Using the Bard TEX Style File for

Homework
Bard Senior Projects
Bard M.A.T. Projects
Junior Seminar Projects
Prospectus Talks
Presentations
Posters

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August 6, 2017

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Introduction

1.1 What is the Bard TEX Style File?

The Bard TEX style file, called bardtex.sty, is a LATEX style designed for seven types of writing:

1. Homework
2. Bard senior projects
3. Bard M.A.T. projects
4. Junior Seminar projects
5. Bard senior project prospectus talks
6. Presentations
7. Posters for poster sessions.

The style file provides LATEX commands for two aspects of these writing projects:

1. **Document Formatting**: for example, the title page, dedication, acknowledgements and correct margins for senior projects, and boxes and headings for posters.
2. **Mathematical Formatting**: for example, theorems, definitions and proofs, and also mathematical notation commonly used in some proofs-based undergraduate mathematics courses such as Abstract Algebra and Real Analysis.

It is assumed that users of this style file already know the basics of LATEX. This manual will discuss commands that are specific to the Bard TEX style file, as well as some standard LATEX

commands that are particularly useful for the types of writing for which this style file would be used.

1.2 Obtaining the Bard TEX Style File and Associated Files

The style file bardtex.sty has seven associated templates:

1. bardtex_homework_template.tex
2. bardtex_seniorproject_template.tex
3. bardtex_matproject_template.tex
4. bardtex_juniorseminar_template.tex
5. bardtex_prospectus_template.tex
6. bardtex_presentation_template.tex
7. bardtex_poster_template.tex,

and seven associated samples:

1. bardtex_homework_sample.tex
2. bardtex_seniorproject_sample.tex
3. bardtex_matproject_sample.tex
4. bardtex_juniorseminar_sample.tex
5. bardtex_poster_sample.tex.

The style file and the associated files (in both .tex and .pdf format) can be downloaded in a single zipped folder from the website

`http://math.bard.edu/bloch/tex/`.

If you find any errors in any of these files, or you have any suggestions for improvements, please send your comments to `bloch@bard.edu`.

1.3 Read this Whole Manual

Knowing LaTeX in general, and the specific LaTeX commands used by the Bard TeX style file in particular, is very helpful for mathematical writing such as homework and senior projects. Even more important, however, is to follow good writing practices for mathematics. Please read all relevant parts of this manual, including the sections on mathematical formatting, using proper LaTeX, figures, bibliography, and good mathematical writing. Reading these sections will both save you time in the long run and lead to better results.

2
Formatting Specific to Each Template

2.1 Homework

The homework template is designed for homework assignments in mathematics, though it could be used just as well for homework assignments in fields such as physics and computer science. A number of options are available for stating the exercises (for example, writing only the number of the exercise but not its statement, or writing both the number and the statement of exercise), and for writing the solutions (for example, saying "solution" or saying "proof").

2.1.1 Homework Information

To write the basic information about a homework assignment, insert

```
\hwinfo{Your Name}{Course}{Date of Assignment}
```

immediately after `\begin{document}`. Be sure to insert your own name, course and date of assignment.

2.1.2 Exercises and Solutions

In contrast to the other templates for this style file, where the theorems, lemmas, definitions and the like are numbered automatically by LaTeX, in the homework template the most common occurrence is to refer to exercises in the textbook that already have numbers, and which therefore should not be numbered automatically by LaTeX.

The formats for exercises and solutions are shown below. These formats include an option where you give only the number of an exercise but not its statement, seen in the first example, and other options where you give both the number and statement of the exercise, as also

shown. For each format, an example is shown followed by the command used to obtain that example.

1. Exercise Number but No Statement

Exercise 3.2.1

```
\exernum{3.2.1}
```

2. Exercise Number and Statement

Exercise 3.2.1. For this exercise, you given the number and the statement. ♢

```
\exero{3.2.1}
For this exercise, you given the number and the statement.
\eexero
```

3. Exercise Number, Name and Statement

Exercise 3.2.1 (Fred's Theorem)**.** For this exercise, you give the number, a name and the statement. ♢

```
\exero{3.2.1}[Fred's Theorem]
For this exercise, you give the number, a name and the statement.
\eexero
```

4. Exercise Statement, but no Number

Exercise. This exercise has a statement, but not a number. ♢

```
\exern
This exercise has a statement, but not a number.
\eexern
```

5. Exercise Statement and Name, but no Number

Exercise (Theorem of Fred)**.** This exercise has a statement and a name, but not a number. ♢

```
\exern[Theorem of Fred]
This exercise has a statement and a name, but not a number.
\eexern
```

6. Exercise with a Statement and Automatic Numbering

Exercise 2.1.1. This exercise has a statement, and is numbered automatically.

```
\exer\label{thmA}
This exercise has a statement, and is numbered automatically.
\eexer
```

7. Exercise with a Statement, Automatic Numbering and a Name

Exercise 2.1.2 (F. Smith's Theorem)**.** This exercise has a statement and a name, and is numbered automatically.

```
\exer[F.\ Smith's Theorem]\label{thmB}
This exercise has a statement and a name, and is numbered automatically.
\eexer
```

8. Referring to a Theorem that is Automatically Numbered

This is Theorem 2.1.1. It is automatically numbered, so you use `\ref` with the internal label.

```
This is Theorem~\ref{thmA}.  It is automatically numbered,
so you use \verb+\ref+ with the internal label.
```

9. Referring to a Theorem that is not Automatically Numbered

This is Theorem 3.2.1. It is not automatically numbered, so you write the number directly.

```
This is Theorem~3.2.1.  It is not automatically numbered,
so you write the number directly.
```

10. Solution

Solution. Finding a solution is fun. □

```
\solu
Finding a solution is fun.
\esolu
```

11. Proof

Proof. How could this theorem not be true? □

```
\demo
How could this theorem not be true?
\edemo
```

12. Proof of a Named Theorem or a Theorem that is Not Automatically Numbered

Proof of Theorem 3.2.1. Obviously, this theorem is true. □

```
\demoname{Proof of Theorem~3.2.1}
Obviously, this theorem is true.
\edemoname
```

13. Proof of a Theorem that is Automatically Numbered

Proof of Theorem 2.1.1. Obviously, this theorem is true. □

```
\demoname{Proof of Theorem~\ref{thmA}}
Obviously, this theorem is true.
\edemoname
```

2.2 Senior Project

The senior project template is designed for Bard senior projects, though it could be used just as well for theses written elsewhere (via a simple modification of the title page command in the style file). Various formatting issues are taken care of by the style file and template (both text issues, for example the correct margins and the title page, and mathematical issues, such as formatting theorems and proofs).

Examples of using the various commands described below (except for the last one) are seen in the senior project sample that is found in the folder containing the bardtex.sty style file.

2.2.1 Title Page

To create the title page of a senior project, insert

```
\titlepg{Title of Project}{Your Name}
{Month of Graduation}{Year of Graduation}
```

immediately after `\begin{document}`. Be sure to insert your own title, name, and month and year of graduation.

For drafts of your project, you can comment out the title page command.

2.2.2 Abstract, Dedication, Acknowledgments and Introduction

Every senior project requires an abstract. To put an abstract in your project, insert

```
\abstr
```

after the titlepage and before the command `\tableofcontents`. Put the text of your abstract after the abstract command.

It is customary (though not required) to put a dedication and/or acknowledgments in your senior project. These should be inserted right after the command `\tableofcontents`, and before the command `\startmain`.

To put a dedication in your project, insert

```
\dedic
```

and then put in the text of your dedication.

To put acknowledgments in your project, insert

```
\acknowl
```

and then put in the text of your acknowledgments.

Every senior project should have an introductory chapter. To put an introduction in your project, insert

```
\intro
```

and then put in the text of your introductory chapter. This brief chapter, which can be thought of as an expanded version of the abstract, is meant to give the big picture, and should include a discussion of the background to the project, place the project in the context of known results, and provide an informal summary of the main results. Additionally, the introductory chapter should make clear what in the project is exposition of known results and what is original work.

When you use any of the above four commands, the appropriate heading, page breaks and the like will be done automatically.

The abstract, dedication and acknowledgments are usually written when you are done writing the bulk of your project. For drafts of your project, you can comment out these three commands.

2.2.3 Automatica Numbering of Theorems, Lemmas and the Like

Whereas the commands for writing theorems, lemmas, definitions, and the like are the same for all the templates, the automatic numbering works differently in the various templates. In the senior project template, the numbering for theorems, lemmas and the like is by chapter and section. Please do not override those settings.

2.2.4 Appendices

Appendices can be added to a senior project, using the following commands (which are in the senior project template).

All appendices are inserted between the commands

```
\begin{appendices}


\end{appendices}
```

Each appendix is considered a chapter within the appendices, and they are automatically numbered *A*, *B*, *C*, etc. Each section within a chapter within the appendices is numbered *A*.1, *A*.2, etc. The same chapter and section commands are used for appendices as are used for regular chapters and sections.

In the senior project template, one chapter and one section is given within the appendices, using the following commands, though you can add as many chapters and sections within the appendices as needed.

```
\chapter{Title of First Chapter of Appendices}
\label{label}

\section{Title of First Section of Appendices}
\label{label}
```

Be sure to insert your own chapter title, section title and labels. Keep in mind that every chapter and every section needs a different label. Mnemonic labels such as "`appendixone`" are helpful, though not necessary.

If you do not want any appendices, remove the commands `\begin{appendices}` and `\end{appendices}`, and remove everything in between them.

2.2.5 List of Figures

A list of figures is not needed for most projects, though if you want a list of figures, insert

```
\listoffigures
```

into your text immediately after the command `\tableofcontents`.

2.3 M.A.T. Project

The M.A.T. project template is designed for Bard M.A.T. research projects, though it could be used just as well for theses written elsewhere (via a simple modification of the title page command in the style file). Various formatting issues are taken care of by the style file and template (both text issues, for example the correct margins and the title page, and mathematical issues, such as formatting theorems and proofs).

Examples of using the various commands described below (except for the last one) are seen in the M.A.T. project sample that is found in the folder containing the bardtex.sty style file.

2.3.1 Title Page

To create the title page of a M.A.T. project, insert

```
\titlepgmat{Title of Project}{Your Name}
{Month of Graduation}{Year of Graduation}
```

immediately after `\begin{document}`. Be sure to insert your own title, name, and month and year of graduation.

For drafts of your project, you can comment out the title page command.

2.3.2 Abstract, Dedication, Acknowledgments and Introduction

Every M.A.T. project requires an abstract. To put an abstract in your project, insert

```
\abstr
```

after the titlepage and before the command `\tableofcontents`. Put the text of your abstract after the abstract command.

It is customary (though not required) to put a dedication and/or acknowledgments in your M.A.T. project. These should be put right after the command `\tableofcontents`, and before the command `\startmain`.

To put a dedication in your project, insert

```
\dedic
```

and then put in the text of your dedication.

To put acknowledgments in your project, insert

```
\acknowl
```

and then put in the text of your acknowledgments.

