

Technical Typesetting
for Physics Teachers
with T_EX and LaT_EX

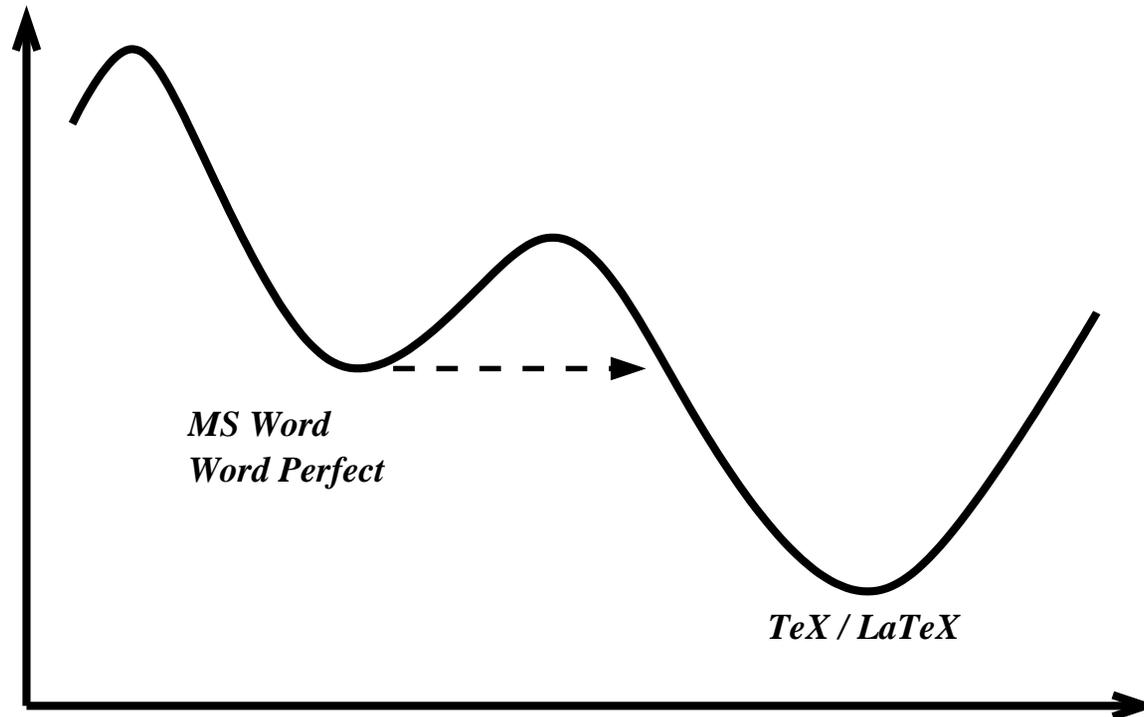
Eric Myers

“Beautiful equations made easy”

Why Use T_EX?

T_EX (pronounced “Tech”) is a technical typesetting system created by Donald Knuth of Stanford University. It is used by most physicists, mathematicians, and computer scientists, and many astronomers.

MS Word works for $E = mc^2$ and H₂O, so why use T_EX?



Scientific typesetting made easy

$\text{T}_{\text{E}}\text{X}$ can correctly typeset complicated mathematical expressions, with proper alignment of all elements and automatic equation numbering:

$$\nabla \cdot \vec{D} = \frac{\rho}{\epsilon} \tag{1a}$$

$$\nabla \cdot \vec{B} = 0 \tag{1b}$$

$$\nabla \times \vec{E} = -\frac{1}{c} \frac{\partial \vec{B}}{\partial t} \tag{1c}$$

