Formatting a Short Paper in LaTeX

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1 What this document is and how to use it.

This document, with its associated TeX file (formatv1.tex), is an example and provides some templates for the formatting of papers for your mathematics courses. There are several associated files which you will need to make use of it.

The file `formatv1.tex` which generates this document. It provides templates which you can copy and paste into your own documents to generate the formating shown. There is an associated file `CirclecorC-E.jpg` which produces the diagram in Figure **??**.

The file `frame.tex` which contains all the preamble and the `\begin{document}` and `\end{document}` commands – copy this file, use the **Save as ...** command on the **File** menu to save the copy with a new name, and type your paper between the "begin" and "end" commands.

This opening section (corresponding to the introductory material of a paper) is in normal paragraph style. Note that pages are numbered, the title, author and date are at the top of the first page, and the bibliography is at the end of the paper.

For a longer paper with multiple sections and chapters, see the document "Formatting a longer Paper in LaTeX" which will include chapter headings, more complex numbering schemes, etc.

You should save these files in your own filespace (h: drive) which is backed up regularly by IT. To use any of the structures and commands, copy the commands from the `formatv1.tex` file into your document and replace the text with your own. Notice that iTeXMac color-codes types of text - commands (such as `\begin`) in blue, curly brackets ({} - used for the arguments in commands) in purple, comments (which don't appear in the printed copy) in green, text (which does print) in black. In general, it will be the black text that you will replace.

Don't make any changes in the preamble or you won't have the correct format for the required style - and you could easily produce an unprintable document.

Keep your lines in the input document (the .tex file) short (in the `formatv1.tex` document they are limited to 80 characters). To make this automatic (in iTeXMac), set the line wrap in "Preferences"[On the iTeXMac menu, slect "Preferences". At the top of the window that opens, select "Text Wrapper"; then click o the "Options" buttom, type "80" in the "Maximum number of characters" box and make sure the "Wrap as you type" box is checked]

Use comments and space to keep the input readable. There is a lot of room to do this because single carriage returns in the input file and extra spaces between words are ignored by the TeX interpreter. [Two carriage returns in a row – producing a blank line in the input file – signals a new paragraph.]

Frequently (as least once per page of input - which is a lot less than a page of output) you should click on the large "T" at the top of the iTeXMac input window. This will try to "Typeset" your

document - showing (onscreen in a .pdf file) the output from your work, simultaneously saving the current version of your typed file and the current version of your output file. A file called LaTeX.pTeXMac is also created on screen which shows the steps followed and *gives error messages indicating what cannot be typeset because of errors in the input.* Especially at the beginning, you want to test for errors at least every page (better every half page) because locating errors can be tricky. An error message will indicate the number of the line at which the TEX interpreter got hung up (you can see the number of the current line at the bottom of the input window) and will say what problem the interpreter has with the commands - the error in typing will be at *or before* this point. If there is only a half screen of new text (since the last successful typesetting), then you know where to look for the error. If there are three pages of new text, it's much harder to find errors.

You need to know how to produce some common typing effects:

Quotation marks For an open quote (‘) mark, use the ` symbol on the keyboard (top key, far left—with the tilde ~) - two of them to get usual quotation marks (“). For a close quote (’) use the apostrophe (next to the return key - don't shift) and for usual quotation marks (”) use two.

Dashes For hyphen—within a word (“like-minded”)—use a dash from the keyboard. For a medium-length “en-dash” —to indicate a number range (45–60)—use two dashes together (`--`). For a longer “em-dash”—used as punctuation, as in this description—use three dashes together `---`). Minus signs are a different size but they occur only in math mode (see below).

Paragraph breaks To end a paragraph, press the return key twice (producing a blank line in the input).

Line breaks To end a line without beginning a new paragraph (and in matrix, displaymath, and other environments), type backslash twice (\\).

Emphasis To *emphasize* text, we use the `\emph{}` command (inserting the text to be emphasized in the braces), rather than underlining or using bold text.

Blank lines Many of the blank lines you need (before and after statement of a themorem, for example) will be produced automatically by TEX. Skipped lines in the input are ignored by the interpreter. If you need a blank line, use `\vskip` with a measurement (inches, centimeters, or points)—`\vskip12pt` produces a blank space of approximately one line with the 11-point type used here. Of course, this should not be used within a paragraph.