Every M.A.T. project should have an introductory chapter. To put an introduction in your project, insert

```
\intro
```

and then put in the text of your introductory chapter. This brief chapter, which can be thought of as an expanded version of the abstract, is meant to give the big picture, and should include a discussion of the background to the project, place the project in the context of known results, and provide an informal summary of the main results. Additionally, the introductory chapter should make clear what in the project is exposition of known results and what is original work.

When you use any of the above four commands, the appropriate heading, page breaks and the like will be done automatically.

The abstract, dedication and acknowledgments are usually written when you are done writing the bulk of your project. For drafts of your project, you can comment out these three commands.

2.3.3 Automatica Numbering of Theorems, Lemmas and the Like

Whereas the commands for writing theorems, lemmas, definitions, and the like are the same for all the templates, the automatic numbering works differently in the various templates. In the M.A.T. project template, the numbering for theorems, lemmas and the like is by chapter and section. Please do not override those settings.

2.3.4 Appendices

Appendices can be added to a senior project, using the following commands (which are in the senior project template).

All appendices are inserted between the commands

```
\begin{appendices}


\end{appendices}
```

Each appendix is considered a chapter within the appendices, and they are automatically numbered A, B, C, etc. Each section within a chapter within the appendices is numbered $A.1$, $A.2$, etc. The same chapter and section commands are used for appendices as are used for regular chapters and sections.

In the senior project template, one chapter and one section is given within the appendices, using the following commands, though you can add as many chapters and sections within the appendices as needed.

```
\chapter{Title of First Chapter of Appendices}
\label{label}

\section{Title of First Section of Appendices}
\label{label}
```

Be sure to insert your own chapter title, section title and labels. Keep in mind that every chapter and every section needs a different label. Mnemonic labels such as "`appendixone`" are helpful, though not necessary.

If you do not want any appendices, remove the commands `\begin{appendices}` and `\end{appendices}`, and remove everything in between them.

2.3.5 List of Figures

A list of figures is not needed for most projects, though if you want a list of figures, insert

```
\listoffigures
```

into your text immediately after the command `\tableofcontents`.

2.4 Junior Seminar

The junior seminar template is designed for Bard mathematics Junior Seminar writing projects, though it could be used just as well for short reports written elsewhere (via a simple modification of the title page command in the style file).Various formatting issues are taken care of by the style file and template (both text issues, for example the correct margins and the title page, and mathematical issues, such as formatting theorems and proofs).

Examples of using the various commands described below (except for the last one) are seen in the junior seminar sample that is found in the folder containing the bardtex.sty style file.

2.4.1 Title Page

To create the title page of a junior seminar project, insert

```
\titlepgjrsem{Title of Project}{Your Name}{Month}{Year}
```

immediately after `\begin{document}`. Be sure to insert your own title, name, and month and year.

For drafts of your project, you can comment out the title page command.

2.4.2 Abstract

Every junior seminar project requires an abstract. To put an abstract in your project, insert

```
\abstr
```

after the titlepage and before the command `\tableofcontents`. Put the text of your abstract after the abstract command.

The abstract is usually written when you are done writing the bulk of your project. For drafts of your project, you can comment out this commands.

2.4.3 Automatica Numbering of Theorems, Lemmas and the Like

Whereas the commands for writing theorems, lemmas, definitions, and the like are the same for all the templates, the automatic numbering works differently in the various templates. In the junior seminar project template, the numbering for theorems, lemmas and the like is by section (do not use chapter commands in junior seminar projects).

2.5 Prospectus Talk

The prospectus template is an easy-to-use, though not very fancy, template for senior project prospectus talks. This template produces only very basic slides, which are completely static, and have no dynamic features such as bullet points that appear one at a time; the convenient aspect of this template is that it uses the same mathematical commands used in all the other templates associated with this style file. Various formatting issues are taken care of by the style file and template (both text issues, for example the title slide, and mathematical issues, such as formatting theorems and proofs).

Examples of most of the commands described below are seen in the prospectus sample that is found in the folder containing the bardtex.sty style file.

2.5.1 Title Slide

To create the title slide of a senior project prospectus talk, insert

```
\titleprospectus{Senior Project Title}
{Your Name}{Program Name}
{Month and Year of Prospectus talk}{Adviser's Name}
```

immediately after `\begin{document}`. Be sure to insert your own title, name, program name, month and year of the prospectus talk and adviser's name.

2.5.2 Slide Heading

The slides are entered after the command `\startmain`.

Every prospectus talk has five slides. Each slide has a heading, which appears in a colored strip at the top of the slide. The headings are automatically numbered 1–5; do not insert numbers manually. The headings for each of the five slides are inserted by using the appropriate choice of the commands

```
\prospectusslideone{Heading of Slide \#1}
\prospectusslidetwo{Heading of Slide \#2}
\prospectusslidethree{Heading of Slide \#3}
\prospectusslidefour{Heading of Slide \#4}
\prospectusslidefive{Heading of Slide \#5}
```

Be sure to insert your own headings.

The text of each slide is written after the command for the heading of that slide.

Prospectus talks should be at most five slides, and each slide should be one page, no more. If the text of a slide in a prospectus talk does go over one page, the page with the overflow will not have a heading, which is a sign that there is too much text on that slide.

2.5.3 Color Choices

The prospectus template has four built in choices of color: the color of the title of the prospectus talk, the color of the name of the student, the color of the text in the heading strip at the top of each slide, and the color of the heading strips.

The choice of color is controlled by four commands, which are

```
\prospectustitlecolor{color}
\prospectusnamecolor{color}
\prospectusheadingtextcolor{color}
\prospectusheadingbackgroundcolor{color}
```

These four commands are found just before `\begin{document}`. Be sure to insert your own choice of colors. The default colors are RoyalPurple for the title of the presentation, RoyalBlue for the name of the student, White for the text in the heading strips and Purple for the heading strips.

The possible names for colors are given in Subsection 3.3.1 of this manual.

2.5.4 Automatica Numbering of Theorems, Lemmas and the Like

Whereas the commands for theorems, lemmas, definitions, and the like are the same for all the templates, the automatic numbering works differently in the various templates. In the presentation template, the numbering for theorems, lemmas and the like is consecutive, without chapter or section numbers (you should not use chapter or section commands in presentations).

2.6 Presentation

The presentation template is an easy-to-use, though not very fancy, template for mathematics talks. This template produces only very basic slides; the convenient aspect of this template is that it uses the same mathematical commands used in all the other templates associated with this style file. Various formatting issues are taken care of by the style file and template (both text issues, for example the title slide, and mathematical issues, such as formatting theorems and proofs).

Examples of most of the commands described below are seen in the presentation sample that is found in the folder containing the bardtex.sty style file.

2.6.1 Title Slide

There are two options for creating a title slide.

To create the title slide of a generic presentation, insert

```
\titlepresentationgeneric{Title}{Your Name}
{Affiliation}{Date}
```

immediately after `\begin{document}`. Be sure to insert your own title, name, affiliation and date.

To create the title slide of a senior project presentation, insert

```
\titlepresentationseniorproject{Senior Project Title}
{Your Name}{Program Name}
{Month and Year of Presentation}{Adviser's Name}
```

immediately after `\begin{document}`. Be sure to insert your own title, name, program name, month and year of graduation and adviser's name.

2.6.2 Slide Heading

The slides are entered after the command `\startmain`.

Every slide has a heading, which appears in a colored strip at the top of the slide. Each new heading (which automatically starts a new slide) is created by inserting

```
\presentationslideheading{Heading}
```

Be sure to insert your own heading.

The text of the slides with that heading are written after the command for the heading.

If the text of a slide goes over one page, the heading strip persists on the next page, and will persist for as many pages as desired, until a new heading is inserted.

2.6.3 Bulleted and Itemized Lists—All Items Appearing Together

Use the following variants on enumerated and itemized lists to have the numbers and bullets in such lists be in color.

```
\begin{enumeratec}{colorname}
\item text
\item text
\end{enumeratec}

\begin{itemizec}{colorname}
\item text
\item text
\end{itemizec}
```

Be sure to insert your own color names and text.

The possible names for colors are given in Subsection 3.3.1 of this manual.

The standard LaTeX environments `itemize` and `enumerate` will produce lists that have the bullets (or numbers) and the text all in the same color as the rest of the text in the presentation.

Using the environment `itemizef` the use of custom bullets.

((Put where needed, and fix as needed: Once you have created your bullet figure file, put it in the same folder on your computer as your .tex file. If the bullet figure file is anywhere else, LaTeX will not be able to find it, unless, when you insert the bullet figure into your .tex file, you give the full path+filename for the figure rather than just the filename of the figure.

To use any letters or TeX commands as bullets, insert

```
\bulletchoice{bullet}
```

before `\begin{document}`. For example, the default bullet in this style file is given by `\textcolor{\bulletclr}{$\bullet$}`. To change the bullet from some slide on, put the above command before that slide.

To use a graphics file as a bullet, insert

```
\bulletchoicegraphic{filename}
```

before `\begin{document}`.

In TeXShop, or any other implementation that uses PDFLaTeX, the graphic should be in PDF format. For other TeX implementations, the graphic should be in EPS format.

To change the bullet to a graphic from some slide on, put the above command before that slide.

Most graphics are too large to be used as bullets, and to use a scaled graphic as a bullet, insert

```
\bulletchoicegraphicscale{filename}{scale factor}
```

before `\begin{document}`. The scale factor is a number, which would be less than one if the graphic is too large, and more than one if the graphic is too small. Again, to change the bullet to a scaled graphic from some slide on, put the above command before that slide.

2.6.4 Bulleted and Itemized Lists—Items Appearing One at a Time

As an example, insert the following for a grouping with bullets and headings

```
\groupheadbull number
{title for group of slides}
{first bulleted item}
{second bulleted item}
.
.
.
{last bulleted item}
```

Be sure to insert your own number (the number of items, which can be $0-8$), title for the groups of slides, and the various bulleted items.

It is important that the number after the command `\groupheadbull` match the number of bulleted items (not counting the heading).

It is very important to have the the extra brackets as indicated (though they do not have to be typed on separate lines—that is just for convenience).

The various types of groupings with bulleted or enumerated items and with heading are as follows:

Bulleted or Enumerated, Heading

Command	Features	Number of Items
`\groupheadbull`	Bullets	0-8
`\groupheadbullc`	Bullets, different color for items	0-8
`\groupheadenum`	Enumeration	0-8
`\groupheadenumc`	Enumeration, different color for items	0-8

2.6.5 Color Choices

The presentation template has four built in choices of color: the color of the title of the presentation, the color of the name of the author, the color of the text in the heading strip at the top of each slide, and the color of the heading strips.

The choice of color is controlled by four commands, which are

```
\presentationtitlecolor{color}
\presentationnamecolor{color}
\presentationheadingtextcolor{color}
\presentationheadingbackgroundcolor{color}
```

These four commands are found just before `\begin{document}`. Be sure to insert your own choice of colors. The default colors are RoyalPurple for the title of the presentation, RoyalBlue for the name of the author, White for the text in the heading strips and Purple for the heading strips.