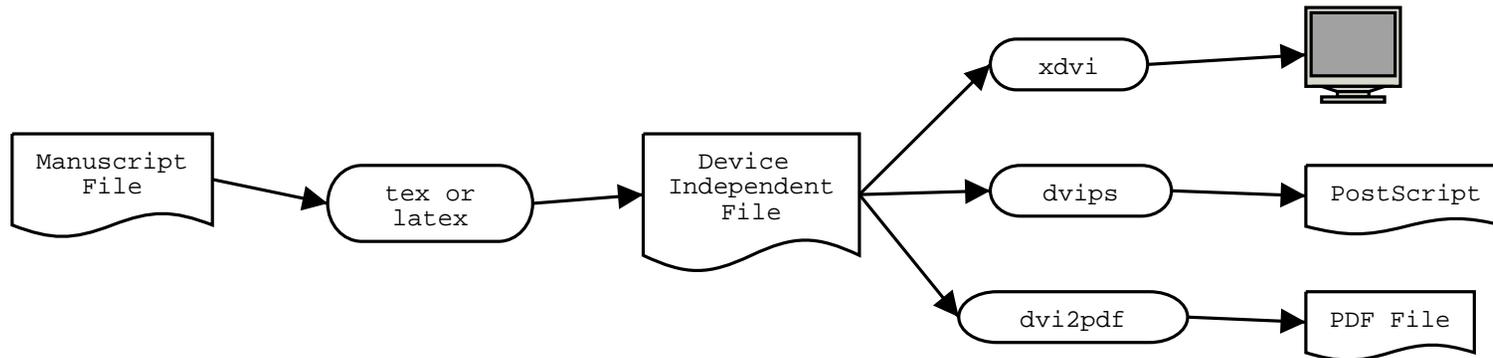
$$\nabla \times \vec{H} = \frac{\partial \vec{D}}{\partial t} + \vec{J} \tag{1d}$$

This is no mere “processing” of words.

Some type of $\text{T}_{\text{E}}\text{X}$ or $\text{L}\text{a}\text{T}_{\text{E}}\text{X}$ is required to submit papers to the arXiv.

The T_EX Process – it’s not WYSIWYG

Typesetting a paper with T_EX is like **compiling a computer program**:



1. Instructions in “manuscript” file, `myfile.tex` (**source code**)
2. `tex` or `latex` (the T_EX “engine” and macros (**libraries**)) produces device independent (DVI) file, `myfile.dvi` (**object file**)
3. DVI file viewed on screen, converted to PostScript file, or converted to a PDF file. (**loader/linker**)

On a Mac or PC this is all behind the scenes.

Note! pdfT_EX goes straight from `.tex` to `.pdf`

Typesetting: The Finer Points

Typesetting is more complex than word processing, but for regular text (no equations) typesetting is easy if you keep a few subtle points in mind:

- A new paragraph is signaled in $\text{T}_{\text{E}}\text{X}$ by a *blank line*. The entire paragraph is typeset at one time, with optimal line breaks chosen to make the entire paragraph look good.
- *Quotation marks* are more complicated: You should use left and right single quotes twice to get left and right quotation marks.
- Use a single dash for a short hyphen, “-”, a double dash for a regular hyphen, “—”, and a triple dash for a long hyphen “—”.
- *Diacritical marks* are created with special control characters. For example, typeset the words “façade” and “coördinates” with `fa\c cade` and `co\"ordinates`.

*“I have seen — attack ships on fire off the shoulder of Orion.
I watched c-beams glitter in the dark near the Tannhäuser Gate.”*

Symbols, Subscripts, Superscripts

Mathematics text is typeset differently. Variables are typeset in italics, with different spacing. Mathematics in the body of a text must therefore be enclosed in “math quotes”, which are dollar signs, \$.

Math symbols are indicated by a “control word” name, which begins with a backslash, (eg. `α` and `Ω` produce α and Ω).

Subscripts are indicated with an underscore `_` , while superscripts are indicated with a circumflex `^` . Grouping is indicated with curly brackets `{` and `}` .

