

[Introduction](#)

[Hello World!](#)

[Scientific Papers in LaTeX](#)

[Getting and Installing a . . .](#)

[Support and Reference . . .](#)

[Home Page](#)

[Title Page](#)



[Page 1 of 22](#)

[Go Back](#)

[Full Screen](#)

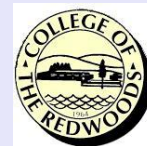
[Close](#)

[Quit](#)

Writing Scientific Papers in L^AT_EX

David Arnold

August 29, 2016

[Introduction](#)[Hello World!](#)[Scientific Papers in LaTeX](#)[Getting and Installing a . . .](#)[Support and Reference . . .](#)[Home Page](#)[Title Page](#)[Page 1 of 22](#)[Go Back](#)[Full Screen](#)[Close](#)[Quit](#)

1. Introduction

We assume that our readers¹ have a working \TeX system on their computers. If this is not the case, see Section 4, [Getting and Installing a \$\text{\TeX}\$ System](#).

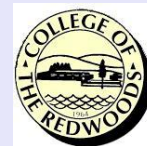
There are a number of editors that work well with \TeX , but Microsoft Word is not one of them (unless you save the Word files as pure text). These editors range in complexity, from the simple Notepad program that comes with all Windows systems, to [GNU Emacs](#), a powerful text editor, perhaps the favorite of the math and science community. However, we will use a shareware program called [\$\text{\TeX}\$ works](#) in all of our demonstrations in these pages. There are two reasons for this choice:

1. \TeX works is installed on all of our systems at [College of the Redwoods](#).
2. \TeX works comes preinstalled with MiK \TeX .

This article does not pretend to be a complete introduction to \LaTeX . There are plenty of tutorials written on the internet that already give complete descriptions of the \LaTeX language (see Section 5, entitled [Support and Reference Materials](#), for a number of books and tutorials on \LaTeX and \TeX). Rather, we have a simple goal: get you up to speed on using \LaTeX to type the project paper due at the end of the term.

With that goal in mind, we begin by writing a simple “Hello, World!” document, just to get you up and running. We then show how to set the title page and abstract and spend some time discussing section headers. We will spend quite some time discussing mathematics, but again, this is by no means a complete discussion. See the reference texts in [Support and Reference Materials](#) for further assistance in typesetting mathematics. Also, you might want to investigate the American Mathematical Society’s [User’s Guide for the \$\text{amsmath}\$ Package](#).

¹Note that this document is fully hyperlinked. Some links are obvious (see the control panel at the right), but there are others that may not immediately be apparent. In general, colored text in the narrative has a high probability of being a link. One color is used for links within the document, another color for URL’s and links to documents outside this document. Passing your mouse over a link will reveal the nature of the link. Click these links for more information, then use the “Back” button in the panel at the right to return to your previous position in this document and continue reading.

[Introduction](#)[Hello World!](#)[Scientific Papers in LaTeX](#)[Getting and Installing a . . .](#)[Support and Reference . . .](#)[Home Page](#)[Title Page](#)[◀◀](#) [▶▶](#)[◀](#) [▶](#)[Page 2 of 22](#)[Go Back](#)[Full Screen](#)[Close](#)[Quit](#)

Any good scientific writer will eventually need to reference sections, equations, figures, etc., so we spend a bit of time on referencing, then we complete our discussion with a word about bibliographies. These are the main ingredients of any well written scientific article.

Let's begin.

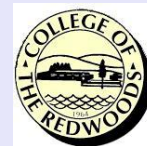
2. Hello World!

Every programming class opens with a “Hello, World!” program, whether it be C++ or Fortran or Lisp. The idea is to write and compile an extremely simple program, just to get you started. We will follow that lead here. Open TeXworks, create a new document, then enter the following source code.

```
\documentclass{article}
\begin{document}
Hello, World!
\end{document}
```

Save the document as `intro.tex`.² After saving your file, select `pdfLaTeX` from the `Typeset` menu, then select `Typeset` from the `Typeset` menu. Note that there are options for this as well on the toolbar, a drop down menu where you can select `pdfLaTeX` (if it is not selected already) and a green button to the left of the drop down menu that you can click to begin the compilation process (there are also shortcut keys for this: Ctrl+T on Windows, Command+T on the Mac). You can then watch a number of responses scroll by in the Console output window at the bottom of the screen as your file is compiled. If there are errors, fix the errors (see Section 2.2, [A Word on Errors](#)), then recompile by clicking the `Typeset` icon again.

²A word about file organization. It is not a good idea to lump all files into one common directory. Good organization of directories (folders) is a must. So, for this activity, create a folder called **Intro** on your hard drive (or in your network folder at school) and save the file `intro.tex` in this folder. Later, when you are working on your final project, create a folder called **Project** and place all files associated with your project in your **Project** folder.