The possible names for colors are given in Subsection 3.3.1 of this manual.

2.6.6 Automatica Numbering of Theorems, Lemmas and the Like

Whereas the commands for theorems, lemmas, definitions, and the like are the same for all the templates, the automatic numbering works differently in the various templates. In the presentation template, the numbering for theorems, lemmas and the like is consecutive, without chapter or section numbers (you should not use chapter or section commands in presentations).

2.7 Poster

The poster template is designed for posters for the Bard Division of Science, Mathematics, and Computing senior project poster session, though it could be used just as well for posters written or presented elsewhere (via some modifications of the style file). Various formatting issues are taken care of by the style file and template (both text issues, for example the poster heading and formatting text boxes, and mathematical issues, such as formatting theorems and proofs).

Examples of most of the commands described below are seen in the poster sample that is found in the folder containing the bardtex.sty style file.

2.7.1 Platform

Although most aspects of TEX are platform independent, there does seem to be some variation from platform to platform when making posters using this style file. The poster template has been tested using TEXShop on a Mac and TEXworks on a PC. There may be problems using this template in Linux.

2.7.2 Paper Size

The default paper size produced by this poster style is 42" x 42". That is the size required for the Bard senior project poster session.

The poster produces a large box of fixed size surrounding the text boxes. Make sure the content of your poster does not overflow the large box.

If you are producing a poster that needs a different paper size, you can change the height and width of the paper and the size of each of the four margins by opening the bardtex.sty style file and modifying the command

```
\geometry{paperheight=42 truein, paperwidth=42 truein,
```

```
tmargin=2 truein, bmargin=2 truein,
lmargin=2 truein, rmargin=2 truein}
```

2.7.3 Poster Style

There are four built-in options for the style of posters, called “styleone,” “styletwo,” “stylethree” and “stylefour." The default is “styleone.”

If you want to change the poster style from the default style, insert the command

```
\posterstyle{style}
```

just before `\begin{document}`. Be sure to insert your own choice of “styleone,” “styletwo,” “stylethree” or “stylefour." Inserting anything other than one of these four style options in this command will result in the default style.

Note that for all four poster styles, all the other commands for making a poster remain unchanged.

2.7.4 Optional Graphics on Either Side of the Title Box

The default design of the poster style has nothing to the left or right of the title box. If you want to insert a graphic (for example the Bard seal) on both sides of the title box, insert the command

```
\leftrightlogo{figure file name}
```

just before `\begin{document}`. Be sure to insert your own figure file name. The figure file must be in the same folder as the poster .tex file.

If you want to insert a graphic on only one side of the title box, or different graphics on the two sides of the title box, insert either or both of the commands

```
\leftlogo{figure file name}
\rightlogo{figure file name}
```

just before `\begin{document}`. Be sure to insert your own figure file names. The figure files must be in the same folder as the poster .tex file.

If you want to insert graphics on either or both sides of the title box, you need to supply your own graphics files.

2.7.5 Top and Bottom of Poster

The first item in the poster file after the `\begin{document}` command is

```
\begin{posterbard}
```

The last item in the poster file before the `\end{document}` command is

```
\end{posterbard}
```

2.7.6 Heading Content

After the `\begin{posterbard}` command, insert

```
\postertop {Senior Project Title}{Your name}{Program}
{Month and year of graduation}{Adviser's name}
```

Be sure to insert your own senior project title, name, program (Mathematics, Physics, Computer Science, etc.), month and year of graduation and adviser's name.

2.7.7 Heading Size

If the title of the senior project is long, the title will be wrapped within the box containing the title, resulting in a taller box.

To accommodate lengthy titles, the box containing the title can be slightly widened. To do that replace the command

```
\postertop {Senior Project Title}{Your name}{Program}
{Month and year of graduation}{Adviser's name}
```

with the command

```
\postertopscale {Senior Project Title}{Your name}{Program}
{Month and year of graduation}{Adviser's name}{scale}
```

Be sure to insert your own scale, which can be a number from 1 to 2, but not larger.

If you are using a graphic on either, or both, sides of the title box, then the scale needs to be smaller than 2, to avoid overlap of the title box with the graphics, or having the graphics going outside the box surrounding the whole poster. For example, if the logo of the Bard Mathematics Program (math_prog_logo.pdf) is used as the graphic, then the maximal scale that still looks good is 1.6; the same holds for any graphic is that has roughly the same height and width. For other graphics, the maximal scale to be used depends upon the shape of the graphic. The poster will not turn out right if the title box is scaled too large.

2.7.8 Heading Words

There are four built-in variations of the word "adviser" available for poster headings, and they are "adviser," "advisor," "advisers" and "advisor." The default is "adviser."

If you want to change the word "adviser" from the default, insert the command

```
\adviseroption{adviser}
```

before `\begin{document}`. Be sure to insert your own choice of "adviser," "advisor," "advisers" or "advisor." Inserting anything other than one of these four words in this command will result in the default option.

There are two built-in variations of the word "program" available for poster headings, and they are "program" and "programs." The default is "program."

If you want to change the word "program" from the default, insert the command

```
\programoption{program}
```

before `\begin{document}`. Be sure to insert your own choice of "program" or "programs." Inserting anything other than one of these two words in this command will result in the default option.

2.7.9 Text Boxes With Title and Without Title

The text of the poster is contained in text boxes, which are designed to make the poster easy to read. The text boxes will be distributed roughly equally between the three columns of the poster. As many text boxes as desired can be inserted, as long as the text boxes stay within the large box of fixed size surrounding the text boxes.

The format for a text box with a title is

```
\begin{posterboxtitle}{title}
Text of this box
\end{posterboxtitle}
```

Be sure to insert your own title and text.

The format for a text box without a title is

```
\begin{posterboxnotitle}
Text of this box
\end{posterboxnotitle}
```

Be sure to insert your own text.

2.7.10 Abstract

The first text box should contain the abstract for the poster, and should use the format

```
\begin{posterboxabstract}
Text of abstract
\end{posterboxabstract}
```

Be sure to insert your own text of the abstract.

2.7.11 Color Choices

The poster template has three built in choices of color: the color of the boxes (in styleone both the text boxes and the larger surrounding box, and in the other styles only the larger surrounding box); the color of the title of the poster (in styleone the color of the text of the title, and in the other styles the background color of the box containing the title); and the color of the titles of the text boxes with titles (in styleone the color of the text of the title of the box, and in the other styles the background color of the box containing the title of the box).

The choice of color is controlled by three commands, which are

```
\boxcolor{color}
\toptitlecolor{color}
\boxtitlecolor{color}
```

These three commands are found before `\begin{document}`. Be sure to insert your own choice of colors. The default colors are Mulberry for the boxes, RedViolet for the title of the poster and BlueViolet for the titles of the text boxes with titles.

The possible names for colors are given in Subsection 3.3.1 of this manual.

2.7.12 Automatica Numbering of Theorems, Lemmas and the Like

Whereas the commands for theorems, lemmas, definitions, and the like are the same for all the templates, the automatic numbering works differently in the various templates. In the poster template, the numbering for theorems, lemmas and the like is consecutive, without chapter or section numbers (you should not use chapter or section commands in posters).

3
Formatting Common to All Templates

3.1 Document Formatting

Some of the topics below use commands specific to this style file, whereas others (such as chapters and sections) use standard LaTeX commands that have been included here for the sake of completeness.

3.1.1 Do Not Delete Blank Pages

When LaTeX makes a document designed for double-sided printing, it has odd-numbered pages be on the left side of the page, and it has every chapter, and every special section such as acknowledgments and dedication, start on the left side of the page. To do that, LaTeX will leave some pages blank (though numbered).

Warning: Do not remove the blank pages created by LaTeX.

3.1.2 Double-Sided Printing vs. Single-Sided Printing

The default setting for all the templates (other than posters) is double-sided printing, meaning printing on both sides of every sheet of paper. This default setting would also work if the document were printed single-sided, but then copied double-sided.

If you want single-sided printing, replace the word

```
twoside
```

with the word

```
oneside
```

in the `\documentclass` declaration at the start of the template.

3.1.3 Double-Spaced vs. Single-Spaced

The default setting for all the templates (other than posters) is double-spaced text for the main part of the document, though single-spaced text for the abstract, table of contents, dedication, acknowledgements and bibliography.

If you want to have the main part of the document be single-spaced, you can insert the command

```
\singlespace
```

right after the command `\startmain`.

Warning: For most documents, it is best to leave the main part double-spaced.

3.1.4 Chapters and Sections

The format for chapter and section headings are

```
\chapter{Title of Chapter}
\label{label}
```

and

```
\section{Title of Section}
\label{label}
```

Be sure to insert your own chapter title, section title and labels. Keep in mind that every chapter and every section needs a different label. Mnemonic labels such as "`chapmainresults`" are helpful, though not necessary.

Warning: Do not write the chapter number or section number as part of the chapter title or section title, because the number is inserted automatically by LaTeX.

To refer to a chapter or section, write

```
Chapter~\ref{label}
```

for chapters, and similarly for sections.

Warning: Be sure to use the symbol `~` between the word "Chapter" (or "Section") and `\ref{label}`. This symbol, which is a non-breaking space, ensures that the chapter or section number is not placed by itself at the start of a new line.

3.2 Mathematical Formatting

This section discusses two types of issues related to writing mathematics, the first of which involves constructs such as theorems, definitions, proofs, and the like, and the second of which is specific symbols used in some standard undergraduate mathematics courses such as Abstract Algebra and Real.

3.2.1 Theorems, Definitions, Proofs and the Like

Whereas LaTeX has a very large number of built-in mathematical structures, for example fractions, matrices and the like, there is one important type of mathematical structure that is not pre-defined in LaTeX, which includes theorems, definitions, proofs and other such constructs. These constructs, which the user would otherwise have to set up, have been defined in the Bard TeX style file, and can be used without any additional set up.

The format for theorems, definitions, proofs and the like is shown below, using the particular case of theorems as an example. The analogous commands for lemmas, corollaries, definitions, etc. are given in the tables that follow.

Warning: Do not the write the theorem number manually, because the number is inserted automatically by LaTeX.