An interword space Occasionally the the typsetter will not leave proper space before the next word after a symbol. In this case you need to insert the "space" command `\ ` (that's a backslash followed by a space—produced by the spacebar). For example : without this command we get TEXfollowed by a word [notice the incorrect spacing] and with the command we get TEX followed by a word [notice the correct spacing].

2 Theorems, Definitions, and other formal statements

Mathematical writing involves a number of special structures, which are reflected in the formatting of the pages.

There are several types of statements that are specially laid out - titled in bold, numbered in a sequence, and set in appropriate type. In TEX and LATEX, these are "environments" - each begins with a `\begin` command and ends with an `\end` . The "preamble" section on the LATEX file formatv1.tex [the part before `\begin{document}` – contained in the `frame.tex` document] has been written to define these environments and take care of the numbering.

Definition 1. This is an example of the Definition (Def) environment. There is one *term being defined* which is emphasized. The rest of the text is in standard type.

Theorem 2. *This is an example of the theorem (Thm) environment. The text is in italic type. A theorem states properties of a known object, gives a relationship between two (or more) known objects, or asserts the existence or non-existence of some object.*

Proof. This is an example of the proof environment. Every theorem has a proof (even if the proof is not written in every paper). The proof is likely to be broken into paragraphs and otherwise appear very much like any other text.

Additional paragraphs would be indented as usual for text. The end of the proof is marked by a symbol at the right-hand margin, as shown here, and there is a blank line after the end. □

Lemma 3. *This is an example of the lemma (Lem) environment. A lemma is a specialized theorem used to organize a long proof by breaking it into sections (a "helper theorem"). usually lemmas are stated and proved before the theorem they "help".*

Corollary 4. *This is an example of the corollary (Cor) environment. A corollary is a theorem which is a quick and easy consequence of some other theorem (a "cheap theorem").*

Proposition 5. *This is an example of the proposition (Prop) environment. A proposition is a theorem giving an interesting, but not major, result. Propositions often function as lemmas, giving steps on the way to a big result (a "minor theorem").*

Big Famous Theorem. *This is an example of the named theorem (Nmthm) environment - used to quote a result from another source without including it in the numbering system.*

Smith's observation. *A second example of the Nmthm environment, showing that any text can be used in the header.*

Example 6. This is an example of the example (Exa) environment. Note the plain type. Every example should include enough text to say what the reader should learn from it.

Remark 7. This is an example of a Remark - a comment that is important enough to be highlighted, but that does not move the main discussion forward.

Definitions, theorems (all types—lemmas, corollaries, propositions), examples, remarks are all numbered in the same sequence—as shown here. Figures (diagrams, illustrations), equations, and tables each have their own numbering sequences.

3 Formulas, Symbols, Equations

For formulas, symbols, equations, etc. to be properly displayed, LATEX must be in *math* mode [The other modes of reading files are *LR* (left-right) mode and *paragraph* mode. Most text is entered in paragraph mode, which is the default. You have to close math mode to return to paragraph mode and resume typing ordinary text.] Math mode can be opened and closed four different ways: (The following numbered list is produced using the "enumerate" listing environment.)

1. It may be opened by the `\begin{math}` command and ended by the `\end{math}` command
2. It may be opened and closed by the short form of these commands: `\(` to open and `\)` to close
3. It may be opened and closed by the dollar sign $ symbol (so we have $stuff in math mode$) (this is the easiest method for typing symbols or expressions in text—but sould not be used for anything longer than one line of text—losing count of your dollar signs is one of the most common sources of error messages)
4. It is automatically opened in a displaymath or equation environment (and closed with the end of the environment).

Symbols such as ϵ and α are inserted by inserting appropriate commands (`$\epsilon$` and `$\alpha$` for these two - notice the use of the $ symbol to enter and leave math mode, since these are being typed in ordinary text). These commands can be used only in the math mode - for single symbols, short expressions, the easiest procedure is to use the dollar sign ($) symbol to open and close math mode, as shown above. The iTeXMac program has menus of symbols that can be inserted - at the top of the input window marked with Σ. The "Symbols" popup menu gives access to sets of symbols including most you will need (Greek letters, relational symbols such as $\subset$ and $\geq$, binary operators such as $\cap$ and $\times$, arrows such as $\Rightarrow$ and $\downarrow$, accents (which go over/under other symbols) such as $\hat{x}$, $\widehat{abc}$ and a lot of Miscellaneous symbols $\exists, \surd, \emptyset$) - just click on the symbol Σ and work down through the menu to the name of the symbol you want.