[Introduction](#)[Hello World!](#)[Scientific Papers in LaTeX](#)[Getting and Installing a . . .](#)[Support and Reference . . .](#)[Home Page](#)[Title Page](#)[◀](#) [▶](#)[◀](#) [▶](#)[Page 3 of 22](#)[Go Back](#)[Full Screen](#)[Close](#)[Quit](#)

Once you've successfully compiled `intro.tex`, a file named `intro.pdf` will open in a second window. This is the compiled version of your code, the final document that you will print and hand in for credit.

2.1. New Paragraphs

You start a new paragraph by entering a blank line in your source code (two consecutive strikings of the Enter key). At this point, it would be a good exercise to just do some normal typing to get the feel of how easy \LaTeX can be. So, type in a few paragraphs, separating each with a blank line in the source, then recompile and view the resulting pdf file.

2.2. A Word on Errors

As you enter your source code in TeXworks, you will constantly make errors. Sometimes you will catch these errors as you type, but more often than you would like to see, errors will show up when you compile your document. For example, edit the first line of `intro.tex` so that the file reads as follows.

```
\documentclass{article
\begin{document}
Hello, World!
\end{document}
```

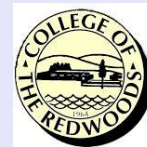
Note that we left off the closing brace after the word 'article.' Click the **Typeset** icon to compile the file. On our system, the log window reports the following error.

```
Runaway argument? {article \begin {document} Hello, World! \end
{document} ! File ended while scanning use of \@fileswithoptions.
```

<inserted text>

\par

<*) Intro.tex

[Introduction](#)[Hello World!](#)[Scientific Papers in LaTeX](#)[Getting and Installing a . . .](#)[Support and Reference . . .](#)[Home Page](#)[Title Page](#)[Page 4 of 22](#)[Go Back](#)[Full Screen](#)[Close](#)[Quit](#)

?

First-time users of T_EX systems are often frustrated with the error messages supplied by the compiler. Not to worry, even advanced T_EX users find these error messages somewhat cryptic. However, a little common sense and the patience to read the error message will usually cure the error. In this case, for example, the compiler is reporting a “Runaway argument.” This usually means that we’ve left off a closing brace on the argument to some command, as is certainly the case here in the first line where we have entered `\documentclass{article.`

Correct the error, coding it properly by adding a closing brace (as in `\documentclass{article}`), then recompile.

3. Scientific Papers in LaTeX

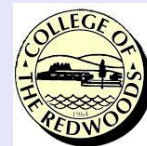
Every well-written scientific paper contains these key ingredients: the title, author, and date, an abstract, logically arranged sections and subsections, good references throughout, and a bibliography citing references.

Let’s begin with the title page.

3.1. The Title Page

The area in the source that lies between the opening `\documentclass{article}` and the line indicating the beginning of the main body, `\begin{document}`, is called the *preamble* of the document. It is in this area that you initialize the title, author, and date.

Add this additional code to your source, `intro.tex`, recompile and view the result.

[Introduction](#)[Hello World!](#)[Scientific Papers in LaTeX](#)[Getting and Installing a . . .](#)[Support and Reference . . .](#)[Home Page](#)[Title Page](#)[◀◀](#)[▶▶](#)[◀](#)[▶](#)[Page 5 of 22](#)[Go Back](#)[Full Screen](#)[Close](#)[Quit](#)

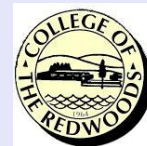
```
\documentclass{article}
\title{Hello, World!}
\author{Your Name}
\date{Today's Date}
\begin{document}
\maketitle
Hello, World!
\end{document}
```

Note that the title, author, and date are initialized in the preamble, but the actual making of the title is accomplished with the `\maketitle` command, which is placed immediately following the `\begin{document}` command.

L^AT_EX will automatically enter and update the date on your article if you do not use the `\date` command in the preamble. That is, if you compile your L^AT_EX file tomorrow, then the tomorrow's date will show up as the current date. Once you want to fix a particular date on your article, you must use the `\date` command in the preamble and enter the preferred fixed date.

Sometimes it is preferred to have a separate title page. This is easily accomplished with one of the many options available to the `\documentclass` command. Adjust your source as follows, recompile, then view the result.

```
\documentclass[titlepage]{article}
\title{Hello, World!}
\author{Your Name}
\date{Today's Date}
\begin{document}
\maketitle
Hello, World!
\end{document}
```

[Introduction](#)[Hello World!](#)[Scientific Papers in LaTeX](#)[Getting and Installing a . . .](#)[Support and Reference . . .](#)[Home Page](#)[Title Page](#)[Page 6 of 22](#)[Go Back](#)[Full Screen](#)[Close](#)[Quit](#)

Next, every good article must have an abstract.

3.2. The Abstract

An abstract is a short synopsis of your article. The basic idea is simple. It must be short and to the point, but it must also be a hook. You want people to read further. It is often the case, due to the vast amount of information available on the internet and in databases, that readers will read no further if they don't find what they need in your abstract. So, writing a good abstract is essential to the success of your article.