1. Plain Theorem

Theorem 3.2.1. *This theorem is automatically numbered.*

```
\thm\label{thmD}
This theorem is automatically numbered.
\ethm
```

2. Theorem with a Name

Theorem 3.2.2 (Smith's Theorem)**.** *This theorem is automatically numbered, and it also has a name.*

```
\thmnamed{Smith's Theorem}\label{thmE}
This theorem is automatically numbered, and it also has a name.
\ethmnamed
```

3. Referring to a Theorem

This is Theorem 3.2.1; it is automatically numbered, and you refer to it using `\ref` with the theorem label.

```
This is Theorem~\ref{thmD}; it is automatically numbered,
and you refer to it using \verb@\ref@ with the theorem label.
```

4. Proof

Proof. How could this theorem not be true? □

```
\demo
How could this theorem not be true?
\edemo
```

5. Proof of a Named Theorem

Proof of Theorem 3.2.2. Obviously, this theorem is true. □

```
\demonamed{Proof of Theorem~\ref{thmE}}
Obviously, this theorem is true.
\edemonamed
```

6. Proof That Ends in a Displayed Equation

Proof. When a proof (or definition, example, etc.) ends with a displayed equation, special care is need so that the end-of-proof (or end-of-definition, end-of-example, etc.) symbol is inserted in the equation, for example

$$g = 1_A \circ g = (h \circ f) \circ g = h \circ (f \circ g) = h \circ 1_B = h. \qquad \square$$

```
\demonb
When a proof (or definition, example, etc.) ends with a
displayed equation, special care is need so that the
end-of-proof (or end-of-definition, end-of-example, etc.)
symbol is inserted in the equation, for example
%
\[
g  =  1_A \circ g  =  (h \circ f) \circ g  =  h \circ (f \circ g)  =  h
\circ 1_B  =  h.\tag*{\qedsymbol}
\]
%
\edemonb
```

7. Numbered Displayed Equation

If you want to number a displayed equation, for example

$$A + B = C. \tag{3.2.1}$$

you write it without `\[ ... \]` or `$$ ... $$`, and instead use

```
\begin{equation}\label{eqD}
A + B = C.
\end{equation}
```

Warning: Do not number every displayed equation; number only the displayed equations to which you need to refer by number.

8. Referring to a Numbered Equation

This is Equation (3.2.1); it is automatically numbered, and you refer to it using `\ref` with the theorem label.

```
This is Equation~(\ref{eqD}); it is automatically numbered,
and you refer to it using \verb@\ref@ with the theorem label.
```

You Write the Statement, Which is Numbered Automatically

Type	Command
Definition	`\defn\label{Label} ... \edefn`
Theorem	`\thm\label{Label} ... \ethm`
Lemma	`\lem\label{Label} ... \elem`
Corollary	`\coro\label{Label} ... \ecoro`
Proposition	`\prop\label{Label} ... \eprop`
Conjecture	`\conj\label{Label} ... \econj`
Claim	`\clm\label{Label} ... \eclm`
Example	`\expl\label{Label} ... \eexpl`
Remark	`\remk\label{Label} ... \eremk`
Algorithm	`\algrthm\label{Label} ... \ealgrthm`
Exercise	`\exer\label{Label} ... \eexer`
Problem	`\prob\label{Label} ... \eprob`

You Write the Number, But Not the Statement

Type	**Command**
Definition	`\defnnum{Number}`
Exercise	`\exernum{Number}`
Problem	`\probnum{Number}`
Theorem	`\thmnum{Number}`
Lemma	`\lemnum{Number}`
Corollary	`\coronum{Number}`
Proposition	`\propnum{Number}`
Conjecture	`\conjnum{Number}`
Claim	`\clmnum{Number}`
Example	`\explnum{Number}`
Remark	`\remknum{Number}`
Algorithm	`\algrthmnum{Number}`

You Write the Number and the Statement

Type	**Command**
Definition	`\defno{Number} ... \edefno`
Exercise	`\exero{Number} ... \eexero`
Problem	`\probo{Number} ... \eprobo`
Theorem	`\thmo{Number} ... \ethmo`
Lemma	`\lemo{Number} ... \elemo`
Corollary	`\coroo{Number} ... \ecoroo`
Proposition	`\propo{Number} ... \epropo`
Conjecture	`\conjo{Number} ... \econjo`
Claim	`\clmo{Number} ... \eclmo`
Example	`\explo{Number} ... \eexplo`
Remark	`\remko{Number} ... \eremko`
Algorithm	`\algrthmo{Number} ... \ealgrthmo`

You Write the Statement, But There is No Number

Type	**Command**
Definition	`\defnn ... \edefnn`
Exercise	`\exern ... \eexern`
Problem	`\probn ... \eprobn`
Theorem	`\thmn ... \ethmn`
Lemma	`\lemn ... \elemn`
Corollary	`\coron ... \ecoron`
Proposition	`\propn ... \epropn`
Conjecture	`\conjn ... \econjn`
Claim	`\clmn ... \eclmn`
Example	`\expln ... \eexpln`
Remark	`\remkn ... \eremkn`
Algorithm	`\algrthmn ... \ealgrthmn`

Proof, Example, Etc., Which Ends with a Displayed Equation

Type	**Command**	**Insert at End of Displayed Equation**
Proof	`\demonb\label{Label} ... \edemonb`	`\tag*{\qedsymbol}`
Named Proof	`\demonamednb\label{Label} \edemonamednb`	`\tag*{\qedsymbol}`
Definition	`\defnnb\label{Label} ... \edefnnb`	`\tag*{\qefsymbol}`
Example	`\explnb\label{Label} ... \eexplnb`	`\tag*{\qexsymbol}`
Remark	`\remknb\label{Label} ... \eremknb`	`\tag*{\qexsymbol}`
Algorithm	`\algrthmnb\label{Label} ... \ealgrthmnb`	`\tag*{\qexsymbol}`

3.2.2 General Mathematical Commands

The first nine of the following commands are specific to the Bard TEX Style file; the others are common LATEX commands that are listed here for convenience. For the union, intersection, sum and product, the in-line versions are shown; the display versions are typed the same way, but look differently.

Warning: Some of the symbols listed below, particularly those that involve the `\mathcal` or `\mathbb` style, may look rather different from what is shown when different fonts are used.

Symbol	**Command**
$\mathbb{N}$	`\nn`
$\mathbb{Z}$	`\zz`
$\mathbb{Q}$	`\qqq`
$\mathbb{R}$	`\rr`
$\mathbb{C}$	`\cc`
$\mathbb{R}^n$	`\rrr{n}`
$\mathscr{P}(A)$	`\powerset A`
$f\colon A \to B$	`\func fAB`
$g \circ f$	`g \rc f`
$\{x \in X \mid \text{blah}\}$	`\{x \in X \mid \text{blah}\}`
$A \subseteq B$	`A \subseteq B`
$A \subsetneqq B$	`A \subsetneqq B`
$\bigcup_{i \in I} A_i$	`\bigcup_{i \in I} A_i`
$\bigcap_{i \in I} A_i$	`\bigcap_{i \in I} A_i`
$\sum_{i=1}^{n} a_i$	`\sum_{i=1}^n a_i`
$\prod_{i=1}^{n} a_i$	`\prod_{i=1}^n a_i`
$\mathscr{A}$	`\mathcal{A}`
$\mathbb{A}$	`\mathbb{A}`
1_A	`\idmap A`

3.2.3 Groups and Rings Commands

Symbol	**Command**
$a \equiv b \pmod{n}$	`\eqmod abn`
$a \not\equiv b \pmod{n}$	`\neqmod abn`
$[a]$	`\relclass a`
$\mathbb{Z}_n$	`\zs n`
$\cong$	`\isomg`
$\leq$	`\subgrp`
$\not<$	`\notsubgrp`
$\langle a \rangle$	`\grpgen a`
$\lvert a \rvert$	`\eltord a`
$\lvert G \rvert$	`\grpord G`
S_n	`\permgrp n`
A_n	`\altgrp n`
C_n	`\cygrp n`
D_n	`\digrp n`
$H \times K$	`H \times K`
$(G : H)$	`\indexgh GH`
$H \lhd G$	`H \nsubgrp G`
$H \not\lhd G$	`H \notnsubgrp G`
$R[x]$	`\polrngrx Rx`

3.2.4 Vector Space Commands

Symbol	**Command**
$\mathsf{0}$	`\zsc`
$\mathit{0}$	`\zv`
$\mathscr{F}(S,F)$	`\funcspce SF`
$\mathrm{span}(S)$	`\spn (S)`
$\dim(V)$	`\dim (V)`
$\mathscr{F}$	`\mathcal{F}`
$a_n x^n + \cdots + a_1 x + a_0$	`\polyaxn axn`
$a_1 x_1 + \cdots + a_n x_n$	`\lincombaxn axn`
$\mathsf{M}_{m\times n}(F)$	`\matspce mnF`
$V \oplus W$	`V \oplus W`
E_λ	`\espce \lambda`
$\langle x, y\rangle$	`\ip xy`
$\|x\|$	`\norm x`
$[x]_\beta$	`\coordv x{\beta}`
$[f]_\beta^\gamma$	`\matrep f{\beta}{\gamma}`
$[f]_\beta$	`\matrepo {f}{\beta}`

3.2.5 Matrix and Linear Map Commands

Symbol	**Command**
$\ker f$	`\ker f`
$\operatorname{im} f$	`\im f`
$\operatorname{nullity}(f)$	`\nll (f)`
$\operatorname{rank}(f)$	`\rk (f)`
$g \circ f$	`g \rc f`
$\mathscr{L}(V,W)$	`\linspce VW`
f	`\mathsf{f}`
$\operatorname{tr} A$	`\tr A`
L_A	`\mmmap A`
$\mathsf{M}_{m\times n}(F)$	`\matspce mnF`
$\operatorname{columnrank} A$	`\crk A`
$\operatorname{rowrank} A$	`\rrk A`
$\det A$	`\det A`
$A^{\perp}$	`A^\perp`
$\operatorname{cof} A$	`\cof A`

3.2.6 Column Vector Commands

Symbol	Command
$\left[\begin{smallmatrix}1\\2\end{smallmatrix}\right]$	`\scolvecqtwo 12`
$\begin{bmatrix}1\\2\end{bmatrix}$	`\colvecqtwo 12`
$\left[\begin{smallmatrix}1\\2\\3\end{smallmatrix}\right]$	`\scolvecqthree 123`
$\begin{bmatrix}1\\2\\3\end{bmatrix}$	`\colvecqthree 123`
$\left[\begin{smallmatrix}x_1\\\vdots\\x_n\end{smallmatrix}\right]$	`\scolvecqxn xn`
$\begin{bmatrix}x_1\\\vdots\\x_n\end{bmatrix}$	`\colvecqxn xn`
$\left[\begin{smallmatrix}a\\\vdots\\b\end{smallmatrix}\right]$	`\scolvecqd ab`
$\begin{bmatrix}a\\\vdots\\b\end{bmatrix}$	`\colvecqd ab`

3.2.7 Matrix Commands

Symbol	**Command**
$\left(\begin{smallmatrix} a & b \\ c & d \end{smallmatrix}\right)$	`\smtwo abcd`
$\begin{pmatrix} a & b \\ c & d \end{pmatrix}$	`\mtwo abcd`
$\left(\begin{smallmatrix} a & b & c \\ d & e & f \\ g & h & i \end{smallmatrix}\right)$	`\smthree abcdefghi`
$\begin{pmatrix} a & b & c \\ d & e & f \\ g & h & i \end{pmatrix}$	`\mthree abcdefghi`