There are ten keyboard symbols that are interpreted by TeX as command symbols, so they cannot be typed directly—these are [**?**] $ (dollar sign—to open and close math mode), % (percent sign—to begin comments), & (ampersand—used mainly to separate items in matrices, tables, etc.), # (hash mark—you probably won't need this except to create commands), _ (underline—to produce subscript, in math mode), { and } (left and right braces—to set off a list of arguments for a command, or the environment for some commands), \ (backslash—begins most commands; doubled—as `\\` —is the "end-of-line" (carriage return) command), ^ (circumflex—to produce superscript, in math mode) and ~ (tilde—used in place of a space to prevent a line break between words). The source document `formatv1.tex` will show you how these symbols are produced in printout if they are needed.

An extensive list of symbols and commands for LateX (including syntax for complex structures) can also be found at [**?**] .

Variables are always set in math mode: "Let x represent the height of a tree" rather than "Let x represent the height of a tree". Subscripts and superscripts require math mode and are produced with `_{}` and `^{}`, respectively – as in x_1^2 (produced by `x_{1}^{2}` in math mode).

"Displayed" expressions

Formulas that are longer than about a third of a line and any important formulas should be "displayed"– set on a separate line and centered. You use the "displaymath" environment to achieve this—opened with `\begin{displaymath}` and closed with `\end{displaymath}` or (shorter form) opened with `\[` and closed with `\]`. If you will refer to the formula later, it should be numbered (formulas/expressions are numbered in order). This uses the "equation" environment.

Here is an example of a displayed formula which also uses the "cases" environment to give the multi-case formula and the "mbox" environment for typing words while in math mode.

$$f(x) = \begin{cases} 3x + 2 & \text{if } x \leq 4, \\ x - 7 & \text{otherwise.} \end{cases}$$

Here is an example of a displayed and numbered formula.

$$\int_a^b f(x)dx = F(b) - F(a) \text{ if } F'(x) = f(x) \text{ on } [a, b] \tag{1}$$

The command line opening the equation environment includes a label (in this case "fthm"), produced with the `\label{}` command, which does not print but can be used later to refer to the displayed line. The reference uses the `\ref{}` command (the label is entered in the braces) to insert the correct number, which will always be correct (even if other numbered items are inserted or removed) because the program tracks it. Later in the paper, we might note that "Equation (**??**) is one statement of the Fundamental Theorem of the Calculus". [The reference is produced by typing "Equation (`\ref{thm}`) is one ...".]

If your paper involves a string of calculations, these would usually be set in the "display" environment.

If there are several equations or inequalities together (a derivation or series of calculations, a system of equations or inequalities ...), they are usually lined up by the equality or inequality signs, using the "align" environment (if the equations should be numbered) or the "align*" environment (if they should not). The ampersand (&) is used to mark the character to be aligned, the end-of-line command (\\) is used to start a new line.

$$\begin{aligned} 5x_1 - 3x_2 + x_3 &< 8 \\ 4x_1 + 3x_2 &= 5 - 2x_3 \end{aligned}$$

4 Matrices, Determinants

Standard matrices are produced with the 'pmatrix' (p for parentheses) environment; determinants with the 'vmatrix' (vertical line) environment. Each will allow up to ten columns in the matrix – if more are needed, the number can be increased by using the `\setcounter{MaxMatrixCols}{}` command – putting the new number of columns in the last braces (It is best to set this number back to 10 afterward, to allow TEXto work faster). The ampersand (&) separates entries in a row, the end-of-line symbol \\ is used to end all rows except the last (which is ended by the appropriate `\end{}` statement). The matrix commands work only in math mode.