- To get “ $Y_l^m(\theta_1, \phi')$ ” you type:

```
 $Y_1^m(\theta_1, \phi^{\prime})$ 
```

- To get “ $G_{\mu\nu} = g_{\mu\nu}R + \frac{1}{4}R_{\mu\nu}$ ” type:

```
 $G_{\mu\nu} = g_{\mu\nu} R + \{1 \over 4\} R_{\mu\nu}$ 
```

Displayed Equations

Long equations, or important equations, are set off from the text as “displayed” equations. To get a displayed equation you double the math quotes. To get this:

$$\langle \psi_1 | \psi_2 \rangle = \int_{-\infty}^{\infty} \frac{Y_l^m(\theta_1, \phi_1) Y_l^m(\theta_2, \phi_2)}{\sqrt{2\pi}} d\Omega$$

you would type this:

\$\$

```
\langle \psi_1 | \psi_2 \rangle =
\int_{-\infty}^{\infty} {
Y_l^m(\theta_1, \phi_1) Y_l^m(\theta_2, \phi_2)
\over \sqrt{2\pi} } \, d\Omega
```

\$\$

(In LaTeX you use `\[` and `\]` instead of `$$`)

Maxwell's Equations

$$\nabla \cdot \vec{D} = \frac{\rho}{\epsilon}$$

$$\nabla \cdot \vec{B} = 0$$

$$\nabla \times \vec{E} = -\frac{1}{c} \frac{\partial \vec{B}}{\partial t}$$

$$\nabla \times \vec{H} = \frac{\partial \vec{D}}{\partial t} + \vec{J}$$

Maxwell's equations, nicely aligned, are produced by typing:

\$\$

```
\eqalign{
```

```
\nabla \cdot \vec{D}      &=  {\rho \over \epsilon}      \cr
```

```
\nabla \cdot \vec{B}      &=  0                      \cr
```

```
\nabla \times \vec{E}      &=
```

```
      - {1 \over c} {\partial \vec{B} \over \partial t} \cr
```

```
\nabla \times \vec{H}      &= \phantom{-}
```

```
      {\partial \vec{D} \over \partial t} + \vec{J} \cr
```

\$\$

Macro Definitions

\TeX is extendable by defining new control words as “**macros**”.
For example:

```
\def\Sph#1{Y_1^m(\theta_{#1},\phi_{#1})}
```

The argument #1 is replaced with whatever argument you give to the macro. So you can produce

$$\langle \psi_1 | \psi_2 \rangle = \int_{-\infty}^{\infty} Y_l^m(\theta_1, \phi_1) Y_l^m(\theta_2, \phi_2) d\Omega$$

by typing:

```
$$  
\langle \psi_1 \ \text{\vert} \ \psi_2 \ \rangle =  
  \int_{-\infty}^{\infty} \Sph{1} \Sph{2} \ , \ d\Omega  
$$
```

Large collections of pre-defined macros are called “**formats**”.
 $\text{REV}\text{\TeX}$ and $\text{\TeX}\text{sis}$ are special formats for physicists.

Figures and Images

Drawings and figures can be included in the document if they are in an “Encapsulated” PostScript file (ie, an .eps file).

- In Plain T_EX you need to use the macro file `epsf.tex`, like so:

```
\input epsf.tex
:
\line{\epsfxsize=\hsize\epsfbox{TeX-Process.eps}}
```

- In L_AT_EX you use the “`graphicx`” style package, like so:

```
\usepackage{graphicx}
:
\includegraphics[width=\columnwidth]{LAT96Fig2}
```

JPEG and PNG images can be converted to EPS first. Example:

```
$ pngtopnm TeXShopScreen.png | pnmtops -noturn > TeXShopScreen.eps
```

Citations and References

A utility program called BIB $\text{T}_{\text{E}}\text{X}$ makes it easy to manage citations and references:

1. You collect one or more bibliography files (eg. `mylist.bib`) containing a list of fields (title, author, journal, etc..) for each work that you might wish to cite. Each item is identified by a unique 'key'. For example:

```
@book{Bevington1969,  
      title = {Data Reduction and Error Analysis  
              for the Physical Sciences},  
      author = {Philip R. Bevington},  
      edition = {First},  
      publisher = {McGraw Hill},  
      year = {1969}  
}
```

