

Math 233

In the following pages I have excerpted some pages from *The Not So Short Introduction to L^AT_EX 2 ϵ* , by Tobias Oetiker. The full text of this document is also posted on our class Blackboard page, under “Reference.”

placement of `\bar` for a variable with subscript. The apostrophe mark `'` gives a prime:

```
$f(x) = x^2 \quad f'(x)
= 2x \quad f''(x) = 2\[[5pt]
\hat{XY} \quad \widehat{XY}
\quad \bar{x}_0 \quad \bar{x}_0$
```

$$f(x) = x^2 \quad f'(x) = 2x \quad f''(x) = 2$$

$$\hat{XY} \quad \widehat{XY} \quad \bar{x}_0 \quad \bar{x}_0$$

Vectors are often specified by adding small arrow symbols on top of a variable. This is done with the `\vec` command. The two commands `\overrightarrow` and `\overleftarrow` are useful to denote the vector from A to B :

```
$\vec{a} \quad \vec{AB}
\overrightarrow{AB}$
```

$$\vec{a} \quad \vec{AB} \quad \overrightarrow{AB}$$

Names of log-like functions are often typeset in an upright font, and not in italics as variables are, so L^AT_EX supplies the following commands to typeset the most important function names:

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

```
\[\lim_{x \rightarrow 0}
\frac{\sin x}{x}=1\]
```

$$\lim_{x \rightarrow 0} \frac{\sin x}{x} = 1$$

For functions missing from the list, use the `\DeclareMathOperator` command. There is even a starred version for functions with limits. This command works only in the preamble so the commented lines in the example below must be put into the preamble.

```
%\DeclareMathOperator{\argh}{argh}
%\DeclareMathOperator*\Nut{Nut}
\[3\argh = 2\nut_{x=1}\]
```

$$3 \operatorname{argh} = 2 \operatorname{Nut}_{x=1}$$

For the modulo function, there are two commands: `\bmod` for the binary operator “ $a \bmod b$ ” and `\pmod` for expressions such as “ $x \equiv a \pmod{b}$ ”:

```
$a\bmod b \quad \backslash
x\equiv a \pmod{b}$
```

$$a \bmod b$$

$$x \equiv a \pmod{b}$$

3.8 List of Mathematical Symbols

The following tables demonstrate all the symbols normally accessible from *math mode*.

To use the symbols listed in Tables 3.12–3.8,⁸ the package `amssymb` must be loaded in the preamble of the document and the $\mathcal{A}\mathcal{M}\mathcal{S}$ math fonts must be installed on the system. If the $\mathcal{A}\mathcal{M}\mathcal{S}$ package and fonts are not installed on your system, have a look at `CTAN:macros/latex/required/amslatex`. An even more comprehensive list of symbols can be found at `CTAN:info/symbols/comprehensive`.

Table 3.1: Math Mode Accents.

\hat{a}	<code>\hat{a}</code>	\check{a}	<code>\check{a}</code>	\tilde{a}	<code>\tilde{a}</code>
\grave{a}	<code>\grave{a}</code>	\dot{a}	<code>\dot{a}</code>	\ddot{a}	<code>\ddot{a}</code>
\bar{a}	<code>\bar{a}</code>	\vec{a}	<code>\vec{a}</code>	\widehat{AAA}	<code>\widehat{AAA}</code>
\acute{a}	<code>\acute{a}</code>	\breve{a}	<code>\breve{a}</code>	\widetilde{AAA}	<code>\widetilde{AAA}</code>
\mathring{a}	<code>\mathring{a}</code>				

Table 3.2: Greek Letters.

There is no uppercase of some of the letters like `\Alpha`, `\Beta` and so on, because they look the same as normal roman letters: A, B...

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

⁸These tables were derived from `symbols.tex` by David Carlisle and subsequently changed extensively as suggested by Josef Tkadlec.

Table 3.3: Binary Relations.

You can negate the following symbols by prefixing them with a `\not` command.