3.2.8 Real Analysis Commands

Symbol	**Command**
$\operatorname{lub} A$	`\lub A`
$\operatorname{glb} A$	`\glb A`
$\lim_{x \to c}$	`\limd xc`
$\frac{dz}{dy}$	`\ddx zy`
$\|P\|$	`\norm P`
$S(f, P, T)$	`\rsumm fPT`
$\int_a^b f(x)\,dx$	`\intr abfx`
$\int_a^b [f+g](x)\,dx$	`\intrn ab{[f + g](x)}x`
$M_i(f)$	`\maxi fi`
$m_i(f)$	`\mini fi`
$U(f, P)$	`\usum fP`
$L(f, P)$	`\lsum fP`
$\overline{\int_a^b} f(x)\,dx$	`\intor abfx`
$\underline{\int_a^b} f(x)\,dx$	`\intur abfx`
$\left\vert \text{BIG} \right\vert$	`\labs \text{\LARGE BIG} \rabs`
$\int f(x)\,dx$	`\intir fx`
$\int [f+g](x)\,dx$	`\intirn {[f + g](x)}x`

3.2.9 Sequences and Series Commands

Symbol	Command
$\{a_n\}_{n=1}^{\infty}$	`\seqa a`
$\{a_n\}_{n=0}^{\infty}$	`\seqao a`
$\{a_n\}_{n=p}^{\infty}$	`\seqai ap`
$\{a_n + b_n\}_{n=1}^{\infty}$	`\seqna {a_n + b_n}`
$\{a_n + b_n\}_{n=p}^{\infty}$	`\seqnai {a_n + b_n}p`
$\{a_w + b_w\}_{w=p}^{\infty}$	`\seqnaik {a_w + b_w}pw`
$\left\{a_{n_k}\right\}_{k=1}^{\infty}$	`\subseqa a`
$\left\{a_{n_w}\right\}_{w=1}^{\infty}$	`\subseqak aw`
$\sum_{n=1}^{\infty} a_n$	`\sera a`
$\sum_{n=0}^{\infty} a_n$	`\serao a`
$\sum_{n=p}^{\infty} a_n$	`\serai ap`
$\sum_{n=1}^{\infty} (a_n + b_n)$	`\serna {(a_n + b_n)}`
$\sum_{n=0}^{\infty} (a_n + b_n)$	`\sernao {(a_n + b_n)}`
$\sum_{n=p}^{\infty} (a_n + b_n)$	`\sernai {(a_n + b_n)}p`
$\sum_{w=p}^{\infty} (a_w + b_w)$	`\sernaik {(a_w + b_w)}pw`
$\sum_{n=0}^{\infty} c_n(x-a)^n$	`\powser cxa`
$\sum_{n=0}^{\infty} (c_n + d_n)(x-a)^n$	`\sernai {(c_n + d_n)(x - a)^n}0`
$\sum_{n=0}^{\infty} c_n x^n$	`\macser cx`
$\sum_{n=0}^{\infty} \frac{f^{(n)}(a)}{n!}(x-a)^n$	`\taylors fa`
$\sum_{n=0}^{\infty} \frac{f^{(n)}(0)}{n!}x^n$	`\maclors f`

3.2.10 Topology Commands

Symbol	Command
$\operatorname{Int} A$	`\Int A`
$\overline{A}$	`\clos A`
$B_d(x,\epsilon)$	`\balled dx\epsilon`
$B(x,\epsilon)$	`\balle x\epsilon`
$\bar{d}$	`\bar d`
$\sim$	`\sim`
$\simeq$	`\htp`
$\simeq_p$	`\htpp`
$C(X,Y)$	`\cmp XY`
$P(Y;x_0,x_1)$	`\psp Y{x_0}{x_1}`
$[f]$	`\rcl f`
$f * g$	`f \ast g`
$P(X;x_0)$	`\lsp X{x_0}`
$\pi_1(X,x_0)$	`\fgrp X{x_0}`
$\hat{\alpha}$	`\hat \alpha`
$\bar{\alpha}$	`\bar \alpha`
$\cong$	`\cong`

3.3 Color

It is simple to use color in LaTeX, though it is best used in only the appropriate situations. On the one hand, the use of color (for text, boxes, bullet points and the like) is encouraged for visual work, such as prospectus talks, presentations and posters. On the other hand, the use of color in purely written work, such homework and senior projects, should be restricted to color figures (and even that only as needed), to make printing more convenient and less costly.

To use color in LaTeX, the LaTeX package color.sty must be used, which requires that you must first insert

```
\usepackage{color}
```

into your file prior to `\begin{document}`. This package has already been inserted into all the templates associated with this style file.

3.3.1 Color Choices

The following chart is a list of names of predefined colors available in this style file. You must use upper case letters in the names of the colors exactly as written. (This chart is from color-package-demo.tex by Bent Petersen.)

The 68 Available Colors by Name

Apricot	Aquamarine	Bittersweet	Black
Blue	BlueGreen	BlueViolet	BrickRed
Brown	BurntOrange	CadetBlue	CarnationPink
Cerulean	CornflowerBlue	Cyan	Dandelion
DarkOrchid	Emerald	ForestGreen	Fuchsia
Goldenrod	Gray	Green	GreenYellow
JungleGreen	Lavender	LimeGreen	Magenta
Mahogany	Maroon	Melon	MidnightBlue
Mulberry	NavyBlue	OliveGreen	Orange
OrangeRed	Orchid	Peach	Periwinkle
PineGreen	Plum	ProcessBlue	Purple
RawSienna	Red	RedOrange	RedViolet
Rhodamine	RoyalBlue	RoyalPurple	RubineRed
Salmon	SeaGreen	Sepia	SkyBlue
SpringGreen	Tan	TealBlue	Thistle
Turquoise	Violet	VioletRed	
WildStrawberry	Yellow	YellowGreen	YellowOrange

3.3.2 Color for Text

To apply color to some text, use the format

```
\textcolor{colorname}{text}
```

Be sure to insert your own color names and text.

The possible names for colors are given in Subsection 3.3.1 of this manual.

3.3.3 Color in Lists

Use the following variants on enumerated and itemized lists to have the numbers and bullets in such lists be in color.

```
\begin{enumeratec}{colorname}
\item text
\item text
\end{enumeratec}

\begin{itemizec}{colorname}
\item text
\item text
\end{itemizec}
```

Be sure to insert your own color names and text.

The possible names for colors are given in Subsection 3.3.1 of this manual.

4
General LaTeX Formatting

4.1 Use Proper LaTeX

LaTeX is at times tricky to use, and can be a source of frustration. However, spending a bit of time learning to use LaTeX properly will, in the long run, lead to both better results and less frustration.

The most important thing to keep in mind when using LaTeX is to let LaTeX do the formatting; you should focus on the content.

Warning: Do not try to override LaTeX formatting commands (for example, for new lines and new paragraphs); do make use of built-in LaTeX commands for both text and mathematics.

4.1.1 Make and Use Your Own Macros

One of the most convenient features of LaTeX is that the user can define her own mathematical LaTeX commands, called macros, which can then be used similarly to any other LaTeX command. Using macros saves a lot of time when writing a lengthy text, and allows for very easy notational changes in the course of writing. Macros are best suited for mathematical notation, not for text (if you try using macros for text, be careful with spacing issues following such macros).

Defining a macro is via the `\newcommand` command. All such commands are inserted before `\begin{document}`.

For example, suppose we want to write the expression $(v_1, \ldots, v_n)$ often. We could then define a macro for this expression, by writing

```
\newcommand{\vecn}{(v_1, \ldots, v_n)}
```

We would then type `$\vecn$`, instead of `$(v_1, \ldots, v_n)$`, to obtain $(v_1, \ldots, v_n)$.

Warning: The symbols `$` `$` are not included in macros, so that the commands defined by the macros can be used inside larger formulas.

When you define a macro, you can choose any name you want, as long as it is not the name of an existing LaTeX command, and as long as it is entirely letters (no numbers or other characters).

It is often useful to use variables in a macro. For example, suppose that in addition to writing $(v_1, \ldots, v_n)$, we need to change the number n in this expression to other numbers. We could then define a macro with a variable, for example

```
\newcommand{\vecnv}[1]{(v_1, \ldots, v_{#1})}
```

We would then type `$\vecnv p$` to obtain $(v_1, \ldots, v_p)$, and `$\vecnv {2n + 1}$` to obtain $(v_1, \ldots, v_{2n+1})$.

Warning: When the variable used with a macro has more than one symbol, it must be surrounded by `{` `}`.

If more than one variable is needed in a macro, replace `[1]` in the definition with the appropriate number; up to nine variables are allowed.

There is no definitive rule about which mathematical notation should be defined via macros (as opposed to typing the symbols out each time they are used), but, in a lengthy text, the more often you use some notation, the more effort you will save by defining that notation via a macro, and the easier it will be to change the notation if you ever need to.

4.1.2 Common LaTeX Errors

1. When doing display mathematics, which is done with either `$$ ... $$` or `\[ ... \]` (the latter being the preferred usage), do not leave a blank line before the display mathematics, and do not leave a blank line after it unless you are starting a new paragraph. Putting in unnecessary blank lines leads to unwanted spaces before and after the display mathematics.

2. Do not use `\\` other than inside mathematical commands such as matrices, align and cases. Let LaTeX do all the line breaking, paragraph indenting, and the like automatically. If you are not sure how to get LaTeX to do basic formatting such as starting a new paragraph, consult any introductory manual or website for LaTeX, or ask a more experienced LaTeX user.

3. To write a set such as $\{x \in \mathbb{R} \mid x^2 < \pi\}$, use

   ```
   $\{x \in \mathbb{R} \mid x^2 < \pi\}$
   ```

   Observe that the curly brackets are written `\{` and `\}`, and that the vertical line is written `\mid`, NOT `|` (which would produce the wrong spacing).

4. To write an inner product such as $\langle x, y \rangle$, use

   ```
   $\langle x, y \rangle$
   ```

Observe that the brackets are written `\langle` and `\rangle`, NOT < and > (which would produce the wrong spacing).

5. To write a function such as $f\colon A \to B$, use

```
$f \colon A \to B$
```

Observe that the colon is written `\colon`, NOT : (which, yet again, would produce the wrong spacing).

When you use the Bard TeX style, a shortcut for writing $f\colon A \to B$ is

```
$\func fAB$
```

which takes care of the colon and arrow automatically.

4.1.3 Lengthy Comments

To make a comment to yourself in your .tex file that is ignored when the document is compiled, use the % character. Any line in the .tex file that starts with % is ignored; if a % in inserted in the middle of a line, all the text following the % symbol is ignored. Some implementations of LaTeX, for example TeXShop and TeXworks, put comments that start with % in a different color.

Unfortunately, the standard LaTeX program does not give a method for commenting out long sections of the .tex file, other than using lots of % symbols. Fortunately, there is a nice LaTeX package called verbatim.sty that solves this problem. To use this package, you must first insert

```
\usepackage{verbatim}
```

into your file prior to `\begin{document}`.

Then, simply type `\begin{comment}` before the text that you want commented out, and `\end{comment}` after the text. Comments that are made in this way will not be color coded.

Warning: Do not place one lengthy comment inside another.