As our abstract is for demonstration purposes only, we'll keep it short. Adjust your source to include the new lines that follow, recompile, and view the result. Note that we've removed the `titlepage` option.

```
\documentclass{article}
\title{Hello, World!}
\author{Your Name}
\date{Today's Date}
\begin{document}
\maketitle
\begin{abstract}
This is a very short abstract.
\end{abstract}
Hello, World!
\end{document}
```

Replace the `titlepage` option (as in `\documentclass[titlepage]{article}`) and recompile. In this case, the abstract is put on a separate page, which may be desirable in articles that run for many pages. However, in the case of a ten-page term paper, it might be better to have the abstract on the same page as the title and the opening lines of text. This is accomplished by removing the `titlepage` option as was done in the source above.

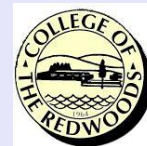
Any good scientific paper must have sound logical structure. This is best accomplished by breaking your ideas into sections and subsections.

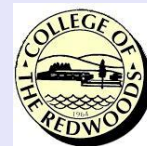
3.3. Section Headers

A section is similar in form to the paragraph. A good paragraph has a topic sentence, and when you begin to move away from the central theme introduced by your topic sentence, it's time to start a new paragraph. Sections are similar. A section discusses a central idea, but it is usually composed of several paragraphs. However, all of the paragraphs are usually constructed about a unifying central idea. When the flow of the writing moves on to another central idea, it might be time to create a new section.

Within each section, you might feel the need to break your central idea into smaller logical units to ease the explanation of the central idea. If this is the case, then use subsections. An excellent way to organize your writing is to craft a good outline. Think of the sections and subsections of your paper as the headers and subheaders listed in your outline.

Once you've decided on the logical structure of your paper, it is an easy task to set sections and subsections. There are even subsubsections, but the good writer will be careful not to get too carried away. Just because you can do something, doesn't mean you should. Without further ado, we add a simple section and subsection to our source code. Make these changes to `intro.tex`, recompile, and view the result.

[Introduction](#)[Hello World!](#)[Scientific Papers in LaTeX](#)[Getting and Installing a . . .](#)[Support and Reference . . .](#)[Home Page](#)[Title Page](#)[◀◀](#)[▶▶](#)[◀](#)[▶](#)[Page 7 of 22](#)[Go Back](#)[Full Screen](#)[Close](#)[Quit](#)

[Introduction](#)[Hello World!](#)[Scientific Papers in LaTeX](#)[Getting and Installing a ...](#)[Support and Reference ...](#)[Home Page](#)[Title Page](#)[Page 8 of 22](#)[Go Back](#)[Full Screen](#)[Close](#)[Quit](#)

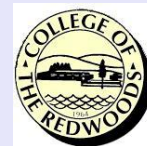
```
\documentclass{article}
\title{Hello, World!}
\author{Your Name}
\date{Today's Date}
\begin{document}
\maketitle
\section{Introduction}
\subsection{Proclamation}
Hello, World!
\end{document}
```

If you wish to suppress section numbering, you can add the command `\setcounter{secnumdepth}{0}` to your preamble.

```
\documentclass{article}
\title{Hello, World!}
\author{Your Name}
\date{Today's Date}
\setcounter{secnumdepth}{0}
\begin{document}
\maketitle
\section{Introduction}
\subsection{Proclamation}
Hello, World!
\end{document}
```

3.4. Typesetting Mathematics

By necessity, scientific papers are likely to contain a lot of mathematical expressions and symbols. This is the main reason that \TeX and \LaTeX are used to typeset mathematical and

[Introduction](#)[Hello World!](#)[Scientific Papers in LaTeX](#)[Getting and Installing a . . .](#)[Support and Reference . . .](#)[Home Page](#)[Title Page](#)[◀◀](#)[▶▶](#)[◀](#)[▶](#)[Page 9 of 22](#)[Go Back](#)[Full Screen](#)[Close](#)[Quit](#)

scientific papers. With \TeX and \LaTeX , you get textbook quality typesetting of mathematics.

It is beyond the scope of this introductory article to give a complete rendition of mathematical typesetting. Rather, we have a less lofty intent. We just want to learn enough to get you on your way. After that, you will learn new mathematical typesetting routines as the need arises.

To save space, we will no longer display the entire source file. Rather, we will give you fragments of code that you are to insert and test in the file `intro.tex`. It is best to put these fragments directly after the line `Hello, World!` in the source. Then recompile and view the result. Let's begin.