$<$	<code><</code>	$>$	<code>></code>	$=$	<code>=</code>
\leq	<code>\leq</code> or <code>\le</code>	\geq	<code>\geq</code> or <code>\ge</code>	\equiv	<code>\equiv</code>
\ll	<code>\ll</code>	\gg	<code>\gg</code>	\doteq	<code>\doteq</code>
\prec	<code>\prec</code>	\succ	<code>\succ</code>	\sim	<code>\sim</code>
\preceq	<code>\preceq</code>	\succeq	<code>\succeq</code>	\simeq	<code>\simeq</code>
\subset	<code>\subset</code>	\supset	<code>\supset</code>	\approx	<code>\approx</code>
\subseteq	<code>\subseteq</code>	\supseteq	<code>\supseteq</code>	\cong	<code>\cong</code>
\sqsubset ^a	<code>\sqsubset</code> ^a	\sqsupset ^a	<code>\sqsupset</code> ^a	\Join ^a	<code>\Join</code> ^a
\sqsubseteq	<code>\sqsubseteq</code>	\sqsupseteq	<code>\sqsupseteq</code>	\bowtie	<code>\bowtie</code>
\in	<code>\in</code>	\ni , \owns	<code>\ni</code> , <code>\owns</code>	\propto	<code>\propto</code>
\vdash	<code>\vdash</code>	\dashv	<code>\dashv</code>	\models	<code>\models</code>
\mid	<code>\mid</code>	\parallel	<code>\parallel</code>	\perp	<code>\perp</code>
\smile	<code>\smile</code>	\frown	<code>\frown</code>	\asymp	<code>\asymp</code>
$:$	<code>:</code>	\notin	<code>\notin</code>	\neq or \ne	<code>\neq</code> or <code>\ne</code>

^aUse the `latexsym` package to access this symbol

Table 3.4: Binary Operators.

$+$	<code>+</code>	$-$	<code>-</code>	\triangleleft	<code>\triangleleft</code>
\pm	<code>\pm</code>	\mp	<code>\mp</code>	\triangleright	<code>\triangleright</code>
\cdot	<code>\cdot</code>	\div	<code>\div</code>	\star	<code>\star</code>
\times	<code>\times</code>	\setminus	<code>\setminus</code>	\ast	<code>\ast</code>
\cup	<code>\cup</code>	\cap	<code>\cap</code>	\circ	<code>\circ</code>
\sqcup	<code>\sqcup</code>	\sqcap	<code>\sqcap</code>	\bullet	<code>\bullet</code>
\vee , \lor	<code>\vee</code> , <code>\lor</code>	\wedge , \land	<code>\wedge</code> , <code>\land</code>	\diamond	<code>\diamond</code>
\oplus	<code>\oplus</code>	\ominus	<code>\ominus</code>	\uplus	<code>\uplus</code>
\odot	<code>\odot</code>	\oslash	<code>\oslash</code>	\amalg	<code>\amalg</code>
\otimes	<code>\otimes</code>	\bigcirc	<code>\bigcirc</code>	\dagger	<code>\dagger</code>
\triangleleft	<code>\triangleleft</code>	\bigtriangledown	<code>\bigtriangledown</code>	\ddagger	<code>\ddagger</code>
\lhd ^a	<code>\lhd</code> ^a	\rhd ^a	<code>\rhd</code> ^a	\wr	<code>\wr</code>
\unlhd ^a	<code>\unlhd</code> ^a	\unrhd ^a	<code>\unrhd</code> ^a		

Table 3.5: BIG Operators.

Σ	<code>\sum</code>	\cup	<code>\bigcup</code>	\vee	<code>\bigvee</code>
\prod	<code>\prod</code>	\cap	<code>\bigcap</code>	\wedge	<code>\bigwedge</code>
\coprod	<code>\coprod</code>	\sqcup	<code>\bigsqcup</code>	\uplus	<code>\biguplus</code>
\int	<code>\int</code>	\oint	<code>\oint</code>	\odot	<code>\bigodot</code>
\oplus	<code>\bigoplus</code>	\otimes	<code>\bigotimes</code>		

Table 3.6: Arrows.

