A GRADUA

A Graduate Student's Guide to LaTeX and AMS-LaTeX

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Abstract

In this article we will show the basic usage o A in writing athe atical a ers e will concentrate on escribing arious arts o a stan ar source ocu ent o t e article ro its rea ble through sections with athe atical contents to re erences sage o se eral stan ar co an s ro A AMS A an `amsmath amsthm` an `amssymb` ac ages will be iscusse e will also brie iscuss the usage o `ttuthesis.sty` st le le or co osing aster theses an octoral issertations that con or to the re uire ents o the ra uate chool [1]

Keywords: ource le co osing or t esetting is la ing or ulas auto atic re erencing A A ε AMS A

Contents

```
\documentclass{article}
%%% Here starts the preamble of the document
%%% Formatting commands, if needed
\setlength{\oddsidemargin}{-0.25in}
\setlength{\textwidth}{7.00in}
\setlength{\topmargin}{-0.25in}
\setlength{\textheight}{9.0in}
...
\mathsurround 1.5pt
%%% Commands to load extra packages, if needed
\usepackage{amsmath}
\usepackage{amssymb}
...
%%% Custom definitions and macros
\def\beq{\begin{equation}}
\def\eeq{\end{equation}}
...
\newcommand{\Id}{{\bf 1}}
\newcommand{\ed}{\end{document}}
...
%%% New environments
\newtheorem{lemma}{Lemma}
...
%%% Here starts the top matter of the document body
\begin{document}
\title{...}
\author{...}
\date{...}
\maketitle
\tableofcontents
%%% Here starts the abstract
\begin{abstract}
...
\end{abstract}
%%% Here starts the main matter of the document body
\chapter{...}

\section{...}

\subsection{...}

\appendix{...}
...
%%% Here starts the back matter of the document body
\begin{thebibliography}{9}
...
\end{thebibliography}
\end{document}
```

i r 1 T str ct r o an articl oc m nt

n t is articl ill conc ntrat primaril on sp ci c LaTeX comman s an ampl s o t ir sa t at ar s l n ritin a mat matical pap r or a t sis. o r it is p ct t at t s ampl s ill also s l n pr parin a i or a t st. T n it is no o co rs to a on

2 Proclamations

roclamations in LaTeX ar t or ms propositions l mmas nitions corollari s tc. ic ot r is constit t ma/or compon nts o an mat matical ritin . T com in i r nt st l s an can n m r in man i r nt a s. ill isc ss t asic on s t at ar alr a pr n in LaTeX an a mor anc on s t at com a aila l pon loa in pac a amsthm. otic t at to loa t is pac a a plac in t pr am l comman \usepa age amsthm . T is a ar loa in t r o t most s l pac a s t at t n LaTeX

```
\usepa age amsmath
\usepa age amssymb
\usepa age amsthm
```

2.1 Basic LaTeX proclamations

n or r to s a proclamation it n s to n rst in t pr am l it t comman \ne the rem. or ampl to n t or m proposition l mma corollar ampl nition an r mar n ironm nts plac t ollo in comman s in pr am l

```
\ne the rem the rem   he rem
\ne the rem pr p siti n   r p siti n
\ne the rem lemma   emma
\ne the rem   r llary   r llary
\ne the rem example   xample
\ne the rem  e initi n   e initi n
\ne the rem remar   emar
```

To in o an o t s proclamations it n s to s as a an n ironm nt. or ampl to stat a t or m on ins t t or m n ironm nt it \begin the rem an n s t t or m it \en the rem as ollo s

```
\begin the rem
 n ateg ry \b et  the m n m rphisms are /ust the in/e ti e un ti ns  the un ti ns
su h that  x l  y l  implies  x y )l
\label  set
\en the rem
```

ic i s

Theorem 1. *In category* Set*, the monomorphisms are just the injective functions (the functions f such that $f(x) = f(y)$ implies $x = y$).*

T rst ar m nt in \ne the rem the rem he rem is t nam or t n ironm nt t at ill in o t t or m t s con ar m nt he rem is t nam t at ill print . LaTeX ill a tomaticall n m r t proclamation an print t t t in a s ita l ont.