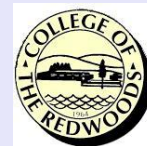
There are two basic types of mathematical typesetting, in-line code and displayed code. In-line mathematics appears right in the line of type, as in $f(x) = a_1x^2 + a_2x + a_3$. But displayed mathematics appears on separate lines, centered in the middle of the paper or screen for effect, such as:

$$f(x) = a_1x^2 + a_2x + a_3$$

There are two basic types of mathematical typesetting, in-line code and displayed code. In-line mathematics appears right in the line of type, as in `$f(x)=a_1x^2+a_2x+a_3$`. But displayed mathematics appears on separate lines, centered in the middle of the paper or screen for affect, such as:

```
$$f(x)=a_1x^2+a_2x+a_3$$
```

Just surround in-line mathematics with single-dollar signs, and displayed mathematics with double-dollar signs. What could be simpler? Note that the symbol `^` takes the very next character and typesets it as a superscript, while the symbol `_` (the underscore) is used for subscripts. If you want more than one character as a superscript or subscript, surround the characters with braces. For example, to typeset a_{ij} , use braces as grouping symbols, as in `a_{ij}`.

[Introduction](#)[Hello World!](#)[Scientific Papers in LaTeX](#)[Getting and Installing a . . .](#)[Support and Reference . . .](#)[Home Page](#)[Title Page](#)[Page 10 of 22](#)[Go Back](#)[Full Screen](#)[Close](#)[Quit](#)

3.5. AMS Math

The American Mathematical Society provides an additional set of macros for typesetting mathematics. Add the following line to your preamble, below `\documentclass{article}`, as shown below.

```
\documentclass{article}
\usepackage{amsmath}
```

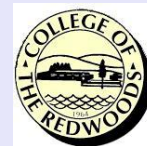
You now have access to literally hundreds of new commands. For example, to center mathematics as we did above, you can use AMSMath's `equation` environment.

There are two basic types of mathematical typesetting, in-line code and displayed code. In-line mathematics appears right in the line of type, as in $f(x)=a_1x^2+a_2x+a_3$. But displayed mathematics appears on separate lines, centered in the middle of the paper or screen for affect.

```
\begin{equation*}
f(x)=a_1x^2+a_2x+a_3
\end{equation*}
```

L^AT_EX provides a number of environments to help “display” or center mathematics in the middle of the page, and the `amsmath` package provides additional structures for this purpose. In the example above, we used the `\begin{equation*} . . . \end{equation*}` environment to display the function. The “star” version of the environment suppresses numbering of the equation. Try using the “unstarred” version `\begin{equation} . . . \end{equation}` to see the difference in performance.

In many situations, one can almost guess the appropriate L^AT_EX command. For example, `\frac` is used to construct fractions.



In line fractions should be typeset differently than displayed fractions. For example, the form $f(x) = (x + 1)/(x - 1)$ is most appropriate for inline display, but the displayed fraction should be typeset as follows.

$$f(x) = \frac{x + 1}{x - 1}$$

In line fractions should be typeset differently than displayed fractions. For example, the form $f(x)=(x+1)/(x-1)$ is most appropriate for inline display, but the displayed fraction should be typeset as follows.

```
\begin{equation*}
  f(x)=\frac{x+1}{x-1}
\end{equation*}
```

If we had used the `\frac` command inline, it would have caused an inordinate amount of spacing to appear between lines. Again, just because something is possible, it doesn't mean that its use is appropriate in all situations.

It's easy to guess the command for square root, and trig functions and greek letters are naturally defined.

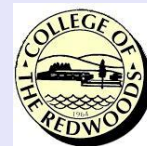
$$\sqrt{1 - \sin^2 \theta} = \cos \theta$$

It's easy to guess the command for square root, and trig functions and greek letters are naturally defined.

```
\begin{equation*}
  \sqrt{1-\sin^2\theta}=\cos\theta
\end{equation*}
```

The `amsmath` package provides a number of commands for typesetting matrices. The `\ampersand` & is used to separate elements in a row and `\\` is used to signal the end of a row.

[Introduction](#)[Hello World!](#)[Scientific Papers in LaTeX](#)[Getting and Installing a...](#)[Support and Reference...](#)[Home Page](#)[Title Page](#)[Page 11 of 22](#)[Go Back](#)[Full Screen](#)[Close](#)[Quit](#)

[Introduction](#)[Hello World!](#)[Scientific Papers in LaTeX](#)[Getting and Installing a . . .](#)[Support and Reference . . .](#)[Home Page](#)[Title Page](#)[Page 12 of 22](#)[Go Back](#)[Full Screen](#)[Close](#)[Quit](#)

A 3×3 Hilbert matrix is defined by $H = (h_{ij})$, where

$$h_{ij} = \frac{1}{i+j-1}.$$

The Hilbert matrix in this case is

$$H = \begin{pmatrix} 1 & 1/2 & 1/3 \\ 1/2 & 1/3 & 1/4 \\ 1/3 & 1/4 & 1/5 \end{pmatrix}.$$

A 3×3 Hilbert matrix is defined by $H=(h_{ij})$, where

`\begin{equation*}`

`h_{ij}=\frac{1}{i+j-1}.`

`\end{equation*}`

The Hilbert matrix in this case is

`\begin{equation*}`

`H=\begin{pmatrix}`

`1 & 1/2 & 1/3\\`

`1/2 & 1/3 & 1/4\\`

`1/3 & 1/4 & 1/5`

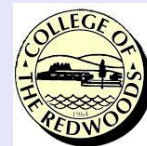
`\end{pmatrix}.`

`\end{equation*}`

The delimiters `\begin{pmatrix}... \end{pmatrix}` produce matrices delimited by parentheses (“p” for parentheses). The delimiters `\begin{bmatrix}... \end{bmatrix}` produce bracketed matrices, while the delimiters `\begin{vmatrix}... \end{vmatrix}` are used to typeset the determinant.