\leftarrow	<code>\leftarrow</code> or <code>\gets</code>	\longleftarrow	<code>\longleftarrow</code>
\rightarrow	<code>\rightarrow</code> or <code>\to</code>	\longrightarrow	<code>\longrightarrow</code>
\leftrightarrow	<code>\leftrightarrow</code>	\longleftrightarrow	<code>\longleftrightarrow</code>
\Leftarrow	<code>\Leftarrow</code>	\Lleftarrow	<code>\Lleftarrow</code>
\Rightarrow	<code>\Rightarrow</code>	\Rrightarrow	<code>\Rrightarrow</code>
\Leftrightarrow	<code>\Leftrightarrow</code>	\Leftrightarrow	<code>\Leftrightarrow</code>
\mapsto	<code>\mapsto</code>	\longmapsto	<code>\longmapsto</code>
\hookrightarrow	<code>\hookrightarrow</code>	\hookrightarrow	<code>\hookrightarrow</code>
\leftharpoonup	<code>\leftharpoonup</code>	\rightharpoonup	<code>\rightharpoonup</code>
\leftharpoondown	<code>\leftharpoondown</code>	\rightharpoondown	<code>\rightharpoondown</code>
\rightleftharpoons	<code>\rightleftharpoons</code>	\iff	<code>\iff</code> (bigger spaces)
\uparrow	<code>\uparrow</code>	\downarrow	<code>\downarrow</code>
\updownarrow	<code>\updownarrow</code>	\Uparrow	<code>\Uparrow</code>
\Downarrow	<code>\Downarrow</code>	\Updownarrow	<code>\Updownarrow</code>
\nearrow	<code>\nearrow</code>	\searrow	<code>\searrow</code>
\swarrow	<code>\swarrow</code>	\nwarrow	<code>\nwarrow</code>
\leadsto	<code>\leadsto</code> ^a		

^aUse the `latexsym` package to access this symbol

Table 3.7: Arrows as Accents.

\overrightarrow{AB}	<code>\overrightarrow{AB}</code>	\underrightarrow{AB}	<code>\underrightarrow{AB}</code>
\overleftarrow{AB}	<code>\overleftarrow{AB}</code>	\underleftarrow{AB}	<code>\underleftarrow{AB}</code>
\overleftrightarrow{AB}	<code>\overleftrightarrow{AB}</code>	\underleftrightarrow{AB}	<code>\underleftrightarrow{AB}</code>

Table 3.8: Delimiters.

(())	↑	\uparrow
[[or \lbrack]] or \rbrack	↓	\downarrow
{	\{ or \lbrace	}	\} or \rbrace	↕	\updownarrow
<	\langle	>	\rangle	↗	\Uparrow
	or \vert		\ or \Vert	↘	\Downarrow
/	/	\	\backslash	↕	\Updownarrow
⌊	\lfloor	⌋	\rfloor		
⌈	\rceil	⌉	\lceil		

Table 3.9: Large Delimiters.

(\lgroup)	\rgroup	⎵	\lmoustache
	\arrowvert		\Arrowvert		\bracevert
⎵	\rmoustache				

Table 3.10: Miscellaneous Symbols.

...	\dots	...	\cdots	:	\vdots	⋯	\ddots
\hbar	\hbar	i	\imath	j	\jmath	l	\ell
\Re	\Re	\Im	\Im	\aleph	\aleph	\wp	\wp
\forall	\forall	\exists	\exists	\mho	\mho ^a	∂	\partial
'	'	'	\prime	\emptyset	\emptyset	∞	\infty
∇	\nabla	\triangle	\triangle	\square	\Box ^a	\diamond	\Diamond ^a
\perp	\bot	\top	\top	\angle	\angle	\surd	\surd
\diamond	\diamondsuit	\heartsuit	\heartsuit	\clubsuit	\clubsuit	\spadesuit	\spadesuit
\neg	\neg or \lnot	\flat	\flat	\natural	\natural	\sharp	\sharp

^aUse the latexsym package to access this symbol

Table 3.11: Non-Mathematical Symbols.

These symbols can also be used in text mode.

†	\dag	§	\S	©	\copyright	®	\textregistered
‡	\ddag	¶	\P	£	\pounds	%	\%

Table 3.12: \mathcal{AMS} Delimiters.

\ulcorner	<code>\ulcorner</code>	\urcorner	<code>\urcorner</code>	\llcorner	<code>\llcorner</code>	\lrcorner	<code>\lrcorner</code>
\lvert	<code>\lvert</code>	\rvert	<code>\rvert</code>	\lVert	<code>\lVert</code>	\rVert	<code>\rVert</code>

Table 3.13: \mathcal{AMS} Greek and Hebrew.

\digamma	<code>\digamma</code>	\varkappa	<code>\varkappa</code>	\beth	<code>\beth</code>	\gimel	<code>\gimel</code>	\daleth	<code>\daleth</code>
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Table 3.14: Math Alphabets.

See Table 6.4 on 111 for other math fonts.