n proclamation ma a an optional ar m nt or instanc

```
\begin the rem  ier e s  he rem
 n ateg ry \b et  the m n m rphisms are /ust the in/e ti e un ti ns  the un ti ns
su h that  x l  y l  implies  x y )l
\label  set
\en the rem
```

ic i s

Theorem 2 (Pierce's Theorem). *In category* Set*, the monomorphisms are just the injective functions (the functions f such that $f(x) = f(y)$ implies $x = y$).*

otic t at sinc a s la ls \label set an \label set it a t or m co nt r can no r r to t or ms. or instanc in T or m 2 a s o n o an optional param t r can s . r no ins rt anot r proclamation its n m rin ill start a r s . or ampl

```
\begin  e initi n
 n arr     \rightarr      is an  \b epim rphism  i     r any pair  arr  s
 g     \rightarr      an   h     \rightarr       the e uality  g \ ir     h \ ir
implies that  g h
\label   epi
\en   e initi n
```

Definition 1. *An arrow $f \quad A \to B$ is an* **epimorphism** *if, for any pair of arrows $g \quad B \to C$ and $h \quad B \to C$, the equality $g \circ f \;,\; h \circ f$ implies that $g \;,\; h$.*

ptic t at a intro c t anot r co nt r or nitions. T is a nition 1 is o r nition n m r 1.
t is possi l to n m r all proclamations cons c ti l in ic cas o r rst nition o l a n m r sinc a stat t o t or ms so ar. t is also possi l to n m r proclamations it in a s ction. or mor in ormation s .

n t pac a **amsthm** is loa a itional options com a aila l . ! n o t m is t st l o a procla mation. T r ar t r st l s

i **plain** t most mp atic an t a lt

ii **e initi n** l ss mp atic

ii **remar** t l ast mp atic.

T st l o all proclamations is s t in t pr am l it t comman **\the remstyle** . n t is articl a s

```
\the remstyle plain
```

ic is also t a lt st l s LaTeX.

not r option a aila l it **amsthm** is to s t * rsion o **\ne the rem** ic n s a proclamation t at is not n m r t nam . or ampl in t pr am l a n t o s c proclamations **ain he rem** an **imit he rem**.

```
\ne the rem* main   ain  he rem
\ne the rem* limit   imit  he rem
```

or instanc can no r1 2 T r m2 1 1T ialso

Proof. T is is a proo_ t at is n ‸ t stan ar . . . s_ m‸ ol. □

• n t proo_ n s ‵ it an ‵ ation ‸ t not t t it is c‵ stomar_ to omit t . . . s_ m‸ ol

```
\   umentstyle name re eren es   appr
```

inc ss ntiall r t in ls ma r main t sam in t oc m nt it is no s rpris LaTeX is so pop lar amon mat maticians an sci ntists.

n cas on ants to mo i t a lt pa s t p rom e ault emplate on s o l s t age rmat emplate rom TEX 2. otic t ollo in comman s at t top o t is so rc l . s t s mar in s ttin comman s to ormat t is articl .

- irst s t t l t mar in T a lt is 1 inc so t ollo in comman s ts a inc l t mar in.

  ```
  \setlength \   si emargin  #    in
  ```

- T n s t t i t o t t t at is l t ill t ri t mar in. n t is cas ri t mar in is . in in in.

  ```
  \setlength \text i th      in
  ```

- To s t t top mar in sinc t a lt is 1 inc s t ollo in comman to s t it to inc

  ```
  \setlength \t pmargin  #    in
  ```

- To s t t i t o t t t iss t ollo in comman at is l t ill t ottom mar in. n t is cas ottom mar in is 11 in in in in

  ```
  \setlength \textheight      in
  ```

3.2 Itemizing and numbering

T a o ll t it ms r cr at sin t so call *itemized environment* as ollo s

```
\begin itemi e
\item  his is the irst item  r example  x l   \sin  x# l
\item  hile a   main r  r  is  \ #\pi \pi l
\en  itemi e
```

n t p s t t is pro c s

- T is is t rst it m or ampl f x , sin 2x − .
- il a omain or f is −π, π .