4.1.4 Typesetting Simulated Computer Code

The problem with writing simulated computer code in LaTeX is that LaTeX wants to override the spacing and line breaks that you put in the code.

The simplest way to write a small amount of simulated computer code in LaTeX is to use the verbatim.sty package. To use this package, you must first insert

```
\usepackage{verbatim}
```

into your file prior to `\begin{document}`.

Then, simply type `\begin{verbatim}` before the simulated computer code, and type `\end{verbatim}` after it. *Everything* within the `verbatim` environment is typeset in typewriter font exactly as it appears in the .tex file, leaving spaces and line breaks exactly as in

the .tex file, and not recognizing any special symbols. Be careful, however, if your code has very long lines, because they might run off the page.

For example, to obtain

```
This is     verbatim text, where $ signs are
just $ signs, and commands such as \huge are ignored.
```

simply write

```
\begin{verbatim}
This is     verbatim text, where $ signs are
just $ signs, and commands such as \huge are ingored.
\end{verbatim}
```

Another useful package, called moreverb.sty, contains some variants of the `verbatim` environment. To use this package, you must first insert

```
\usepackage{moreverb}
```

into your file prior to `\begin{document}`.

The `listing` environment from the moreverb.sty package is similar to the `verbatim` environment, except that it numbers lines. The `listing` environment has two parameters, the first (in square brackets) specifies the step between numbered lines (a value of 1 makes every line numbered), and the second parameter (in curly brackets) specifies the number of the first line.

To obtain

```
     This is the environment       that
8    numbers lines. In this example,
     every other line is numbered,
10   and the first line is set at line 7.
```

write

```
\begin{listing}[2]{7}
This is the environment       that
numbers lines. In this example,
every other line is numbered,
and the first line is set at line 7.
\end{listing}
```

The `listingcont` environment from the moreverb.sty package is like the `listing` environment, except that it does not have any parameters, and it continues numbering lines where the previous `listing` or `listingcont` environment left off. The `listing*` and `listingcont*` environments from the moreverb.sty package are very much like the `listing` and `listingcont` environments, respectively, except that they write ␣ for each blank space in the original text.

Yet another useful package, called alltt.sty, contains a different variant of the `verbatim` environment. To use this package, you must first insert

```
\usepackage{alltt}
```

into your file prior to `\begin{document}`.

The `alltt` environment from the alltt.sty package is similar to the `verbatim` environment, except that in the `alltt` environment any LaTeX command that starts with `\` is obeyed, and `{ }` is respected. Hence, styles such as bold and italics can be used in the `alltt` environment. Mathematics symbols can also be used in the `alltt` environment, though only those that start with the `\` symbol; therefore `$a^{x+y}$` would not be recognized (because neither `$` nor `^` starts with the `\` symbol), but it could be replaced with the less commonly used `\(a\sp{x+y}\)`, where `\(  \)` is another way of starting and ending in-line mathematics mode, and `\sp` means superscript (the commands `\[  \]` are another way of starting and ending display mathematics mode, and `\sb` means subscript).

To obtain

This is a^{x+y} in **alltt**.

write

```
\begin{alltt}
This is \(a\sp{x+y}\) in {\bf alltt}.
\end{alltt}
```

4.2 Figures

There are a number of issues concerning the use of figures in LaTeX: what format the figures need to be in, how to create figures, where to put the figure files on your computer, how to insert figures into a LaTeX document and how to refer to figures elsewhere in the text.

4.2.1 Format for Figures for Use in LaTeX

The standard format of the figures you use in LaTeX is PDF. It is also possible to use JPEG and PNG files.

4.2.2 Creating Mathematical Figures

Any figures file in the correct format can be inserted into LaTeX, no matter how it was created.

For mathematical writing, there are three common ways to create graphics: via mathematical software such as Sage, Mathematica or Maple; via vector drawing programs such as Adobe Illustrator, Inkscape or GeoGebra; or via LaTeX packages such as TikZ.

Warning: For mathematical figures, it is best to avoid bitmap graphics programs such as Adobe Photoshop or Gimp, because their images do not scale properly, and can appear pixelated; vector drawing programs are much better suited to mathematics.

Whatever method you use to create figures, it is best to work in the proprietary format of the program while you are making the graphic, and only when you are done, export the graphic to PDF format.

One thing to keep in mind when creating graphics is to make sure that when a graphic is exported to PDF format there is no extra white space surrounding the graphic (having extra white space creates problems with spacing when the figure is inserted into LaTeX). Some programs can export to PDF format just the actual graphic with no extra white space around it, in which case nothing needs to be done. In some instances, however, PDF files are created with the graphic located on an entire blank page, and in that case the white space needs to be cropped using an appropriate program (such as Preview on the Mac).

4.2.3 Where to Put the Figure Files on Your Computer

Once you have created your figure files, put them in the same folder on your computer as your .tex file. If the figure files are anywhere else, LaTeX will not be able to find them, unless, when you insert the figures into your .tex file, you give the full path+filenames for the figures rather than just the filenames of the figures.

4.2.4 Inserting Figures in LaTeX—Everything But Posters

The standard way to insert graphics into LaTeX documents is to use either the graphicx.sty package or the graphics.sty package. The two packages are essentially the same, but use slightly different formats for a few commands; the package graphicx.sty is recommended. The manual for these two packages, called grfguide.pdf, can be found on the web; it is a very useful guide to inserting graphics into LaTeX documents, and also to using color.

To use the graphicx.sty package, you must first insert

```
\usepackage{graphicx}
```

into your file prior to `\begin{document}`. The command `\usepackage{graphicx}` has already been inserted in all five templates for the Bard TeX style file.

To insert a PDF file, use

```
\begin{figure}[ht]
\centering
\includegraphics{filename}
\caption{caption}
\label{figure Label}
\end{figure}
```

Be sure to insert your own filename, caption, and figure label. Make sure that the filename includes the three-letter suffix .pdf.

The caption can be left blank if you do not wish to insert one (though you will still need to write `\caption{}` if you leave the caption blank).

Warning: Do not write the figure number in the caption, because the number is inserted automatically by LaTeX.

4.2.5 Referring to Figures—Everything But Posters

To refer to a figure that you have inserted, write

```
Figure~\ref{figure label}
```

Warning: Be sure to use the symbol ~ between the word "Figure" and `\ref{figure label}`. This symbol, which is a non-breaking space, ensures that the figure number is not placed by itself at the start of a new line.

Here are some important points to note when you refer to figures in a mathematics text.

1. *Every figure* must be referred to by its figure number somewhere in the text. If a figure is not referred to, it will not necessarily be read.

2. Every figure should be inserted *after* it is first referred to.

3. The main explanation of a figure should be done in the text, not in the caption. Captions should be left blank, or should be minimal.

4.2.6 Inserting Figures in LaTeX—Posters

Inserting a figure into a poster is similar to, though not exactly the same as, inserting a figure into regular mathematical writing (such as homework and senior projects).

The standard way to insert graphics into LaTeX documents is to use either the graphicx.sty package or the graphics.sty package. The two packages are essentially the same, but use slightly different formats for a few commands; the package graphicx.sty is recommended. The manual for these two packages, called grfguide.pdf, can be found on the web; it is a very useful guide to inserting graphics into LaTeX documents, and also to using color.

To use the graphicx.sty package, you must first insert

```
\usepackage{graphicx}
```

into your file prior to `\begin{document}`. The command `\usepackage{graphicx}` has already been inserted in all five templates for the Bard TeX style file.

To insert a PDF file into a poster, use

```
\begin{center}
\includegraphics{filename}
\end{center}
```

Be sure to insert your own filename. Make sure that the filename includes the three-letter suffix .pdf.

Warning: In contrast to regular mathematical writing, in posters you do not use the commands `\begin{figure}` `\end{figure}`.

In posters, there is no automatic numbering of figures and no built-in environment for captions. If you want to add a figure number and/or caption manually, use

```
\begin{center}
\includegraphics{filename}\\
figure number: caption
\end{center}
```

Be sure to insert your own filename, figure number and caption, where for the figure number you should write "Figure 1" or the like. If you do not want a caption, then just write the figure number without ": caption."

4.2.7 Referring to Figures—Posters

Because the commands `\begin{figure}` `\end{figure}` are not used in posters, in order to refer to a figure that you have inserted, you do not use `\ref`, but rather you refer to the figure directly, by writing "Figure 1," or "the following figure," or the like.

4.2.8 Changing the Size of a Figure

If a figure that you want to insert into a LaTeX document is the wrong size, there are two possible solutions: either change the size of the figure itself (using the program that created the figure or a graphics program), or use a LaTeX command to scale the figure when it is inserted into the .tex file. Scaling the figure using a LaTeX command is usually the easier approach, as long as the figure itself is scalable without becoming pixelated (which works for graphics created via vector drawing programs, and sometimes for graphics created via mathematical software).

To scale a figure using a LaTeX command, there are two common options, where in both options you replace

```
\includegraphics{filename}
```

with one of the following modified versions of this command.

1. Scale the Figure by a Ratio

Replace `\includegraphics{filename}` with

```
\includegraphics[scale=ratio]{filename}
```

where the ratio is a number in decimal form. For example, use `[scale=0.5]` if you want to make the graphic half its actual size, and use use `[scale=2]` if you want to double the size of the graphic. The ratio has no units.

2. Scale the Figure So That It Has a Given Height

Replace `\includegraphics{filename}` with

```
\includegraphics[height=number units]{filename}
```

where the number is the desired height in the given units, and the units are `in` (for inches) or `cm` (for centimeters). For example, use `[height=2.5 in]` if you want to make the graphic be 2.5 inches high.

4.3 Bibliography

The bibliographic style used in mathematical writing is different from the bibliographic styles used in other disciplines (for example, the MLA and Chicago styles). Although the proper style for a mathematical bibliography can be done manually in LaTeX, the most convenient way to make a bibliography in the correct mathematical style is to use a LaTeX package designed to format mathematical bibliographies automatically, without the writer even having to know the proper style.

4.3.1 Use the amsrefs.sty Package

There are two standard LaTeX tools for bibliographies: amsrefs.sty and BibTeX. Whereas BibTeX is older and is more well-known, the amsrefs.sty package works much better, and is highly recommended.

To use the amsrefs.sty package, you must first insert

```
\usepackage{amsrefs}
```

prior to `\begin{document}`. The command `\usepackage{amsrefs}` has already been inserted in all five templates for the Bard TeX style file.

Warning: All the commands for bibliographies described below are specific to the amsrefs.sty package.

4.3.2 Top and Bottom of the Bibliography

The bibliography is put at the very end of the document (just before `\end{document}` in everything other than posters, and just before `\end{posterbard}` in posters).

The bibliography is started by inserting

```
\begin{bibliog}
```

and the bibliography is ended by inserting

```
\end{bibliog}
```

The commands `\begin{bibliog}` and `\end{bibliog}` have already been inserted in all five templates for the Bard TeX style file. (These two commands are specific to the bardtex.sty style file; the rest of the bibliographic commands described below will work with the amsrefs.sty package regardless of the bardtex.sty style file.)