Example	Command	Required package
$ABCDEabcde1234$	<code>\mathrm{ABCDE abcde 1234}</code>	
$ABCDEFabcde1234$	<code>\mathit{ABCDE abcde 1234}</code>	
$ABCDEFabcde1234$	<code>\mathnormal{ABCDE abcde 1234}</code>	
$ABCDE$	<code>\mathcal{ABCDE abcde 1234}</code>	
$\mathcal{A}\mathcal{B}\mathcal{C}\mathcal{D}\mathcal{E}$	<code>\mathscr{ABCDE abcde 1234}</code>	mathrsfs
$\mathfrak{A}\mathfrak{B}\mathfrak{C}\mathfrak{D}\mathfrak{E}\mathfrak{a}\mathfrak{b}\mathfrak{c}\mathfrak{d}\mathfrak{e}\mathfrak{1}\mathfrak{2}\mathfrak{3}\mathfrak{4}$	<code>\mathfrak{ABCDE abcde 1234}</code>	amsfonts or amssymb
$\mathbb{A}\mathbb{B}\mathbb{C}\mathbb{D}\mathbb{E}\mathbb{a}\mathbb{b}\mathbb{c}\mathbb{d}\mathbb{e}\mathbb{1}\mathbb{2}\mathbb{3}\mathbb{4}$	<code>\mathbb{ABCDE abcde 1234}</code>	amsfonts or amssymb

Table 3.15: \mathcal{AMS} Binary Operators.

$\dot{+}$	<code>\dotplus</code>	\cdot	<code>\centerdot</code>		
\ltimes	<code>\ltimes</code>	\rtimes	<code>\rtimes</code>	\div	<code>\divideontimes</code>
\uplus	<code>\doublecup</code>	\mcap	<code>\doublecap</code>	\smallsetminus	<code>\smallsetminus</code>
\veebar	<code>\veebar</code>	$\bar{\wedge}$	<code>\barwedge</code>	$\overline{\bar{\wedge}}$	<code>\doublebarwedge</code>
\boxplus	<code>\boxplus</code>	\boxminus	<code>\boxminus</code>	\ominus	<code>\circleddash</code>
\boxtimes	<code>\boxtimes</code>	\boxdot	<code>\boxdot</code>	\odot	<code>\circledcirc</code>
\intercal	<code>\intercal</code>	\circledast	<code>\circledast</code>	\times	<code>\rightthreetimes</code>
\curlyvee	<code>\curlyvee</code>	\curlywedge	<code>\curlywedge</code>	\times	<code>\leftthreetimes</code>

Table 3.16: \mathcal{AMS} Binary Relations.

\lessdot	<code>\lessdot</code>	\gtrdot	<code>\gtrdot</code>	\doteqdot	<code>\doteqdot</code>
\leqslant	<code>\leqslant</code>	\geqslant	<code>\geqslant</code>	\risingdotseq	<code>\risingdotseq</code>
\leqslantless	<code>\leqslantless</code>	\geqslantgtr	<code>\geqslantgtr</code>	\fallingdotseq	<code>\fallingdotseq</code>
\leqq	<code>\leqq</code>	\geqq	<code>\geqq</code>	\eqcirc	<code>\eqcirc</code>
\lll or \llless	<code>\lll</code> or <code>\llless</code>	\ggg	<code>\ggg</code>	\circeq	<code>\circeq</code>
\lesssim	<code>\lesssim</code>	\gtrsim	<code>\gtrsim</code>	\triangleq	<code>\triangleq</code>
\lessapprox	<code>\lessapprox</code>	\gtrapprox	<code>\gtrapprox</code>	\bumpeq	<code>\bumpeq</code>
\lessgtr	<code>\lessgtr</code>	\gtrless	<code>\gtrless</code>	\Bumpeq	<code>\Bumpeq</code>
\lesseqgtr	<code>\lesseqgtr</code>	\gtreqless	<code>\gtreqless</code>	\thicksim	<code>\thicksim</code>
\lesseqqgtr	<code>\lesseqqgtr</code>	\gtreqqless	<code>\gtreqqless</code>	\thickapprox	<code>\thickapprox</code>
\preccurlyeq	<code>\preccurlyeq</code>	\succcurlyeq	<code>\succcurlyeq</code>	\approxeq	<code>\approxeq</code>
\curlyeqprec	<code>\curlyeqprec</code>	\curlyeqsucc	<code>\curlyeqsucc</code>	\backsim	<code>\backsim</code>
\precsim	<code>\precsim</code>	\succsim	<code>\succsim</code>	\backsimeq	<code>\backsimeq</code>
\precapprox	<code>\precapprox</code>	\succapprox	<code>\succapprox</code>	\vDash	<code>\vDash</code>
\subseteqq	<code>\subseteqq</code>	\supseteqq	<code>\supseteqq</code>	\Vdash	<code>\Vdash</code>
\shortparallel	<code>\shortparallel</code>	\Supset	<code>\Supset</code>	\Vvdash	<code>\Vvdash</code>
\blacktriangleleft	<code>\blacktriangleleft</code>	\sqsupset	<code>\sqsupset</code>	\backepsilon	<code>\backepsilon</code>
\vartriangleright	<code>\vartriangleright</code>	\because	<code>\because</code>	\varpropto	<code>\varpropto</code>
\blacktriangleright	<code>\blacktriangleright</code>	\Subset	<code>\Subset</code>	\between	<code>\between</code>
\trianglerighteq	<code>\trianglerighteq</code>	\smallfrown	<code>\smallfrown</code>	\pitchfork	<code>\pitchfork</code>
\vartriangleleft	<code>\vartriangleleft</code>	\shortmid	<code>\shortmid</code>	\smallsmile	<code>\smallsmile</code>
\trianglelefteq	<code>\trianglelefteq</code>	\therefore	<code>\therefore</code>	\sqsubset	<code>\sqsubset</code>