The `amsmath` package also provides a number of environments for typesetting displayed equations in your document. For example, to number and label an equation for future reference, use the `equation` environment.

$$\ln x = \int_1^x \frac{1}{t} dt \quad (1)$$



Now you can refer to this equation (1) later in the narrative.

For example, to number and label an equation for future reference, use the equation environment.

```
\begin{equation}\label{eq:1}
\ln x=\int_1^x\frac{1}{t}\,dt
\end{equation}
```

Now you can refer to this equation~\eqref{eq:1} later in the narrative.

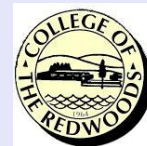
The **align** environment is used to align a sequence of equations. For example, if $a_k = 1/k - 1/(k+1)$, then

$$\begin{aligned}\sum_{k=1}^n a_k &= \sum_{k=1}^n \left(\frac{1}{k} - \frac{1}{k+1} \right) \\ &= \left(1 - \frac{1}{2} \right) + \left(\frac{1}{2} - \frac{1}{3} \right) + \cdots + \left(\frac{1}{n} - \frac{1}{n+1} \right) \\ &= 1 - \frac{1}{n+1}\end{aligned}$$

For example, if $a_k = 1/k - 1/(k+1)$, then

```
\begin{align*}
\sum_{k=1}^n a_k
&= \sum_{k=1}^n \left( \frac{1}{k} - \frac{1}{k+1} \right) \\
&= \left( 1 - \frac{1}{2} \right) + \left( \frac{1}{2} - \frac{1}{3} \right) \\
&\quad + \cdots + \left( \frac{1}{n} - \frac{1}{n+1} \right) \\
&= 1 - \frac{1}{n+1}
\end{align*}
```

[Introduction](#)[Hello World!](#)[Scientific Papers in LaTeX](#)[Getting and Installing a...](#)[Support and Reference...](#)[Home Page](#)[Title Page](#)[◀](#)[▶](#)[◀](#)[▶](#)[Page 13 of 22](#)[Go Back](#)[Full Screen](#)[Close](#)[Quit](#)

[Introduction](#)[Hello World!](#)[Scientific Papers in LaTeX](#)[Getting and Installing a . . .](#)[Support and Reference . . .](#)[Home Page](#)[Title Page](#)[Page 14 of 22](#)[Go Back](#)[Full Screen](#)[Close](#)[Quit](#)

Note that the ampersand `&` is used to align the equations, in this case, on the equal sign on each line. Further, note that a new line in an `align*` environment is indicated with `\\`.³ The construct `\left(`, which must always be matched with a corresponding `\right)`, provides parentheses that expand in height to match what is contained between them. Note that we used `align*`, which suppresses the numbering of equations. Try the above code in a `\begin{align}...\end{align}` environment and note the difference.

The `amsmath` package provides a method for numbering and labelling a block of equations. For example, solve the system

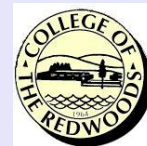
$$\begin{aligned}x_1 + 2x_2 - 3x_3 &= 1 \\ 2x_1 + x_2 + 4x_3 &= 0 \\ -x_1 - x_2 + 5x_3 &= 0\end{aligned}\tag{2}$$

for x_1 , x_2 , and x_3 . Is system (2) nonsingular?

```
For example, solve the system
\begin{equation}\label{sys:1}
\begin{aligned}
x_1+2x_2-3x_3&=1\\
2x_1+x_2+4x_3&=0\\
-x_1-x_2+5x_3&=0
\end{aligned}
\end{equation}
for  $x_1$ ,  $x_2$ , and  $x_3$ . Is system~\eqref{sys:1} nonsingular?
```

The packages from the American Mathematical Society also provide a variety of new symbols. If you place `\usepackage{amssymb}` in the preamble of your document source, then `\mathbb{R}` will produce the symbol used for the set of real numbers by mathematicians.

³Students often use the notation `\\` to generate new lines in their document. You shouldn't do this. The notation `\\` should be reserved for use in `align` environments, tables, etc. It should not be used to start a new line of prose.