Example 8. Matrix and determinant examples:

pmatrix A matrix framed in parentheses (curved), produced with the "pmatrix" environment: $\begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$

bmatrix A matrix framed in square brackets, produced with the "bmatrix" environment: $\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$

vmatrix A determinant, produced with the "vmatrix" environment: $\begin{vmatrix} 0 & 1 & a \\ 1 & 0 & b \\ p & q & r \end{vmatrix}$

"and so on" matrix The Identity matrix is given by $\begin{bmatrix} 1 & 0 & \cdots & 0 \\ 0 & 1 & \cdots & 0 \\ \cdots & \cdots & \cdots & \cdots \\ 0 & 0 & \cdots & 1 \end{bmatrix}$

5 Figures (diagrams & pictures)

Figures are labeled and numbered in their own sequence. The positioning of a figure on a page can be a bit involved. See the section **Floating objects** below.

To include a figure, use the "figure" environment (opened with the `\begin{figure}` command, closed with `\end{figure}`). You provide the caption (the descriptive text title) with the `\caption{}` command just before the `\end{figure}` command. You will usually want a `\label{}` command (within the figure environment) to allow you to easily refer to the figure in text. Usually the subcommand [h] (for "here") will be used - meaning "put the figure here, or as soon as possible" (without this command, the figure would be put at the top of a page - see the section on **Floating objects**). The `\centering` command in the "figure" environment centers the figure on the page. For each figure, you need to have a reference in the text (using "Figure `\ref{}`") so that the reader can make the appropriate connections. [Because of the "floating" nature of figures, the figure may not appear directly below/above the text it illustrates.]

The figure environment for Figure **??** is located here in the text - the actual figure may appear here or may not appear until the top of the next page (depending on spacing), as explained in the section **Floating objects**.

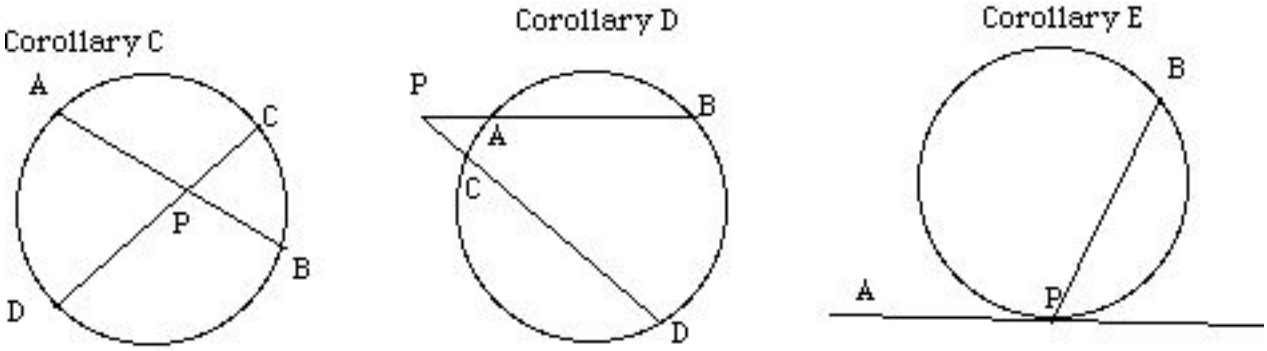

Figure 1: An example of a figure - from a geometry course

Creating figures

The "figure" environment includes the figure in the document for printing, but does not create it. To have the figure, we must create it.

First option for creating diagrams: There is a drawing environment (the "picture" environment) in TeX. Since all commands must be in ASCII, the drawing is described totally by Cartesian coordinate instructions. Straight lines, circles, and text are fairly straightforward; drawing curves can get complicated; see [**?**] for details.

Second – more often used – option for creating diagrams: Diagrams and pictures scanned or created in a graphics program are *kept in other files* that must be saved with the TeX file in order to print in the document; they are included in the document with the `\includegraphics{}` command. The argument (in the brackets) is the filename - including the extension. Because it is producing a .pdf file (rather than a postscript file), the iTeXMac interpreter requires actual graphics files - the easiest form to work with is .jpg graphics. Other interpreters (producing output that goes directly to postscript printers) use *encapsulated postscript (.eps)* files. (Postscript is the printer command language used by most laser printers - an "encapsulated" postscript file has added command lines identifying it as a postscript file and setting certain parameters).

