, footers, page numbers</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>12.3 Marks</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>12.4 Output routines</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>12.5 Page in progress</td>
<td>17</td>
</tr>
<tr>
<td>13</td>
<td>Controlling \TeX{}</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>13.1 Starting, stopping, reading files</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>13.2 Auxiliary files</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>13.3 Reserved characters</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>13.4 Interaction</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>13.5 Dimensions and Glue</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>13.6 Debugging</td>
<td>19</td>
</tr>
<tr>
<td>14</td>
<td>Legend</td>
<td>19</td>
</tr>
</tbody>
</table>