[Introduction](#)[Hello World!](#)[Scientific Papers in LaTeX](#)[Getting and Installing a . . .](#)[Support and Reference . . .](#)[Home Page](#)[Title Page](#)[Page 15 of 22](#)[Go Back](#)[Full Screen](#)[Close](#)[Quit](#)

3.6. Including Graphics

Scientific papers usually include a number of graphics, schematics, and diagrams that need to be referenced by the narrative. As we will soon see, the type of graphics that you may use depends on the way you are compiling your document. However, both methods require that you first import the `graphicx` package in the preamble of your document.

```
\documentclass{article}
\usepackage{graphicx}
```

- If you compile using L^AT_EX (what us old-timers used to do), then you need to use Encapsulated Postscript graphics. You would include encapsulated postscript file in your document with:

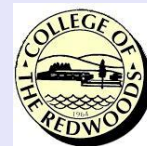
```
\includegraphics{filename.eps}
```

However, nowadays newcomers usually compile in PDFLaTeX, which requires that you use a different type of graphic. If you open a DOS box in Windows or Terminal window on the Mac, the command `epstopdf filename.eps` will convert the encapsulated postscript file to `filename.pdf`.

- If you compile with PDFLaTeX (pdfLaTeX), then you cannot use Encapsulated Postscript graphics. You can only use JPEG, PNG, and PDF graphics. You use a similar technique to include these graphics.

```
\includegraphics{filename.pdf}
```

If you are doing a presentation, then you will probably want to “center” your graphic on your slide in a fixed position. This is easily done as follows:

[Introduction](#)[Hello World!](#)[Scientific Papers in LaTeX](#)[Getting and Installing a . . .](#)[Support and Reference . . .](#)[Home Page](#)[Title Page](#)[Page 16 of 22](#)[Go Back](#)[Full Screen](#)[Close](#)[Quit](#)

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

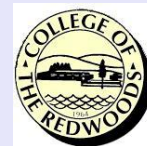
However, inserting graphics in a paper is an entirely different story. In this case, you want \LaTeX to “float” your graphic to an optimal position, where “optimal position” is defined using a strategy that minimizes the amount of white space in your document. When composing your document, it is important that you not try to “force” your graphics into a particular position on the page. That would be counter-productive and a complete waste of your time as added text at a later date might completely change the position of your graphic. The most efficient method is to simply allow \LaTeX complete authority in placing graphics in your paper. Because \LaTeX can “float” a graphic anywhere in your paper, it is extremely important that you label your graphic and then reference the graphic in your narrative.

The proper way to place a graphic in your paper is to use the `figure` environment. Here is an example.

```
\begin{figure}
\centering
\includegraphics{filename.pdf}
\caption{This is your caption text.\label{gears}}
\end{figure}
```

Here are some important observations regarding this example.

1. A “floating” graphic is contained in the figure environment, delimited by the environment `\begin{figure} . . . \end{figure}`.
2. The `\centering` command “centers” the graphic within the figure environment. Note that we do **not** use the `\begin{center} . . . \end{center}` environment to do the centering,



Introduction

Hello World!

Scientific Papers in LaTeX

Getting and Installing a . . .

Support and Reference . . .

Home Page

Title Page



Page 17 of 22

Go Back

Full Screen

Close

Quit

as that would insert a little extra bit of space above and below the graphic. As the environment `\begin{figure}... \end{figure}` already provides a bit of space above and below the graphic, we would wind up with double the needed space. On the contrary, the `\centering` command just centers, without including extra vertical spacing.

3. The `\caption` command allows us to include a caption with our figure. This is usually typeset below the figure and contains text describing key points regarding the figure.
4. Inside the caption command is a `\label`. It is **absolutely required** that all figures are labeled and referenced in your narrative in your paper. This requirement exists due to the fact that the graphic could float anywhere in your document, even to the next page (or to a page after that).
5. Later in your narrative, you must reference your figure as follows:

In Figure~\ref{gears}, we see the result of our efforts.

Note: In your presentation, figures are not “floating.” Rather, they’re centered and “fixed” on each slide. Consequently, labels and references are not necessary.

3.7. Presentations

When you craft your presentation, you are making a summary of your paper on individual slides, which you will use to accompany your talk in front of the class. Unlike your paper, your presentation does not usually include long mathematical derivations, as these would be difficult for your audience to follow. Rather, your presentation is a sequence of “conclusions” slides. For example, if we “do this and that,” the result is “this.”

There are a number of L^AT_EX packages that produce slides for presentations, but your best bet is to use the L^AT_EX “beamer” application. There is a manual of use at:

<http://www.ctan.org/tex-archive/macros/latex/contrib/beamer/doc/beameruserguide.pdf>

However, the user guide is huge (approximately 248 pages), so you might want to get started by trying a tutorial written by Reuben Rostamian.

A Beamer Quickstart

A google search will produce a number of further links with beamer instructions and examples. For example, consider the tutorial written by Charles Batts from the University of North Carolina at Greensboro.