2. In your text, when you wish to cite a work, you simply say `\cite{key}`. Each new work gets a new citation number.

3. At the end of the manuscript file you put

```
\bibliography{mylist}
```

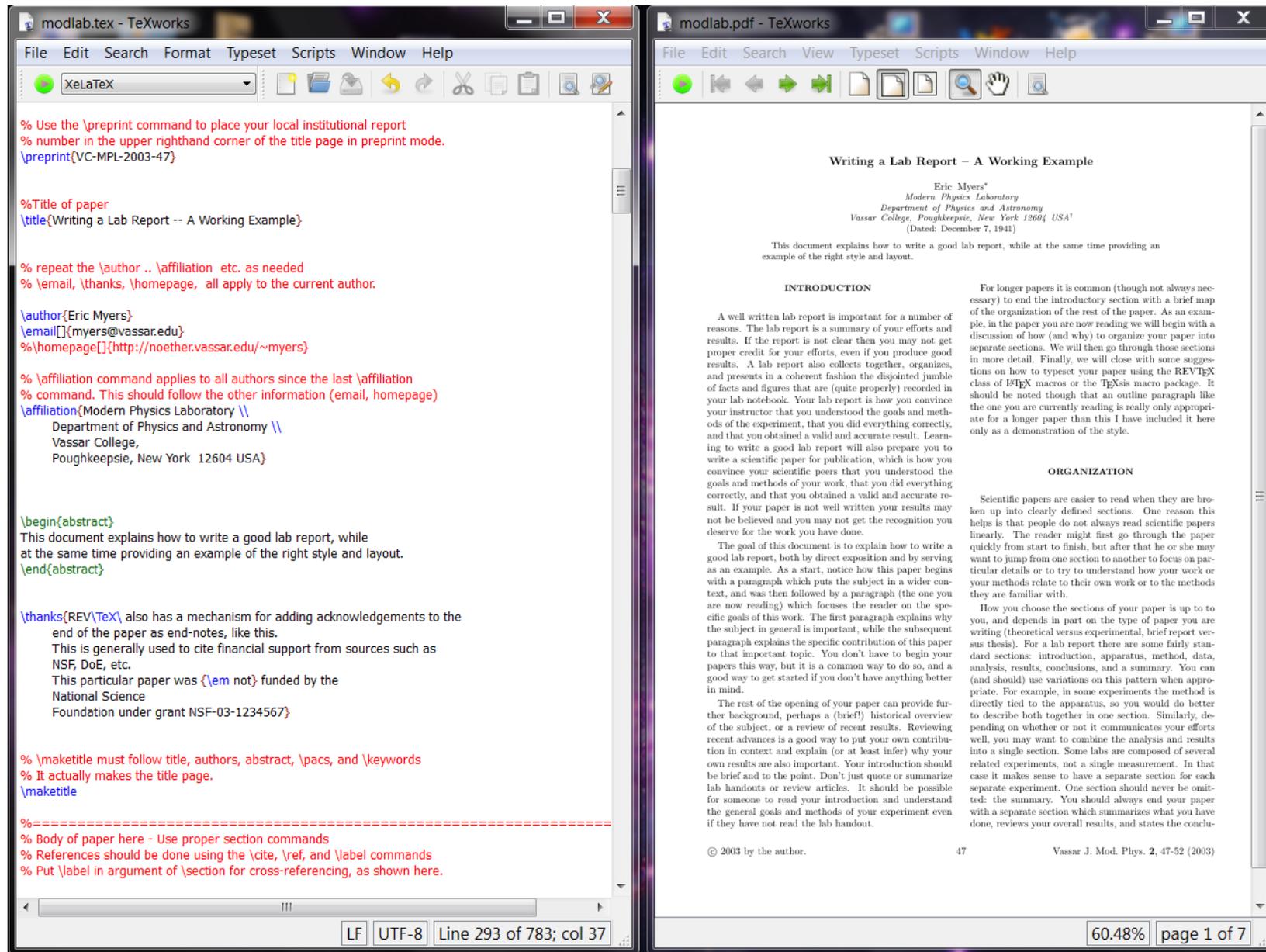
This names the bibliography file (ie, `mylist.bib`) and it is also where the list of references will appear.

