LaTeX Guide for UIUC Physics 582

For this course you will be expected to prepare your exercise solutions in LaTeX format. This is not just to make your life difficult, LaTeX is a tool that you will need in your physics career. Other word processing programs, such as Microsoft Word, are *not* an acceptable substitute.

1 Installation

LaTeX is a set of macros which sit on top of TeX. You will need access to a text editor and a version of LaTeX. A guide to downloading and installing a version of LaTeX may be found at tug.org. On Mac OSX, TeXShop is a great freely available TeX editor. Similar packages exist on all other platforms. If you are using departmental computers, then LaTeX should already be installed and available for your use (for examples, the Windows computers in 257 and 390T have MikTeX and TeXworks installed).

2 Editing Process

The editing process when working with LaTeX generically has the following pattern:

1. Prepare a filename.tex file using your favorite text editor. This file will contain a set of formatting commands, as well as the text of your document.
2. Pass your filename.tex file to LaTeX. LaTeX will produce a .dvi file. This in turn may be converted to pdf or ps formats.
3. Make corrections to your *.tex file and pass it off to LaTeX again. Repeat until all TeX errors have been eliminated and pdf output has been generated.

TeX packages such as TeXShop and MikTeX provide an editor and streamline the processing for you.

3 Actually Doing Your Exercises

To help you complete your exercises, we have provided you with a template file. This file contains the basic formatting necessary to create a *.tex file, all you have to provide are the answers (preferably correct). Almost all LaTeX commands have the format `\command{argument}`. For example the commands `\begin{document}` and `\end{document}` indicate the beginning and ending of all editible content. In the body of your document you will also need to include various environments. An example relevant for the exercises is the enumerate environment induced by the commands `\begin{enumerate}` and `\end{enumerate}`. This environment keeps a numbered list of points.

For our purposes, the most important environments are those which allow mathematical characters to be typed. Mathematical expressions used outside of these environments will not be parsed. There are several such environments:

1. Inline Math Mode - This environment is induced by `$expression$`. LaTeX knows to interpret all commands between the `$` signs as mathematical expressions. For example, `pig $2^n$ latin` in the .tex file produces pig 2^n latin in the output.

2. Equation Mode - This environment is induced by the commands `\begin{equation}` and `\end{equation}`. The result is to produce the equation on its own line. In addition, by default the equations are numbered throughout the document. for example `\begin{equation} \int_0^\infty dx\ e^{-x}=1\end{equation}` produces :

$$\int_0^\infty dx\ e^{-x} = 1 \tag{1}$$

3. Equation Array Mode - This environment is called upon by `\begin{eqnarray}` and `\end{eqnarray}`. This produces an array of equations, each numbered separately by default. For example: `\begin{eqnarray} 2+3 &=& 5 \\ 1 &=& 4-3 \end{eqnarray}` yields:

$$2+3 = 5 \tag{2}$$
$$1 = 4-3. \tag{3}$$

   Notice that the characters lying between the `&` symbols are aligned vertically. Also, the `\\` indicates a newline.

In any of these math modes, there are a variety of *macros* available to create special characters (these will not work outside of math mode). Examples include Greek letters `\alpha,\beta`,... and math symbols such as `\int,\sum,\prod` (each of these can take subscripts (via `_`) and superscripts (via `^`). The example in equation (1) contains many of these. Note that curly braces `{...}` are used to delineate how an operation acts.

Eventually, you may want to also define your own macros to save repetitive typing; to do so, one can use `\newcommand`.

The above environments are probably sufficient for our exercises. All that remains is to fill them with interesting content. Now we come to the primary reason that people use LaTeX it looks so good that even wrong answers look right. From within any of the math environments you may call upon various mathematical symbols.

command	result
`a^b` or `a^{b}`	a^b
`a_{b}`	a_b
`\frac{a}{b}`	$\frac{a}{b}$
`\int_{0}^{\infty}`	$\int_0^\infty$
`\sum_{n=1}^N`	$\sum_{n=1}^N$
`\vec{a}`	$\vec{a}$
`\alpha`	α
`\Delta`	Δ

More complete lists may be found on the web. A simple Google search found LaTeX Math Symbols. There are probably hundreds of similar sites.