Charles Batts Beamer Tutorial

3.8. The Bibliography

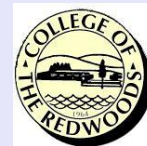
Any good writer will include a list of references at the end of her paper. Researchers with vast arrays of reference materials will use an application called BiBTeX to manage citations. However, for smaller papers, it is probably easier to manage your own references. So, how to proceed?

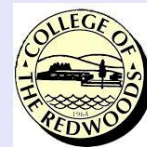
At the end of your paper, start a new section between a `\begin{thebibliography}{99}...` `\end{thebibliography}` pair. In this scenario, citations will be numbered in the output. The number 99 is used to save space. It is not saying that you expect to list 99 references. Rather, you are reserving space for the numbers of your references, and you don't expect that any number in your list will take up more space than the number 99.

Once you have started your environment, list your references with the `\bibitem` command. A completed bibliography will look something like this.

```
\begin{thebibliography}{99}
\bibitem{kn:gnus} D. E. Knudson. {\em 1966 World Gnus Almanac.}
\end{thebibliography}
```

Finally, in your source, should you want to reference one of the works in your bibliography, use `\cite{kn:gnus}`.

[Introduction](#)[Hello World!](#)[Scientific Papers in LaTeX](#)[Getting and Installing a ...](#)[Support and Reference ...](#)[Home Page](#)[Title Page](#)[Page 18 of 22](#)[Go Back](#)[Full Screen](#)[Close](#)[Quit](#)

[Introduction](#)[Hello World!](#)[Scientific Papers in LaTeX](#)[Getting and Installing a . . .](#)[Support and Reference . . .](#)[Home Page](#)[Title Page](#)[Page 19 of 22](#)[Go Back](#)[Full Screen](#)[Close](#)[Quit](#)

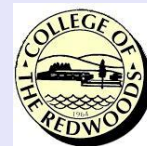
4. Getting and Installing a TeX System

The first step is downloading all of the software that you will need. We list the appropriate links for you here. Note that a complete TeX system requires extensive downloading of files, which really takes a long time using modem and dial up connections. Therefore, you might want to download the necessary files in the lab and then transfer them to a flash drive.

4.1. Windows Installation

The following are instructions for setting up a TeX environment on a PC using the Windows operating system.

- Install Ghostscript, a postscript viewer. Visit the ghostscript.com site.
 1. You first need to determine whether your PC is a 32-bit or a 64-bit machine. Open your file folder, then right-click on on This PC or My Computer, depending on your version of Windows, then select Properties. You will then be able to read the properties to determine if you have 32-bit or 64-bit.
 2. To install Ghostscript, first go to [Ghostscript Downloads](#). Select the appropriate free Ghostscript GPL Release, depending on whether you are 32-bit or 64-bit. Save the file to your Desktop. Once the download is complete, double click the .exe download file, then just keep clicking all the default steps. To see if it runs, go to your applications and click on Ghostscript. You can delete the downloaded .exe file from the desktop.
- Install the [Adobe Reader](#). You'll need to select your operating system from the site on the drop down list, then your language, then we suggest you do not select the DC reader version. Once the download is complete, it is an easy install. Just double-click the executable and accept all defaults when prompted.
- Install [MiKTeX](#). Read the instructions on the [Install MiKTeX](#) site, then click the link for the download page, then click the Basic MiKTeX Installer. This is not a full installation



Introduction

Hello World!

Scientific Papers in LaTeX

Getting and Installing a . . .

Support and Reference . . .

Home Page

Title Page

◀ ▶

◀ ▶

Page 20 of 22

Go Back

Full Screen

Close

Quit

of everything $\text{T}_{\text{E}}\text{X}$ but $\text{MikT}_{\text{E}}\text{X}$ has a package management system that will automatically download needed packages on-the-fly. Once the install begins, accept all of the defaults save one: choose US Letter Paper instead of the European A4 paper. It is highly advisable that you allow $\text{MikT}_{\text{E}}\text{X}$ to install files where it wants. Don't change any paths during the installation.

- Miktex now comes with a TeX editor called TeXworks. Click on your Apps button on the lower left corner of your taskbar and select All apps. Slide down and click on Miktex 2.9, then slide down and click on TexWorks. Once it opens, you will see it on your taskbar. You can Ctrl+Right Click the TeXworks icon on your taskbar, then select “Pin to taskbar.”
- Alain Delmotte, Stefan Löffler, and others hav written a short manual of use which you can download at the following link:

TeXworks Manual

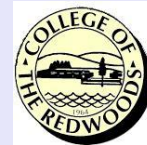
You can also select the menu Help→A short manual for TeXworks to download this manual.

- Test your installation following the “Hello World” example outlined in Section 2, **Hello World!**.

4.2. Macintosh Installation

Installation on the Macintosh is considerably simpler.