To create a .jpg diagram for use with iTeXMac

Draw the diagram with a standard graphics program - easiest is to use Appleworks and create a "Drawing" document (lines, circles, etc. are objects) rather than a "Painting" document (everything is defined as a set of pixels - the program does not recognize lines, curves, etc). When the drawing is done to your satisfaction, save it twice — once as an Appleworks document (so you can edit it if you want to change it) and once as a JPEG (in Appleworks, the option will be "as a JPEG[QT] document") document; include the extension .jpg at the end of the file name. You will need to specify (in a second window) that the figure is in "greyscale" (not color) and set the "quality" (how much information is actually retained - the jpeg format is a compressed format - it drops out information to make files smaller). Unless your diagram includes very small pieces or text in a small font the "medium" quality setting suffices. If you have saved the original, you can try different settings for the jpg version. Use of the .eps format is preferred by many installations because, like the TeX processor, it uses the maximum resolution of whatever printer is being used. This is the second reason for saving the original copy of your diagram (as well as the .jpg version) - you can generate a .eps version of the file for use with other installations of TeX.

6 Tables and arrays

Tables are labeled and numbered in their own sequence. The positioning of a table on a page can be a bit involved. See the section **Floating objects** below.

To include a table, use the "table" environment (opened with the `\begin{table}` command, closed with `\end{table}`). You provide the caption (the descriptive text title) with the `\caption{}` command just after the `\begin{table}` command. You will need a `\label{}` command (within the table environment) because you need to refer to the table in text (using the `\ref{}` command). Usually the subcommand [h] (for "here") will be used - meaning "put the table here, or as soon as possible " (without this command, the figure would be put at the top of a page - see the section on **Floating objects**). The `\centering` command in the "table" environment centers the figure on the page. For each table, you need to have a reference in the text (using "Table `\ref{}`") so that the reader can make the appropriate connections. [Because of the "floating" nature of tables, the table may not appear directly above/below the text explaining it.]

Creating the table

The "table" environment takes care of labeling and numbering. To create the table, we use the "tabular" environment(within the "table " environment). It is opened with a `\begin{tabular}{}` command. The braces contain an alignment command (l, c, or r – left, center, or right) for each column *and* a vertical slash (|) between two letters creates a vertical line separating the columns. An `\hline` command after a `\\` or at the `\begin` command draws a horizontal line across the whole table. A `\cline{i-j}` command in any row draws a horizontal line under columns i to j in that row. The `\multicolumn{n}{pos}{}` command creates an item that spans two or more columns (useful for headings); the parameter n indicates the number of columns; *pos* is a string of letters l, c, or r , one for each column, indicating the alignment of material in the column (left, center, or right). (The symbol | can be used between these letters for vertical framing); the text of the item goes in the last braces. Within the "tabular" environment, TEX is in LR mode - so spaces between words or symbols are printed exactly as typed (Extra spaces are *not* ignored.). Mathematical expressions and symbols can be included in the table – we need to enter and leave math mode with $ ...$.

The commands producing Table **??** appear here in the source file – the table may appear here (if there is space) or at the top of the next page (if this paragraph is too close to the bottom of the

page)

Table 1: A table with a multicolumn heading and framed with lines

type	*style*	
smart	red	short
rather silly	puce	tall

The environment (the commands) for Table **??**, which includes mathematical formulas, appears *after* the environment for Table **??**. The table will appear here or later.

Table 2: Some standard factoring methods

Name	Standard form	Factorization
Difference of squares	$a^2 - b^2$	$(a + b)(a - b)$
Perfect square	$ax^2 \pm 2\sqrt{ac}\,x + c$ $(a, c > 0)$	$(\sqrt{a}\,x \pm \sqrt{c})^2$
General trinomial factoring	$ax^2 + bx + c$ if $b^2 - 4ac \geq 0$	$a\left(x - \frac{-b+\sqrt{b^2-4ac}}{2a}\right)\left(x - \frac{-b-\sqrt{b^2-4ac}}{2a}\right)$

7 Floating objects

To typeset your file, TEX reads through it, interpreting the commands and setting all the text, and cuts off pages as they fill up. Sentences and paragraphs can break across pages, but tables and figures (and other "boxes" that are not discussed here) cannot – a figure or a table has to appear wholly on one page, thus it may have to "float" to a better place, so (since this is a computer program) there has to be an algorithm for location. The placement algorithm deals with four options: top of a page [t], bottom of a page [b], on a page of floating objects (a figures page) [p] or as soon as possible after the location of the command [h].