Warning: For the different types of templates, the bibliography will look different, even though the same commands are used. For example, in senior projects the bibliography will be a new chapter titled "Bibliography," whereas in posters the bibliography will be put in a text box titled "References."

4.3.3 Bibliographic Entries

The individual bibliographic entries are located between the commands `\begin{bibliog}` and `\end{bibliog}`.

There are a number of different types of bibliographic entries.

1. Book

[1] Ronald Graham, Donald Knuth, and Oren Patashnik, *Concrete Mathematics*, 2nd ed., Addison-Wesley, Reading, MA, 1994.

```
\bib{G-K-P}{book}{
author = {Graham, Ronald},
author = {Knuth, Donald},
author = {Patashnik, Oren},
title = {Concrete Mathematics},
edition = {2},
publisher = {Addison-Wesley},
address = {Reading, MA},
date = {1994}
}
```

Every book entry should include all the fields shown above (except for `edition`, which is not needed if the book is the first edition).

2. Article

[1] Thomas Banchoff, *Critical points and curvature for embedded polyhedra*, J. Diff. Geom. **1** (1967), 245–256.

```
\bib{BA1}{article}{
author = {Banchoff, Thomas},
title = {Critical points and curvature for embedded polyhedra},
journal = {J. Diff. Geom.},
volume = {1},
date = {1967},
pages = {245--256}
}
```

Every article entry should include all the fields shown above.

3. Article in a Book

[1] P. Wintgen, *Normal cycle and integral curvature for polyhedra in Riemannian manifolds*, Differential Geometry (Gy. Soós and J. Szenthe, eds.), Colloq. Math. Soc. János Bolyai, vol. 31, North-Holland, Amsterdam, 1982, pp. 805–816.

```
\bib{WINT}{article}{
author = {Wintgen, P.},
title = {Normal cycle and integral curvature for polyhedra in
Riemannian manifolds},
book = {
```

```
  series = {Colloq. Math. Soc. J\'anos Bolyai},
  volume = {31},
  title = {Differential Geometry},
  editor = {So\'os, Gy.},
  editor = {Szenthe, J.},
  publisher = {North-Holland},
  address = {Amsterdam},
  date = {1982}
},
pages = {805--816}
}
```

4. Online Resource

[1] Neal J. A. Sloane, *The On-Line Encyclopedia of Integer Sequences*, `http://www.research.att.com/~njas/sequences`.

```
\bib{SLOA}{report}{
author = {Sloane, Neal J. A.},
title = {The On-Line Encyclopedia of Integer Sequences},
eprint = {http://www.research.att.com/~njas/sequences}
}
```

5. Unpublished

[1] Tim Goldberg, *Combinatorial Laplacians of Simplicial Complexes*, 2002, Bard senior project.

```
\bib{GOLD}{report}{
author = {Goldberg, Tim},
title = {Combinatorial Laplacians of Simplicial Complexes},
date = {2002},
status = {Bard senior project}
}
```

Each new bibiographic entry starts with

```
\bib{label}{type of item}{
```

Be sure to insert your own label and type of item. The type of item can be `article`, `book`, `report`, `misc` or `thesis`.

Warning: Each bibliographic entry ends with `}`. Do not delete this bracket.

Warning: Do not forget the commas between the fields (though there is no comma after the last field).

Note that authors are always listed with last name first. If there are multiple authors, each one is listed separately, in the order listed in the original book or article.

In contrast to regular text, where LaTeX automatically puts a double space after every period (which needs to be overridden in the case of a period that is not at the end of a sentence), in the bibliographic entries LaTeX knows to put a single space after each period.

4.3.4 Referring to Bibliographic Entries

To refer to an item in the bibliography, use

```
\cite{label} or \cite{label}*{location}
```

Be sure to insert your own label, and location if needed. The optional location can be something such as "Chapter~3," or "Theorem~1.2.3" or the like.

Warning: In the optional location, be sure to use the symbol ~ between the word "Chapter," "Theorem" or the like and the number. This symbol, which is a non-breaking space, ensures that the chapter, theorem, etc., number is not placed by itself at the start of a new line.

4.3.5 Alphabetize the Bibliography

Whereas amsrefs.sty formats each bibliographic entry in the correct mathematical style, the one thing that amsrefs.sty does not do, and which you need to do manually, is to alphabetize the bibliographic entries by the last name of the first author in each entry.

4.3.6 Double-Spaced Bibliography

The default formatting for the bibliography is single-spaced, even if the rest of the document is double-spaced. If you want to make the bibliography double-spaced, insert

```
\doublespace
```

right after `\begin{bibliog}`, and before the first bibliographic entry.

4.4 Fonts in LaTeX

The default font used in LaTeX is Computer Modern, which was designed by Donald Knuth, the creator of TeX (of which LaTeX is a dialect). The advantage of Computer Modern is that it has an extensive set of mathematical symbols; the disadvantage of Computer Modern is that, for some people, it isn't the most aesthetically pleasing font. In particular, it is rather thin and light.

Switching fonts in LaTeX is not as simple as in regular word processors. In part the difficulty is due to the way LaTeX works internally, and in part it is due to the fact that the various fonts available for regular word processors do not have the needed mathematical symbols.

However, while it is not easy to use a variety of different fonts throughout a single document, there are a number of free font packages that change the overall fonts (text and mathematics) of a document, and which are included in the standard implementations of LaTeX. On the following two pages is a list of some font packages that appear to be generally available, together with a sample of each font. The font in which this document is written is the one called fourier.

To use one of these font packages, you insert

```
\usepackage{font package name}
```

prior to `\begin{document}`. Be sure to insert your own choice of font package name.

Font Comparison Examples

1. Default LaTeX font (Computer Modern)

Here is some text. Let $f\colon A \to B$ be a function. Let I be a non-empty set, and let $\{U_i\}_{i\in I}$ be a family of sets such that $U_i \subseteq A$ for all $i \in I$.

$$f\left(\bigcup_{i\in I} U_i\right) = \bigcup_{i\in I} f(U_i) \qquad \int_a^b \frac{x^2}{x+3}\,dx \qquad \sin(\alpha+\theta) \qquad \sum_{n=1}^{\infty} \frac{1}{n^2}.$$

2. `\usepackage{stix}`

(This font, a new one based upon Times New Roman, has a large selection of mathematical symbols.)

Here is some text. Let $f\colon A \to B$ be a function. Let I be a non-empty set, and let $\{U_i\}_{i\in I}$ be a family of sets such that $U_i \subseteq A$ for all $i \in I$.

$$f\left(\bigcup_{i\in I} U_i\right) = \bigcup_{i\in I} f(U_i) \qquad \int_a^b \frac{x^2}{x+3}\,dx \qquad \sin(\alpha+\theta) \qquad \sum_{n=1}^{\infty} \frac{1}{n^2}.$$

3. `\usepackage{mathptmx}`

(This font is an older one based upon Times New Roman.)

Here is some text. Let $f\colon A \to B$ be a function. Let I be a non-empty set, and let $\{U_i\}_{i\in I}$ be a family of sets such that $U_i \subseteq A$ for all $i \in I$.

$$f\left(\bigcup_{i\in I} U_i\right) = \bigcup_{i\in I} f(U_i) \qquad \int_a^b \frac{x^2}{x+3}\,dx \qquad \sin(\alpha+\theta) \qquad \sum_{n=1}^{\infty} \frac{1}{n^2}.$$

4. `\usepackage{fourier}`

Here is some text. Let $f\colon A \to B$ be a function. Let I be a non-empty set, and let $\{U_i\}_{i\in I}$ be a family of sets such that $U_i \subseteq A$ for all $i \in I$.

$$f\left(\bigcup_{i\in I} U_i\right) = \bigcup_{i\in I} f(U_i) \qquad \int_a^b \frac{x^2}{x+3}\,dx \qquad \sin(\alpha+\theta) \qquad \sum_{n=1}^{\infty} \frac{1}{n^2}.$$

5. `\usepackage{fouriernc}`

Here is some text. Let $f\colon A \to B$ be a function. Let I be a non-empty set, and let $\{U_i\}_{i\in I}$ be a family of sets such that $U_i \subseteq A$ for all $i \in I$.

$$f\left(\bigcup_{i\in I} U_i\right) = \bigcup_{i\in I} f(U_i) \qquad \int_a^b \frac{x^2}{x+3}\,dx \qquad \sin(\alpha+\theta) \qquad \sum_{n=1}^{\infty} \frac{1}{n^2}.$$

6. `\usepackage{pxfonts}`

Here is some text. Let $f\colon A \to B$ be a function. Let I be a non-empty set, and let $\{U_i\}_{i\in I}$ be a family of sets such that $U_i \subseteq A$ for all $i \in I$.

$$f\left(\bigcup_{i\in I} U_i\right) = \bigcup_{i\in I} f(U_i) \qquad \int_a^b \frac{x^2}{x+3}\,dx \qquad \sin(\alpha+\theta) \qquad \sum_{n=1}^{\infty} \frac{1}{n^2}.$$

7. `\usepackage{mathpazo}`

Here is some text. Let $f\colon A \to B$ be a function. Let I be a non-empty set, and let $\{U_i\}_{i\in I}$ be a family of sets such that $U_i \subseteq A$ for all $i \in I$.

$$f\left(\bigcup_{i\in I} U_i\right) = \bigcup_{i\in I} f(U_i) \qquad \int_a^b \frac{x^2}{x+3}\,dx \qquad \sin(\alpha+\theta) \qquad \sum_{n=1}^{\infty} \frac{1}{n^2}.$$

8. `\usepackage[charter]{mathdesign}`

Here is some text. Let $f : A \to B$ be a function. Let I be a non-empty set, and let $\{U_i\}_{i\in I}$ be a family of sets such that $U_i \subseteq A$ for all $i \in I$.

$$f\left(\bigcup_{i\in I} U_i\right) = \bigcup_{i\in I} f(U_i) \qquad \int_a^b \frac{x^2}{x+3}\,dx \qquad \sin(\alpha+\theta) \qquad \sum_{n=1}^{\infty} \frac{1}{n^2}.$$

9. `\usepackage[utopia]{mathdesign}`

Here is some text. Let $f\colon A \to B$ be a function. Let I be a non-empty set, and let $\{U_i\}_{i\in I}$ be a family of sets such that $U_i \subseteq A$ for all $i \in I$.

$$f\left(\bigcup_{i\in I} U_i\right) = \bigcup_{i\in I} f(U_i) \qquad \int_a^b \frac{x^2}{x+3}\,dx \qquad \sin(\alpha+\theta) \qquad \sum_{n=1}^{\infty} \frac{1}{n^2}.$$

10. `\usepackage{cmbright}`

(This font is useful for some purposes, though not Bard senior projects or posters.)