- Visit the **MacT_EX** site and download **MacTeX.mpkg.zip**. This is a universal package, so it will install equally well on Snow Leopard, Lion, Yosemite, or El Capitan operating systems, with or without Intel processors. This is a HUGE download (approximately 1.18 GB), as it is a *complete* $\text{T}_{\text{E}}\text{X}$ system. Once the download is complete, installation is a breeze. The Mac should automatically unzip and mount the package and start the installation. Simply accept all of the defaults during the installation.



Introduction

Hello World!

Scientific Papers in LaTeX

Getting and Installing a . . .

Support and Reference . . .

Home Page

Title Page

◀ ▶

◀ ▶

Page 21 of 22

Go Back

Full Screen

Close

Quit

- It is not necessary to install a separate editor because the installation comes with a preinstalled version of T_EXShop. Open your Applications folder, browse to the newly installed TeX folder where you will find an icon for the T_EXShop application. Double-click this icon to start up T_EXShop. You might want to “Keep” the application in your dock for the future. *Note: If you want to use TeXworks on the Mac so that you can work with the same editor as Windows users, you will also find TeXworks in the TeX folder in your Applications folder.*
- Test your installation following the “Hello World” example outlined in Section 2, **Hello World!**. Enter the “Hello World” program in the T_EXShop editor, select L^AT_EX and Pdftex from the Typeset menu, then select Typeset from the Typeset menu. T_EXShop comes with an excellent help file detailing how to use the system.

4.3. Emacs + AuCT_EX

Finally, in fairness, there is an alternate plan for installation, one that involves MiKTeX, AucTeX, and Emacs, one of the world’s most powerful editors, usually used by people on UNIX and Linux systems, but now being ported to Windows. All of the applications named are freeware. Try steps 1, 2, and 3, at this page:

<http://www.gnu.org/software/auctex/download-for-windows.html>

Macintosh users can obtain the same experience by downloading Aquamacs at:

Aquamacs

Should you choose this path. Be cautioned! If you’re new to T_EX, this is probably not a path to choose. This path is for experts!

5. Support and Reference Materials

There is a huge amount of information on $\text{T}_{\text{E}}\text{X}$ and $\text{L}^{\text{A}}\text{T}_{\text{E}}\text{X}$ on the web. There are also a large variety of texts written on $\text{T}_{\text{E}}\text{X}$ and $\text{L}^{\text{A}}\text{T}_{\text{E}}\text{X}$. Let's begin with the books.

- *The $\text{T}_{\text{E}}\text{X}Book$* , Donald Knuth, Addison Wesley. This is the *definitive* source on $\text{T}_{\text{E}}\text{X}$ written by the person who created $\text{T}_{\text{E}}\text{X}$. Any serious mathematics and/or science student should have this text on their shelf.
- *$\text{L}^{\text{A}}\text{T}_{\text{E}}\text{X}$, A Document Preparation System. User's Guide and Reference Manual*, Leslie Lamport, Addison Wesley. This is the definitive guide for $\text{L}^{\text{A}}\text{T}_{\text{E}}\text{X}$, written by the creator of $\text{L}^{\text{A}}\text{T}_{\text{E}}\text{X}$.
- There are a number of free tutorials on the web. I list four of the finest I know about.

1. A *Gentle Introduction to $\text{T}_{\text{E}}\text{X}$* is just that, one of the easiest introductions to the $\text{T}_{\text{E}}\text{X}$ language I've seen. About 100 pages, and once you're through, you are pretty proficient in the use of plain $\text{T}_{\text{E}}\text{X}$. *Note: this is $\text{T}_{\text{E}}\text{X}$, not $\text{L}^{\text{A}}\text{T}_{\text{E}}\text{X}$, which we will be using in class.*

<https://www.ctan.org/tex-archive/info/gentle/?lang=en>

2. The *Not So Short Introduction to $\text{L}^{\text{A}}\text{T}_{\text{E}}\text{X}2\epsilon$* is an excellent beginner's tutorial for the $\text{L}^{\text{A}}\text{T}_{\text{E}}\text{X}$ language.

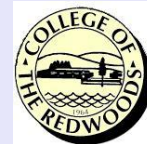
<https://tug.ctan.org/info/lshort/english/lshort.pdf>

3. For graphics in $\text{L}^{\text{A}}\text{T}_{\text{E}}\text{X}$ documents, there are several methods. One of the easiest methods is tikz.

<http://ctan.mirror.rafael.ca/graphics/pgf/base/doc/pgfmanual.pdf>

4. Finally, an excellent introduction to the math constructs of the American Mathematical Society's `amsmath` package is the *User's Guide for the amsmath Package*.

<http://www.tug.org/tetex/tetex-texmfdist/doc/latex/amsmath/amslatex.pdf>



Introduction

Hello World!

Scientific Papers in $\text{L}^{\text{A}}\text{T}_{\text{E}}\text{X}$

Getting and Installing a . . .

Support and Reference . . .

Home Page

Title Page

◀ ▶

◀ ▶

Page 22 of 22

Go Back

Full Screen

Close

Quit