4. When you run `TEX`, the citations are added to an auxiliary file, `myfile.aux`. You then run the `BIBTEX` program, which collects the citations, selects the references from the bibliography file, and outputs the list of references as `myfile.bbl`.

5. When you run `TEX` again the list of references (in `myfile.bbl`) is inserted at the end of your document (where you put the `\bibliography`).

You only need to run `BIBTEX` again if you add, delete, or re-arrange references.

TeX on Windows – MiKTeX and TeXWorks



TeX on Mac – TeXShop

The screenshot shows the TeXShop application window. The top menu bar includes File, Edit, Source, Macros, Typeset, Preview, Window, and Help. The window title is 'modlab.tex'. The left pane shows the source code for 'modlab.tex', which includes document class settings, package loading, author information, and the start of a document. The right pane shows the rendered PDF, 'modlab.pdf', which is titled 'Writing a Lab Report – A Working Example'. The PDF content includes the author's name, affiliation, date, and the beginning of the 'INTRODUCTION' and 'ORGANIZATION' sections.

```
21 %\documentclass[aps,rmp,twocolumn,draft,floatfix](revtex4)
22 \documentclass[aps,prl,twocolumn,twoside,floatfix](revtex4)
23
24 %% Special packages to use for graphics and such:
25 \usepackage{graphicx}% so you can include figure files (see example below)
26
27 %%%
28 %%% Editing History:
29 %%% -EAM 06Jun2003 Added vjmp style and page style
30 %%%
31
32 \usepackage{vjmp}
33 \def\theAuthor{E. Myers}
34 \def\theVolume{2}
35 \def\pageRange{(47-52)}
36 \def\theYear{2003}
37
38 \begin{document}
39 \setcounter{page}{47}
40 \pagestyle{vjmp}
41 \date{October 12, 2014}
42
43
44 %=====
45 % Title material:
46
47 % Use the \preprint command to place your local institutional report
48 % number in the upper righthand corner of the title page in preprint mode.
49 \preprint{VC-MPL-2003-47}
50
51
52 %Title of paper
53 \title{Writing a Lab Report -- A Working Example}
54
55
56 % repeat the \author .. \affiliation etc. as needed
57 % \email, \thanks, \homepage, all apply to the current author.
58
59 \author{Eric Myers}
60 \email{myers@vassar.edu}
61 %\homepage{http://noether.vassar.edu/~myers}
62
63 % \affiliation command applies to all authors since the last \affiliation
64 % command. This should follow the other information (email, homepage)
65 \affiliation{Modern Physics Laboratory \\\
66 Department of Physics and Astronomy \\\
67 Vassar College,
68 Poughkeepsie, New York 12604 USA}
69
70
71
72 \begin{abstract}
73 This document explains how to write a good lab report, while
74 at the same time providing an example of the right style and layout
```

Writing a Lab Report – A Working Example

Eric Myers*
Modern Physics Laboratory
Department of Physics and Astronomy
Vassar College, Poughkeepsie, New York 12604 USA[†]
(Dated: October 12, 2014)

This document explains how to write a good lab report, while at the same time providing an example of the right style and layout.

INTRODUCTION

A well written lab report is important for a number of reasons. The lab report is a summary of your efforts and results. If the report is not clear then you may not get proper credit for your efforts, even if you produce good results. A lab report also collects together, organizes, and presents in a coherent fashion the disjointed jumble of facts and figures that are (quite properly) recorded in your lab notebook. Your lab report is how you convince your instructor that you understood the goals and methods of the experiment, that you did everything correctly, and that you obtained a valid and accurate result. Learning to write a good lab report will also prepare you to write a scientific paper for publication, which is how you convince your scientific peers that you understood the goals and methods of your work, that you did everything correctly, and that you obtained a valid and accurate result. If your paper is not well written your results may not be believed and you may not get the recognition you deserve for the work you have done.

The goal of this document is to explain how to write a good lab report, both by direct exposition and by serving as an example. As a start, notice how this paper begins with a paragraph which puts the subject in a wider context, and was then followed by a paragraph (the one you are now reading) which focuses the reader on the specific goals of this work. The first paragraph explains why the subject in general is important, while the subsequent paragraph explains the specific contribution of this paper to that important topic. You don't have to begin your papers this way, but it is a common way to do so, and a good way to get started if you don't have anything better in mind.