on pr rs to n m r list it ms on o l n to s t so call *enumerated environment* as ollo s

```
\begin enumerate
\item  his is the irst item  r example  x l   \sin  x# l
\item  hile a   main r  r  is  \ #\pi \pi l
\en  enumerate
```

n t p s t t is pro c s

1. T is is t rst it m or ampl f x , sin 2x − .
2. il a omain or f is −π, π .

r on can s t rst a anta o sin LaTeX its a ilit to a tomaticall r n m r list it ms n a n it m is ins rt . or ampl l t s ins rt a n it m in t n t t o it ms a o

```
\begin enumerate
\item  his is the irst item  r example  x)l  \sin  x# )l
\item  ere is a ne  item  say  \  s x#\pi)l  un ti n
\item  hile a  main r  is  \ #\pi \pi)l
\en  enumerate
```

t r t p s ttin t

1. T is is t rst it m or ampl $f\ x\ ,\ \sin 2x -\ .$
2. r is a n it m sa cos $x\ \pi$ nction.

. il a omain or f is $-\pi, \pi$

it a n n m rin . nst a o t n m rs on can s l tt rs t t la ls ar not c an t n a tomaticall . s a ain t rst n ironm nt.

```
\begin itemi e
\item  a)l  his is the irst item  r example

 x)l  \sin  x# )l

\item  b)l  hile a  main r  is  #\pi \pi)l
\item  )l  he thir  item n  ill be  isplaye  an  numbere
\begin e uati n
 x)l  \sin  x# )l
\label e  sine
\en  e uati n
\item  b)l  hile a  main r  is  #\pi \pi)l
\en  itemi e
```

t

a T is is t rst it m or ampl

$$f\ x\ ,\ \sin 2x -\ .$$

il a omain or f is $-\pi, \pi$.

c T t ir it m no ill ispla an n m r

$$f\ x\ ,\ \sin 2x -\ .$$

otic i r nt small tra spacin s in ic a n cr at ins rtin \ a t r \ an or \ an t n xy\l g x y\l. n incr asin or r o spac si s LaTeX as t s pr n comman s or ori ontal spacin \ \ \ \ua \ua . n rall comman \hspa e ex t at ta s a l n t param t r li ex incr as s ori ontal spacin in orm las. om tim s on n s to ins rt t s tra spac s or t orm la to loo tt r. r is anot r s c ampl .

$$a \int_0^{\pi} \sin x dx, \quad 2, \quad |-f\ x\ |$$

$$c \int_0^{\pi} \sin x\, dx, \quad 2, \quad |-f\ x\ |$$

r spacin in s ms tt r. t as n accomplis it t is co

! n mor comm nt , n t la l

```
\label e
\en  e uati n
```

$$\mathbf{e}_1\mathbf{e}_2\,,\quad \mathbf{e}_1\quad \mathbf{e}_2\quad A_{12}\quad g_{12}\,,\quad \mathbf{e}_1\quad \mathbf{e}_2\quad B_{12}$$
$$\mathbf{e}_1\mathbf{e}_2\,,\quad -\mathbf{e}_1\quad \mathbf{e}_2 - A_{12}\quad g_{12}\,,\quad -\mathbf{e}_1\quad \mathbf{e}_2\quad B_{21}$$
$$,\quad -\mathbf{e}_1\quad \mathbf{e}_2\quad B^{\top}{}_{12}$$

otic t at ispla loo s tt r t an . otic also t at in ot ispla s t r as on sin l n m r assi n to t ntir arra .

4.2 Example of `align` environment

can ispla ations i r ntl sin comman `align` ic allo s s to ali n al si ns. ot o r t at t is r s l comman is not pr s nt in stan ar LaTeX t is a aila l pon loa in t `amsmath` pac a it t comman `\usepa age amsmath` s t pr am l . a ain r r to an or mor in ormation.

```
\begin align
\e  \e                          \e  \ \e  #      #g      \e  \ \e  #         \\    ex
 \e  \e  l\til e \phant m x     #\e  \ \e  #      #g     #\e  \ \e  #       \\    ex
                                #\e  \ \e  #   \t p l
\en  align
```

e

\begin e uati n

```
\begin e uati n
\le.t
\begin array  rr#r
          \\
```

lt o not s in t a o ta l s m ols r o t n s in mat matical pap rs ar $\mathbb{R}$ or t r al l $\mathbb{C}$ or t compl l $\mathbb{H}$ or t at rnionic i ision rin $\mathbb{Z}$ or t rin o int rs. T s t so call mat lac oar l tt rs ar part o anot r pac a `amssymb` ic on can loa in t pr am l sin t comman `\usepa age amssymb` . ot t at to t or ampl $\mathbb{R}$ on can s t lon nam `\mathbb` or t a r iat macro `\` n im t pr am l an li is or ot r l tt rs. T n `\` i s t r al im nsional E cli an spac $\mathbb{R}^3$.