In addition to the math symbols you should beware that math modes omit spaces between characters. To force a space you may use a `\` followed by a space. (`$ a b $` produces ab, while `$ a\ b $` produces $a\ b$) Also, because LaTeX uses `{` in the command structures, you must use `$ \{ $` to print { on the screen in a math mode.

LaTeX does not interpret multiple blank lines in a tex file as skipped lines in the output. In general, the text following multiple blank lines are interpreted simply as a new paragraph, which is indented. To force LaTeX to skip multiple lines, you may use the `\bigskip` command. For more information about spacing, tabbing, and indenting consult an online guide.

Let's finish by looking at a sample exercise file. Suppose we had two exercises, (1) to prove that $\gamma^\mu \not{a} \not{b} \gamma_\mu = 4a\cdot b$ and (2) to show that Tr $\gamma^\mu\gamma^\nu = 4\eta^{\mu\nu}$. (Don't worry if you don't know what these mean, you will in a few months.) A solution tex file might look like (obtained by modifying the template.tex file):

```
% here is a template for 582 exercises. You need to modify
% the title (each time), your name and the exercise numbering
% for each exercise, copy and paste a new \item element

\documentclass{article}
% package for figure graphics
%
%\usepackage{graphicx}

% math fonts, special symbols, etc.
\usepackage{amsmath,amssymb,amsfonts}

\textwidth = 6.5 in \textheight = 9 in \oddsidemargin = 0.0 in
\evensidemargin = 0.0 in \topmargin = 0.0 in \headheight = 0.0 in
\headsep = 0.0 in
\parskip = 0.2in
\parindent = 0.0in

% document begins
\begin{document}
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%
% editable content starts below
%

%change date here as appropriate
\title{UIUC Physics 582: Exercises for 2006-09-24% put date of exercise assignment
%(lecture) here }

% put your name here
\author{Sean Nowling}
\maketitle

%beginning of exercises
\begin{enumerate}




% each exercise should begin with an \item as follows
\item {\bf Exercise 1.1 %edit the c.n appropriately}:
```

```
% text in the body, but not in any math mode essentially prints as you
% type it.

Blah Blah Blah implies Blah Blah Blah therefore

% note that skipped lines in the tex file are not reproduced in the out put




% here we begin a new equation
\begin{equation}
        \gamma^\mu \cancel{a}\cancel{b}\gamma_\mu = 4a\cdot b
\end{equation}

(no answers here, I want to save some fun for later in the semester)


% each exercise should begin with an \item as follows
\item {\bf Exercise 1.2 %edit the c.n appropriately}:

% this time I will use the equation array math mode
\begin{eqnarray}
        \mathrm{statement}\ \mathrm{1}
                &\rightarrow&  \mathrm{statement}\ \mathrm{2}\\
        \mathrm{insert}\ \mathrm{facts}  &&   \nonumber\\
        &\Rightarrow& \mathrm{Tr}\ \gamma^\mu\gamma^\nu=4\eta^{\mu\nu}
\end{eqnarray}

% the command \mathrm{...} prevents the math modes from affecting how letters are displayed
% (rm stands for Times Roman)

% the \\ tells the equation array mode to start a new line
% the \nonumber prevents an equation number from printing

% end of exercises
\end{enumerate}

% end of document
\end{document}
```

(Note that % is used for comments.)

The body of the output file would look like:

1. **Exercise 1.1** : Blah Blah Blah implies Blah Blah Blah therefore

$$\gamma^\mu \not{a}\not{b}\gamma_\mu = 4a\cdot b \tag{1}$$

   (no answers here, I want to save some fun for later in the semester)

2. **Exercise 1.2** :

$$\begin{aligned} \text{statement 1} &\rightarrow \text{statement 2} && (2) \\ \text{insert facts} & \\ &\Rightarrow \text{Tr } \gamma^\mu \gamma^\nu = 4\eta^{\mu\nu} && (3) \end{aligned}$$

This should be enough to get you started. There are many nice guides on the web, a good general reference is the tug.org site. As with most things, the best way to learn is through practice. Eventually you will memorize most common commands, making LaTeX much faster than using Word or any similar word processor.