The rest of the opening of your paper can provide further background, perhaps a (brief!) historical overview of the subject, or a review of recent results. Reviewing recent advances is a good way to put your own contribution in context and explain (or at least infer) why your

ORGANIZATION

Scientific papers are easier to read when they are broken up into clearly defined sections. One reason this helps is that people do not always read scientific papers linearly. The reader might first go through the paper quickly from start to finish, but after that he or she may want to jump from one section to another to focus on particular details or to try to understand how your work or your methods relate to their own work or to the methods they are familiar with.

How you choose the sections of your paper is up to you, and depends in part on the type of paper you are writing (theoretical versus experimental, brief report versus thesis). For a lab report there are some fairly standard sections: introduction, apparatus, method, data, analysis, results, conclusions, and a summary. You can (and should) use variations on this pattern when appropriate. For example, in some experiments the method is directly tied to the apparatus, so you would do better to describe both together in one section. Similarly, depending on whether or not it communicates your efforts well, you may want to combine the analysis and results into a single section. Some labs are composed of several

TEX on Linux – TEX Live

- TEX is available in all major Linux distributions as “TeX Live” (just the TEX engine, no front end, but lots of other tools):

Fedora/Red Hat:

```
$ sudo yum install texlive
```

Ubuntu/Debian:

```
$ sudo apt-get install texlive
```

- Use your favorite editor (`emacs`, `vi`, `nedit`) as the “front-end”.
- Use `xdvi` to view the DVI file, or any PDF viewer for PDF output.
- Or, `texworks` packages also available on Ubuntu, Debian, and Fedora Linux.

T_EX for Physicists

- For L^AT_EX there is a “class” of macros called REV_TE_X which is used by the American Physical Society to typeset their journals (eg. *Physical Review*, *Physical Review Letters*, and *Reviews of Modern Physics*). Authors are encouraged to submit computer manuscripts using REV_TE_X.
- For Plain T_EX the equivalent is T_EXsis (<http://www.texsis.org>)
- For the Vassar Journal of Modern Physics there is a style file called `vjmp.sty` for use with REV_TE_X (see below...)

Modern Physics Laboratory – Physics 201 at Vassar

How I transitioned college students from MS Word to REVTeX:

- Pairs of students performed 5 experiments, each 2 weeks long (2×3 hours per week, lab always open)
- Each team turned in a written report for the first 4 labs, alternating role of “first” and “second” author, using Word, TeX, or whatever they wanted
- Final experiment performed as a team, but each student report written as sole author. Use of REVTeX required.
- REVTeX examples and documentation provided from the start, so each student could transition at their own pace.

See <http://www.spy-hill.net/~myers/vassar/201/notes>

Resources – T_EX Software

- MiKTeX – TeX Engine for Windows (<http://www.miktex.org/>)
- TeXWorks – simple TeX front end for Mac and Windows (<http://www.tug.org/texworks/>)
- WinEdt – text editor for Windows and MiKTeX (<http://www.winedt.com/>)
- TeXShop – TeX front-end for Mac (<http://pages.uoregon.edu/koch/texshop/>)
- MacTeX.pkg – TeX Live for Mac (required by TeXShop) (<http://pages.uoregon.edu/koch/texshop/obtaining.html>)
- TeX Live – comprehensive TeX system for Linux (and Windows) (<https://www.tug.org/texlive/>)

General T_EX Resources

- modlab.zip – example REVTeX paper for Vassar Modern Physics Laboratory (<http://www.spy-hill.net/myers/vassar/201/notes>)
- REVTeX 4.1 – LaTeX macros used by American Physical Society (<https://journals.aps.org/revtex>)
- TUG – T_EX User’s Group (<http://www.tug.org/>)
- “*The T_EXbook*” by Donald Knuth
- “*LaT_EX: A Document Preparation System*” by Leslie Lamport
- “*A Gentle Introduction to T_EX*” by Michael Doob