Here is some text. Let $f\colon A \to B$ be a function. Let I be a non-empty set, and let $\{U_i\}_{i\in I}$ be a family of sets such that $U_i \subseteq A$ for all $i \in I$.

$$f\left(\bigcup_{i\in I} U_i\right) = \bigcup_{i\in I} f(U_i) \qquad \int_a^b \frac{x^2}{x+3}\,dx \qquad \sin(\alpha+\theta) \qquad \sum_{n=1}^{\infty} \frac{1}{n^2}.$$

5
Guide to Good Mathematical Writing

5.1 General Remarks for Good Mathematical Writing

The point of writing mathematics is two-fold: to make sure that the mathematics is correct, and to communicate the mathematics to others. Without doubt, it is the content that is the most important aspect of mathematical writing, but maintaining proper writing style is important too, because good writing helps make sure that the logical structure of the arguments are correct, and helps the reader understand the content. Poor writing gets in the way of the mathematics.

This chapter starts with some general aspects of good mathematical writing, followed by some comments specific to longer works, such as Bard senior projects and M.A.T. projects, and to posters.

Some aspects of good mathematical writing, for example the first three rules stated below, apply to all forms of writing, not only mathematical; other aspects are specific to mathematics.

5.1.1 Keep Your Audience in Mind

Every text should be written with a definite audience in mind.

In particular, each of the five templates for the Bard TEX style file have different audiences. For example, homework is meant for the instructor to read, whereas a Bard senior project should aim at being understandable to other students.

Though it is easy when writing to get so caught up in the mathematical details that the audience gets forgotten, writing well requires regularly reminding yourself of your intended audience.

5.1.2 The Written Text Should Stand on Its Own

A well-written text should be understandable to the reader without any need for clarification by the writer. Err on the side of too much explanation; do not assume the reader is a mind reader.

Do not forget that the reader might not have been thinking about what you have written the same way that you were thinking about it, and things that may seem obvious to you might need explanation.

5.1.3 Revise, Revise, Revise

The single most important thing to do to write well is to revise your drafts repeatedly. To do a thorough revision of a draft, it is best to print it out, take a red (or other) pen, and read through the draft with a critical eye *as if it were written by someone else*, to see if everything you wrote works as written. Some people like to read their drafts out loud to help find what does not work as written.

Be merciless with your own writing—do not be afraid to add, move and delete text. Do not become too attached to anything you have written; if it does not work, it needs revision.

5.1.4 Mathematical Writing is Different from Other Writing

In contrast to writing in some other disciplines, where good style entails artful phrasing and felicitous wording, in mathematics the best writing is simple, clear and plain, to the point of being what in some disciplines would be considered plodding. For mathematics, use short declarative sentences. Say the same thing in the same way every time. Mathematical writing should strive for transparency; the writing should draw as little attention to itself as possible in order to allow the often difficult content to be clear and understandable.

5.1.5 Write Precisely and Carefully

There is no room in mathematics for ambiguity. The most minute matters of phraseology in mathematics can make a difference. Something as seemingly insignificant as the change of the location of a comma can change the meaning of a statement. Make sure that what is written is what you meant.

Use your imagination when exploring the mathematical content about which you are writing, but write your ideas in simple, straightforward, unimaginative prose. Serious mathematics is hard enough as it is, without having unnecessary verbiage or convoluted sentences making it even less clear.

Mathematics is often read by skipping back and forth, and so a particular need for precision is in the statements of theorems, lemmas, propositions and the like, which must contain all their hypotheses, rather than having the hypotheses in some earlier paragraphs. Better a bit of redundancy than a confused reader.

5.1.6 Use Full Sentences and Correct Grammar

The use of correct grammar, such as complete sentences and proper punctuation, is crucial if the reader is to follow what is written. Mathematical writing should be no less grammatically correct than literary prose.

It is very important to recognize that mathematical symbols are nothing but shorthand for expressions that could just as well have been written out in words. For example, the phrase "$y = x^2$" could be written "the variable y equals the square of the variable x." All mathematical symbols, even those displayed between lines, must be embedded in sentences and paragraphs, and are subject to the rules of grammar just as regular text is.

Proper grammar helps the reader follow the logical flow of an argument. Connective words such as "therefore," "hence" and "it follows that" help guide the logical flow, and should be used liberally.

5.1.7 Define All Symbols and Terms You Make Up

All mathematical symbols used as "variables," even simple ones such as x or n, need to be defined before they are used. Such a definition might be as simple as "let x be a real number" or "let $x \in \mathbb{R}$."

Just because a letter such as n is often used to denote an integer, or the letter f is often used to denote a function, we cannot rely upon such conventions, because these same letters can be used to mean other things as well. If you want to use n to denote an integer, you must say so explicitly, and similarly for f denoting a function.

For the sake of readability, avoid as much as possible the temptation to make up new words and symbols and to use exotic alphabets and other complications (such as subscripts of subscripts). Try to stick to standard notation. If you do make up some notation, make sure you define it explicitly.

5.1.8 Break Up Long Proofs into Steps

If a proof is long and difficult to follow, it is often wise to break it up into steps, or to isolate as lemmas those parts of the proof that are self-contained technical steps (a lemma is simply a smaller theorem used to prove a bigger theorem).

If you use lemmas, be sure to state them precisely, with all the needed hypotheses. All lemmas and their proofs should be placed before they are used in the main theorem.

Warning: Do not put the statement and proof of a lemma inside the proof of a theorem; doing so would interrupt the flow of the proof of the theorem, and can be very confusing to the reader.

When a long proof cannot be broken up into pieces, it is helpful to the reader if, prior to going into the details of the proof, a sentence or two outlining the strategy of the proof are provided.

5.1.9 Do Not Mix Rigorous and Informal Writing

Good mathematical writing has both rigorous parts (definitions, theorems, proofs, etc.) and informal parts (overview, comments, background information, etc.). However, it is crucial to

keep the informal writing separate from the formal mathematical content; mixing the two types of writing undermines the purpose of each, by making the rigorous mathematics less rigorous, and by making the informal writing too technical.

In particular, the rigorous aspects of mathematical writing, such as definitions, theorems and proofs, should contain just what they require to be rigorously correct, and nothing more. Informal comments about a definition, theorem or proof are very useful, but such comments must be kept out of the actual definition, theorem or proof.

5.1.10 Miscellaneous Mathematical Writing Tips

1. Do not put a mathematical symbol directly following punctuation. As a corollary, do not start a sentence with a symbol. The only exception to this rule is when the punctuation is part of some mathematical notation, for example "(x, y)." It is important to avoid ambiguities that might arise from using punctuation without proper care. For example, does the expression "$0 < x, y < 1$" mean that both x and y are between 0 and 1, or does it mean that $0 < x$ and $y < 1$?

2. Do not use logical symbols, such as $\wedge$, $\vee$, $\exists$, $\forall$, $\therefore$ and $\Rightarrow$, in the final draft of your writing. Of course, it is fine to use such symbols, and any other abbreviations, in your scratch work. Unless the subject of your writing is logic, where logical symbols are necessary as parts of formulas, the use of logical symbols makes the exposition harder for others to follow.

3. Use consistent notation throughout your writing. For example, if you initially use uppercase letters for matrices and lowercase letters for numbers, stick with that notation for the duration of the project. Do not use the same notation to mean two different things, except when it is unavoidable due to standard mathematical usage; for example, there are multiple standard uses of the notation "(a, b)."

4. Display long formulas, as well as short ones that are important, on their own lines. Recall, however, that displayed formulas are still parts of sentences, and require normal punctuation. In particular, if a sentence ends with a displayed formula, there needs to be the period at the end of the formula.

5. Colons are very rarely needed in mathematical writing. They are usually either unnecessary, or meant as substitutes for words in situations where words would be much more clear. The basic rule is not to use a colon in mathematical writing in a place where you would not use one in non-mathematical writing. Restrict the use of colons in mathematical writing to headings or at the starts of lists, and in certain mathematical symbols (such as the definition of a function).

6. Capitalize names such as "Theorem 2.3" and "Lemma 17." No capitalization is used in phrases such as "by the previous theorem."

5.2 Bard Senior Projects and M.A.T. Projects

For mathematical writing that is longer than a single proof or single example, such as a senior project or M.A.T. project, or a journal article, the overall structure of the writing can have a substantial impact on the clarity of the written text. Listed below are a few points for multi-chapter writing, and in particular for Bard senior projects.

5.2.1 The Audience

The target audience for a Bard senior project or M.A.T. project in mathematics should not be yourself or your adviser, but rather should be other students who have taken the same core upper-level mathematics courses as yourself, but who do not know the topic you are studying.

For example, if some background topics for your project are covered in courses such as Abstract Algebra, Real Analysis, Point Set Topology, etc., there is no need to explain or summarize them in your project. If something is not covered in a standard course, then it should be explained.

5.2.2 Balance Formal and Informal Writing

The core of mathematical writing is the formal content, which in pure mathematics is definitions, theorems and proofs, and in applied mathematics is equations, models and algorithms. To make that mathematical content understandable, not to mention enjoyable, to the reader, it is important to include informal writing between the formal parts. The informal writing can include background, motivation, intuitive ideas, applications, and more.

However, whereas the inclusion of informal writing in longer mathematical works is very important for the sake of readability and understandability, it is very important, as stated above, to keep the informal writing separate from the formal mathematical content.

5.2.3 Introductory Chapter

A longer work should include an introductory chapter that briefly summarizes or previews the content of the whole project. The introductory chapter, which can be thought of as an expanded version of the abstract, is meant to give the big picture, and should include a discussion of the background to the project, place the project in the context of known results, and provide an informal summary of the main results. Additionally, the introductory chapter should make clear what in the project is exposition of known results and what is original work.

5.2.4 Concluding Chapter

In a longer work it is often useful to have a concluding chapter, not to summarize what had been previously stated (such a summary is usually redundant), but rather to provide commentary on the work that was completed, and to give ideas for possible further work in the area.

5.2.5 Chapter Introductions

Every chapter (other than the introductory chapter) should have a short introductory section that briefly summarizes or previews the content of the chapter.

5.2.6 All Text is in Sections

All the text in each chapter, except perhaps for a few introductory sentences if needed, should be within sections. In particular, do not write any formal mathematical structures (theorems, proofs, examples, and the like), or include any figures, before you have the first section heading of the chapter.

5.3 Posters

Writing posters is very different from regular mathematical writing, because the aim of a poster is not to make sure that every detail is correct (though of course nothing incorrect should be stated), but rather to be broadly understandable and visually appealing.

5.3.1 The Audience

The target audience for a poster for the Bard Division of Science, Mathematics, and Computing senior project poster session should not be yourself or your adviser, or even other mathematics majors, but rather should be the general public, who are not necessarily scientists, mathematicians or computer scientists. As such, technicalities should be kept to a minimum.

5.3.2 Making Posters Readable

1. Focus on concrete examples rather than general theorems (though important theorems should be included).
2. A sketch of a proof can work in a poster, but do not give detailed rigorous proofs.
3. Incorporate as many figures as possible.
4. Break the text up into a larger number of small text boxes, rather than fewer large text boxes.
5. Make enough text boxes to fill the poster, but do not go outside the boundary square.
6. Use color to highlight important headings, ideas, and the like.