The default option is [t] – top of a page (to allow maximum space for the object). If the object floats to the top of its page, it may appear *before* the text discussing it [though it will never appear on a *page* before the text that is right before its command.]; if it floats to a later page, the empty space on the current page will be filled up with text. In any case, you need to be sure you refer to the object by name (using the `\ref{}` command) in your text. The [h] ("here or on the first page possible") command tends to give the best results unless you have many figures and tables which can create a backlog of floating objects looking for a home. Ask for help if you get in such a situation.

8 Lists of various sorts (but not the bibliography)

Lists come naturally in three types - bulleted ("itemize"), numbered ("enumerate"), and individually labeled ("description"). Each type is opened with a `\begin{type}` command and ends with a matching `\end{type}` command. Within the list environment, each item begins with an `\item` command. The name or description (if any) of the list is typed *before* the `\begin{}` command. The list environments can be "nested" – one item of a list can be another list, of any type – up to four levels deep [deeper than you should ever want to go]. In the "description" environment, intended for describing a list of objects, each item has a label (the object being described), so the command is of the form `\item{label}` and the spacing adjusts according to the label.

Example 9. A numbered list of examples of lists

1. A definition with a list of terms (using "description")

   Definition 10. We say a triangle is

   isosceles if two sides have the same length,
   equilateral if all three sides have the same length, or
   scalene if all three sides have different lengths.

2. A bulleted list, (using "itemize")
   Items to bring to class:

   - A notebook
   - A writing implement
   - Your head

9 References (bibliography) and Citations

References used in preparing a paper are listed in a standard format. Here is an set of templates for bibliography entries for a book, a journal article, an article in a book, an article or chapter from an on-line book or journal, and a website with no specifically identified author or editor. Generally, the author's name is set in Small Capitals, names of whole volumes (book titles, journal names) are *emphasized*, URL's are set in `<a monospaced font and enclosed in angle brackets>`, and other information is in plain font, with the various pieces separated by commas.

For a book [for example, entry [**?**] in the list of references below] Author's Name, *Book title*, publisher's name, year of publication.

For a journal article [for example, entry [**?**] in the list of references below] Author's Name, "Article Title", *Journal Name* volume number (year), pages.
There are common abbreviations for many journal titles – as shown here

For an article in a book [for example, entry [**?**] in the list of references below] Author's Name, "Article Title", in *Book Title*, Publisher's name, year of publication, pages.
This format can be used – with Chapter Number and Title in place of Article Title – if only one chapter is relevant.

For an article obtained from a website (adapted from [**?**]): (for example, entries [**?**] and [**?**]) Author's Name, "Article Title" (or Chapter Title), *site name* OR *electronic journal name* OR *Title of on-line text*, volume and date (if a journal) OR publisher (if a book) OR organization maintaining the website , Date posted, date accessed, Section/part/page used (if this is other than the title), `<URL>`.

For an on-line book: Author's Name, *Book title*, publisher's name, year of publication, date accessed, `<URL>`.
This is the same format as for a printed book except that "date accessed" and "URL" are added.

For information on a website with no clearly identified author or editor (adapted from [**?**])(for example, entry [**?**] in the list of references below): *Site name*, date published, organization or individual responsible, date accessed, Section/part/page used (if site has multiple pages and parts), `<URL>`.

To organize the bibliography and include citations to the works in the text, you use the "thebibliography" environment opened with `\begin{thebibilography}{99}` and closed with `\end{thebibliography}`. [The {99} entry sets up space for two-digit numbers at the left side of the list, since the references are numbered and cited by number. If you have more than 100 references, you use {999} instead]]

The references are listed in order by author's [last] name [unauthored websites by the first letter in the site name]. Within the "thebibliography" environment each item is marked by a `\bibitem` command and is given a short reference name (in braces:{}).

To cite the reference in text, use the `\cite{}` command, entering the reference name in the braces (as shown in the list of templates, above). The program will put the appropriate number in the citation location (even if references are added or removed) based on the reference name.

References

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