4.6 Example of a more complicated table with `tabular`

T ollo in is an ampl o a mor complicat ta l t at as n cr at sin `tabular` n ironm nt sp ci call s it or cr atin ta l s.

Saturday, May 25

ro	o	oo ent	oo ent	oo ent	oo ent	oo ent
		Announcements				
			No parallel sessions			
		Break				
			No parallel sessions			
		Break				
		Analysis	*eo e ry*	*r res*	*ysi s*	*Appli a ions*
		Lunch				
		Coffee Social				
		General meeting and closing				

T co or t is ta l loo s as ollo s

```
\begin{center}
\begin{small}
\begin{tabular}{|r|r|c c|c c|c c|c c|c c|}  %12 columns
\multicolumn{12}{c}{\bf{Saturday, May 25}} \\\hline
From: & To: & Room: & Event: & Room: & Event: & Room: & Event: & Room: & Event: & Room: & Event:\\\hline
8:15  & 8:30  & BR119 & \multicolumn{9}{c|}{\bf{Announcements}} \\\hline
8:30  & 9:30  & BR119 & PT-S1 & \multicolumn{8}{c|}{\emph{No parallel sessions}} \\\hline
9:30  & 9:40  & \multicolumn{10}{c|}{\e6(An63845)Tj|mp
8:10  & 9:440& Roo19 & PT-S1 & \multicolumn{8}{c|}{\emph{No parallel sessions}} \\\hline\m40& PT-50& Rooulticolumn{10}
```

```
\begin align
 #  \til e ~       \    \label e     \\
                        \label e     \\
   \til e ~             \label e
\en  align
```

$$X \quad X^{\blacktriangleleft}, \quad 1, \tag{2}$$
$$X^{2}, \quad X, \tag{21}$$
$$X X^{\blacktriangleleft}, \bullet. \tag{22}$$

4.8 Example of splitting long expressions with `multline` and `split`

r s o o to split a lon pr ssion amon s ral lin s sin a n n ironm nt rom t **amsmath** pac a t at n s to loa tra into LaTeX. t is `\begin multline` `\en multline` . or mor in ormation a o t t is r s l comman not pr s nt in stan ar LaTeX a ain r r to an . To loa it s comman `\usepa age amsmath` .

```
\begin multline
  # l   # #    ′ L#′ L#  ′  # #′ l #′ L ′   # ′    \\
#′ L#′  #  ′ L#    ′ L  #  ′ L  #    ′   ′ L#  ′
\en  multline
```

t at i s

$$1 \quad q$$

```
\begin{multline}
 f(x) = (x_{1}x_{2}x_{3}x_{4}x_{5}x_{6}x_{7}x_{8})^{6n-7} +
              (x_{1}x_{2}x_{3}x_{4}x_{5}x_{6}x_{7}x_{8})^{9n+7} \\
       + (x_{1}x_{2})^{8n-9}+(x_{3}x_{4})^{4n+10}+(x_{1}x_{2} +
              x_{3}x_{4}+x_{5}x_{6}+x_{7}x_{8})^{6n} \\
       - (x_{1}x_{3})^{6n-9}+(x_{2}x_{4})^{4n-10} +
              (x_{1}x_{4}+ x_{2}x_{3}+x_{6}x_{8}+x_{5}x_{8})^{6n-12}
\label{eq:longone2}
\end{multline}
```

• or mor in ormation.

4.9 Example of gather and gather*

omman t gather* n ironm nt is a tt r rsion o t ispla in il allo in m c control o r spacin il o s not allo or an control. T gather* n ironm nt i rs rom gather n ironm nt in t at t ispla it m or it ms is not ar not n m r . or ampl

```
\begin gather*
\alpha  b  l   \ isplaystyle \ ra    #  l\       # \ ra  b         \ ua
\alpha  b  l   \ isplaystyle \ ra    #  l\       # \ ra  b         \\    ex
\alpha  b   b  l   \ isplaystyle \ ra    #  #   l\       #\ ra    #  lb       #
                                 \ ra    #  lb       #\ ra  b
\en  gather*
```

otic t at t ori ontal spacin in t rst ro is controll it comman \ ua il t rtical spacin is incr as t an s to ex . n t is n ironm nt ispla it ms ar c nt r .