Table 3.17: \mathcal{AMS} Arrows.

\dashleftarrow	<code>\dashleftarrow</code>	\dashrightarrow	<code>\dashrightarrow</code>
\Lleftarrow	<code>\Lleftarrow</code>	\Rrightarrow	<code>\Rrightarrow</code>
\twoheadleftarrow	<code>\twoheadleftarrow</code>	\twoheadrightarrow	<code>\twoheadrightarrow</code>
\leftarrowtail	<code>\leftarrowtail</code>	\rightarrowtail	<code>\rightarrowtail</code>
\leftrightharpoons	<code>\leftrightharpoons</code>	\rightleftharpoons	<code>\rightleftharpoons</code>
\Lsh	<code>\Lsh</code>	\Rsh	<code>\Rsh</code>
\looparrowleft	<code>\looparrowleft</code>	\looparrowright	<code>\looparrowright</code>
\curvearrowleft	<code>\curvearrowleft</code>	\curvearrowright	<code>\curvearrowright</code>
\circlearrowleft	<code>\circlearrowleft</code>	\circlearrowright	<code>\circlearrowright</code>
\multimap	<code>\multimap</code>	\Uparrow	<code>\upuparrows</code>
\downdownarrows	<code>\downdownarrows</code>	\Uparrow	<code>\upharpoonleft</code>
\upharpoonright	<code>\upharpoonright</code>	\Downarrow	<code>\downharpoonright</code>
\rightsquigarrow	<code>\rightsquigarrow</code>	\leftrightsquigarrow	<code>\leftrightsquigarrow</code>

Table 3.18: \mathcal{AMS} Negated Binary Relations and Arrows.

\nless	\ngtr	\nvarsubsetneqq
\lneq	\gneq	\nvarsupsetneqq
\nleq	\ngeq	\nsubseteq
\nleqslant	\ngeqslant	\nsupseteq
\lneqq	\gneqq	\nmid
\lvertneqq	\gvertneqq	\nparallel
\nleqq	\ngeqq	\nshortmid
\lnsim	\gnsim	\nshortparallel
\lnapprox	\gnapprox	\nsim
\nprec	\nsucc	\ncong
\npreceq	\nsucceq	\nvdash
\precneqq	\succneqq	\nvDash
\precnsim	\succnsim	\nVdash
\precnapprox	\succnapprox	\nVDash
\subsetneq	\supsetneq	\ntriangleleft
\varsubsetneq	\varsupsetneq	\ntriangleright
\nsubseteq	\nsupseteq	\ntrianglelefteq
\subsetneqq	\supsetneqq	\ntrianglerighteq
\nleftarrow	\rightarrow	\nleftrightarrow
\nLeftarrow	\nrightarrow	\nLeftrightarrow

Table 3.19: \mathcal{AMS} Miscellaneous.

\hbar	\hslash	\Bbbk
\square	\blacksquare	\textcircled{S}
\triangle	\blacktriangle	\complement
\ntriangledown	\blacktriangledown	\Game
\lozenge	\blacklozenge	\bigstar
\angle	\measuredangle	\backprime
\diagup	\diagdown	\varnothing
\nexists	\Finv	\mho
\eth	\sphericalangle	