$$\alpha_q\ b_1,\quad \frac{q-1}{q}\frac{1}{}\quad \frac{b_1}{q},\quad \alpha_q\ b_2,\quad \frac{q-1}{q}\frac{1}{}\quad \frac{b_2}{q},$$
$$\alpha_q\ b_1b_2,\quad \frac{1-2q}{q^2}\quad \frac{q^2}{}\frac{1}{}\quad \frac{q-1}{q^2}\frac{b_1}{}\quad \frac{q-1}{q^2}\frac{b_2}{}\quad \frac{b_{21}}{q^2}.$$

T r mainin ampl s com rom l s t at cam it TEX 2.

5 Additional examples

5.1 Braces and over braces

```
\ \un erbra e \  erbra e \mathstrut a \l  ts a
         \ a\math har' \rm s
    \  erbra e \mathstrut b \l  ts b
        l\ b\math har' \rm s     #l\rm\ elements \
```

$$\underbrace{a,\ldots,a}_{k\ a\text{'s}}\ \underbrace{b,\ldots,b}_{l\ b\text{'s}}.$$
$$\underbrace{\qquad\qquad}_{k+l\ \text{elements}}$$

5.2 Products and sums

```
\pr    \ge  \biggl \sum   \ge  a     \biggr
   \sum  n\ge    n\ \ iggl \sum
```

```
                          \␣ra  b          #⟩l  \n tag \\
      \phant m    \hspa e*  ex #′   b     #′   b       \label e      \\  ex
        ′  \  #\ isplaystyle \␣ra  t ⌞ b          #     #   #⟩l #
                          \␣ra  t   b           #     #   #⟩l  \n tag \\
      \phant m    \hspa e*  ex #\ isplaystyle \␣ra    #⟩l b          #     #   #
                  #′   b     #′   b
\label e
\en  align
```

$$X\,X$$

r a s parat t i lio rap ical ntri s it a p rc nt si n st r r nc s ill n m r . La ls hahn in \bibitem hahn an grat er in \bibitem grat er ollo an as to r m m r con ntion last nam ollo t ar o p lication. T n in t t t on can r r or cit a r r nc sin t comman \ ite . or ampl can r r to t a o t o it ms list in o r r r nc s at t n o t is articl as 2 an . t is also possi l to r r to t o or mor it ms it on \ ite hahn grat er comman to t 2 . n can also cit sp ci c pa s. or instanc \ ite pages~ ## grat er ill i pa s 2 12 . T onl r l to r m m r a o t t s la ls is t at t cannot start it a spac an cannot contain a comma or a spac .

lt o t r ma mor t an on thebibli graphy n ironm nt in articl on normall o sn t s t at at r nl ss on ants to list r r nc s at t n o ac c apt r or ampl . rt rmor t n in ac i lio rap t ntri s ill n m r rom 1. o r l t m s o r stan ar ormattin r l s o t . nl t titl s ar mp asi an onl t ol m n m in ol ac .

```
\begin thebibli graphy
\bibitem amermesh
    amermesh      \emph r up he ry an ts ppli ati n t hysi al r blems      is n# esley
     n n

\bibitem ablam
    blam i        \emph pin r representati ns      li r \l#    algebras \l#    \l#    symb li \l#    a
```

References

1 am rm s *Groupiy28y and Itsation to Physical Problems* ison sl Lon on

2 lamo ic . *Spinorepresentations 94Cli or algebras: A symbolic appry28ch* sics omm ni cations 115 pp. .

omman \begin thebibli graphy as ar m nt. n o r t is ar m nt is . T is t l 12 L T 1 1T . 7 .

l ss t n an t n s or on n r or it ms.

6.2 Index

t i 12 p 2 ossi l 2 in 2 lar r 2 o 2 c m n 2 ts 2 to 2 ins rt 2 in 2 n 2 tri s 1 t at 2

r sira l n p s ttin oo s. n on t r st is r rr to .

7 Summary

or a itional so rc s o in ormation a o t ttuthesis sty

```
\appen ix
\se ti n  inal   r s
\label  pp .
```